

Ontario Provincial Standards for Roads and Public Works



- Volume 5 -

PROVINCIAL-ORIENTED

MTO GENERAL CONDITIONS OF CONTRACT AND
GENERAL & CONSTRUCTION SPECIFICATIONS



OPS is co-owned by the
Ministry of Transportation, Ontario
and the
Municipal Engineers Association



Municipal
Engineers
Association

MANUAL REVISION RECORD

Provincial-Oriented

Volume 5 – MTO General Conditions of Contract and General & Construction Specifications

This record should remain in the manual at all times. Revisions are numbered sequentially. This sheet should be filled in after each revision has been placed into the manual. It will quickly indicate to users whether the contents of the manual are up-to-date.

REVISION NUMBER	REVISION DATE	ENTERED BY	REVISION NUMBER	DATE	ENTERED BY
1	April 2008	Included in new manuals	25	April 2022	Included in new manuals
2	Nov 2008	Included in new manuals	26	Nov 2022	Included in new manuals
3	Apr 2010	Included in new manuals	27	Apr 2023	Included in new manuals
4	Nov 2010	Included in new manuals	28	July 2023	Included in new manuals
5	Apr 2012	Included in new manuals	29		
6	Nov 2012	Included in new manuals	30		
7	Nov 2013	Included in new manuals	31		
8	Nov 2014	Included in new manuals	32		
9	April 2015	Included in new manuals	33		
10	Nov 2015	Included in new manuals	34		
11	April 2016	Included in new manuals	35		
12	Nov 2016	Included in new manuals	36		
13	April 2017	Included in new manuals	37		
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18	Nov 2019	Included in new manuals	42		
19	April 2020	Included in new manuals	43		
20	Nov 2020	Included in new manuals	44		
21	Jan 2021	Included in new manuals	45		
22	Apr 2021	Included in new manuals	46		
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24	Dec 2021	Included in new manuals	48		



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SECTION GC 1.0 - INTERPRETATION

GC 1.01 Captions

- .01 The captions appearing in these MTO General Conditions of Contract have been inserted as a matter of convenience and for ease of reference only and in no way define, limit, or enlarge the scope or meaning of these MTO General Conditions of Contract or any provision hereof.
- .02 In the event of a conflict of a reference to the number and caption of a section, subsection, clause, or paragraph, reference shall be made to the caption.

GC 1.02 Abbreviations

- .01 The abbreviations listed on the left below are commonly found in the Contract Documents and represent the organizations and phrases listed on the right:

AASHTO	- American Association of State Highway Transportation Officials
ANSI	- American National Standards Institute
ASTM	- ASTM International - formerly American Society for Testing and Materials
AWG	- American Wire Gauge
AWWA	- American Water Works Association
CGSB	- Canadian General Standards Board
CSA	- CSA Group - formerly Canadian Standards Association
CVOR	- Commercial Vehicle Operator's Registration
CWB	- Canadian Welding Bureau
DSM	- Designated Sources for Materials
GC	- MTO General Conditions of Contract
MECP	- Ministry of the Environment, Conservation and Parks
MOE	- Ministry of the Environment, now MECP
MOECC	- Ministry of the Environment and Climate Change (Ontario), now MECP
MTC	- Ministry of Transportation and Communications, now MTO
MTO	- Ontario Ministry of Transportation
MUTCD	- Manual of Uniform Traffic Control Devices, published by MTO
OPS	- Ontario Provincial Standards
OPSD	- Ontario Provincial Standard Drawing
OPSS	- Ontario Provincial Standard Specification
OTM	- Ontario Traffic Manual
PDF	- Portable Document Format
PEO	- Professional Engineers Ontario
SAE	- SAE International - formerly Society of Automotive Engineers
SSPC	- Structural Steel Painting Council
TRA	- The Road Authority
UL	- Underwriters Laboratories
ULC	- Underwriters Laboratories Canada

GC 1.03 Gender and Singular References

- .01 References to the masculine or singular throughout the Contract Documents shall be considered to include the feminine and the plural and vice versa as the context requires.

GC 1.04 Ontario Provincial Standards

- .01 Regardless of the publishing date on OPSSs and OPSDs contained in the OPS manuals and on a MTO website, the Standards applicable to this Contract are listed in the schedule of Provisions, Plans, Standard Drawings, Specifications, and MTO General Conditions of Contract, with the exception the version of OPSS 127 that is current at the time the work is carried out shall apply.

- .02 When an OPSS contains an appendix, the appendix is deleted in its entirety and is not invoked unless specified elsewhere in the Contract Documents. When an appendix is invoked, the information contained in the appendix shall form part of the specification.
- .03 When an OPS specification refers to the Canadian Highway Bridge Design Code; CSA Standard S6-00 or CSA Standard S6-06 or CSA Standard S6-14, it shall be deemed to mean CSA Standard S6:19.
- .04 When an OPS specification refers to the Ministry of the Environment (MOE) or Ministry of the Environment and Climate Change (MOECC), it shall be deemed to mean Ministry of the Environment, Conservation and Parks (MECP).
- .05 When an OPS specification refers to Material Safety Data Sheets (MSDS), it shall also be deemed to mean Safety Data Sheets (SDS).
- .06 When the Contract refers to an address listed in the left column of the following table; it shall be deemed to be the updated address:

Address	Updated Address
Room 15, 145 Sir William Hearst Avenue Downsview, Ontario, M3M 0B6	95 Arrow Road, Shipping Entrance Toronto, Ontario M9M 2L4
Room 15, Building C, 1201 Wilson Avenue Downsview, ON M3M 1J8	
Materials Engineering and Research Office, Ministry of Transportation of Ontario, Room 233, 145 Sir William Hearst Avenue Downsview, Ontario, M3M 0B6	Engineering Materials Office Ministry of Transportation 95 Arrow Road Toronto, Ontario M9M 2L4
Material Engineering and Research Office, 1201 Wilson Avenue, Downsview, M3M 1J8	
Concrete Section, Ministry of Transportation of Ontario, Room 235, 145 Sir William Hearst Avenue Downsview, Ontario, M3M 0B6	Concrete Section, Engineering Materials Office Ministry of Transportation 95 Arrow Road Toronto, Ontario M9M 2L4
Concrete Section Ministry of Transportation of Ontario 1201 Wilson Avenue Downsview, Ontario, M3M 1J8	
Purchasing and Supply Office Ministry of Transportation, 1201 Wilson Avenue, Downsview, Ontario, M3M 1J8	
Bituminous Section Ontario Ministry of Transportation Room 15, 145 Sir William Hearst Avenue Downsview, Ontario M3M 0B6	Bituminous Section, Engineering Materials Office Ministry of Transportation 95 Arrow Road Toronto, Ontario M9M 2L4

GC 1.05**Ontario Traffic Manual**

- .01 All references in the Contract Documents to the MUTCD, including all Parts and Divisions thereof, or MTO Traffic Control Manual for Roadway Work Operations, or Traffic Control Manual for Roadway Operations Field Edition are hereby deleted and replaced by the following books of the Ontario Traffic Manual:
- Book 1 - Introduction to the Ontario Traffic Manual;
 - Book 1A - Illustrated Sign and Signal Display Index;
 - Book 1B - Sign Design Principles;
 - Book 1C - Positive Guidance Toolkit;
 - Book 5 - Regulatory Signs;
 - Book 6 - Warning Signs;
 - Book 7 - Temporary Conditions (and Temporary Conditions Field Edition);
 - Book 11 - Pavement, Hazard and Delineation Markings;
 - Book 12 - Traffic Signals.
- .02 Any reference in the Contract Documents to OTM shall be deemed to be the Ontario Traffic Manual Books 1, 1A, 1B, 1C, 5, 6, 7, 11, and 12.
- .03 The Contractor shall comply with the applicable requirements of the above OTM books.

GC 1.06**Conflict of Interest**

- .01 The Contractor, any of the Subcontractors and any of their respective advisors, partners, directors, officers, employees, agents, and volunteers shall not engage in any activity or provide any services to the Minister where such activity or the provision of such services, creates a conflict of interest (actually or potentially in the sole opinion of the Minister) with the provision of services pursuant to this Contract. The Contractor acknowledges and agrees that it shall be a conflict of interest for it to use confidential information of the Crown relevant to the services where the Minister has not specifically authorized such use.
- .02 The Contractor shall disclose to the Minister, without delay, any actual or potential situation that may be reasonably interpreted as either a conflict of interest or a potential conflict of interest.
- .03 A breach of this section by the Contractor shall entitle the Minister to terminate the Contract, in addition to any other remedies that the Minister has in this Contract, in law or in equity.

GC 1.07**Definitions**

For the purpose of this Contract, the following definitions apply:

Abnormal Weather means an extreme climatic condition characterized by wind speed, air temperature, precipitation, or snowfall depth, that is less than or greater than 1½ standard deviations from the mean determined from the weather records of the 25 years immediately preceding the tender opening date.

Access Road means a private road built or existing road used by the Contractor to gain access to the Work or to a source of material.

Actual Measurement means the field measurement of that quantity within the approved limits of the Work.

Addendum means an addition to or a change in the Contract Documents issued prior to tender closing.

Additional Work means work not provided for in the Contract and not considered by the Contract Administrator to be essential to the satisfactory completion of the Contract within its intended scope.

Adjudication means as defined under Part II.1 of the *Construction Act*.

Aggregate means gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, or rock other than metallic ores, slag, and clinkers.

Agreement means the signed document between the Minister or delegated representative and the Contractor for the performance of the Work included in the Contract Documents.

Base means a layer of Material of specified type and thickness placed immediately below the Pavement, driving surface, finished grade, curb with gutter, or sidewalk.

Basic Holdback means the statutory holdback, equal to 10% of the services or Materials as they are supplied under the Contract, required to be retained pursuant to the *Construction Act*.

Bonds means both the Contract Bonds and the Statutory Bonds prescribed in the Contract Documents.

Business Day means any Day which is not:

- a) A Saturday or a Sunday; or
- b) A Day observed as a holiday under the laws of the Province of Ontario or the federal laws of Canada applicable to the Province of Ontario.

Certificate of Conformance means a MTO form PH-CC-822 issued by an Engineer confirming that the specified components of the Work are in conformance with the Contract Documents.

Change in the Work means the deletion, extension, increase, decrease, or alteration of lines, grades, dimensions, quantities, methods, drawings, changes in the character of the work to be done, or Materials of the Work or part thereof, within the intended scope of the Contract.

Change Order means a written order to the Contractor covering contingencies, Extra Work, increase or decrease in Contract quantities, and additions or alterations to the plans or specifications, within the scope of the Contract and establishing the basis of payment. Also means, a written authorization covering Additional Work.

Change Proposal means a proposal by the Contractor for a modification to the Contract Documents that is expected to result in design improvement benefits or a reduction in costs or both, or Contract Time.

Claim means the submission of a dispute for review under the clause GC 3.15.01, Claim Review Process.

Commercial Motor Vehicle means as defined under Section 16 of the *Highway Traffic Act*, R.S.O. 1990, c. H.8, as amended (*Highway Traffic Act*).

Commercial Source means a place where Aggregate or a product containing Aggregate is made available for sale.

Compensation Request means a request submitted to the Contract Administrator, in writing, for a modification in payment and/or Contract Time from the original tender.

Construction Act means the *Construction Act*, R.S.O. 1990, c.C.30, as amended.

Construction Signs means all traffic control devices and signs, including vehicles, trailers, and the like that are provided to support signs, and equipment to supply sign lighting, but excludes Contract identification signs and Highway number markers, all as may be described in the OTM.

Constructor means for the purposes of, and within the meaning of the *Occupational Health and Safety Act*, R.S.O. 1990, c. O.1, as amended, the Contractor who executes this Contract.

Contract means the undertaking by the Owner and the Contractor to perform their respective duties, responsibilities, and obligations as prescribed in the Contract Documents.

Contract Bonds means the surety bonds executed by the Contractor and its Surety prescribed in the Contract Documents but does not include Statutory Bonds.

Contract Administrator means the person, partnership, or corporation designated by the Owner to be the Owner's representative for the purposes of the Contract.

Contract Bulletin means a publication of MTO on the MTO's website www.raqs.merx.com.

Contract Completion means the Work has passed all inspection and testing requirements, the Contractor has rectified all deficient Work, and the Contractor has fulfilled all obligations under the Contract, except warranty obligations.

Contract Completion Certificate means the certificate issued by the Contract Administrator at Contract Completion.

Contract Documents means the Agreement, Tender, MTO General Conditions of Contract, Standard Specifications and Standard Drawings, Special Provisions, Contract Drawings, Addenda incorporated into any aforementioned document, documents referenced in the aforementioned documents, and subsequent amendments to any of these documents made pursuant to the provisions of the Agreement.

Contract Drawings or **Contract Plans** mean drawings or plans provided by the Owner for the Work and without limiting the generality thereof may include soil profiles, foundation investigation reports, reinforcing steel schedules, aggregate sources lists, quantity sheets, and cross-sections.

Contract Time means the time stipulated in the Contract Documents for completion of the Work, including any extension of Contract Time made pursuant to the Contract Documents.

Contractor means the person, partnership, or corporation undertaking the Work as identified in the Agreement.

Contractor's Intellectual Property means Intellectual Property owned by the Contractor prior to its performance under this Contract or created by the Contractor during this Contract independently of the performance of Contractor obligations under this Contract.

Controlling Operation means any component of the Work that, if delayed, will delay the completion of the Work.

Cut-off Date means the date up to which a progress payment shall be made for work performed.

CVOR Abstract means a level 1 Commercial Vehicle Operator's Registration (CVOR) abstract obtained from MTO.

CVOR Certificate means a Commercial Vehicle Operator's Registration certificate issued under the *Highway Traffic Act*.

CVOR Holder means a person or company to whom a CVOR Certificate was issued that has not been cancelled nor currently under suspension.

Daily Work Records means daily records for any part of the Work detailing the work in question, names, and categories of workers and hours worked or on standby; types and quantities of Equipment and number of hours in use and/or on standby; and description and quantities of Material used.

Day means a calendar day.

Decision means a written response to a Compensation Request or a Claim issued to the Contractor, that includes the Rationale and any quantum.

Earth Grade means the earth surface, whether in cut or fill, as prepared for the Base or Subbase.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Environmental Incident means an event such as a spill, discharge, emission, release, or escape of a material, pollutant, contaminant, deleterious substance, or dangerous good as defined in the legislation referenced in paragraph .01 of clause GC 7.13.02, Environmental Incident Management Under Legislation Protecting the Environment and Natural Resources.

Equipment means all machinery and equipment used for preparing, fabricating, conveying, or erecting the Work and normally referred to as construction machinery and equipment.

Estimate means a calculation of the quantity or cost of the Work or part of it, depending on the context.

Extra Work means Change in the Work.

Finishing Work means the Work to be completed after certification of substantial performance and prior to and necessary to be supplied or performed to complete the Contract.

Finishing Work Deficiency List means a list of deficiencies and Work yet to be completed, identified independently by the Contractor and the Contract Administrator.

Grade means the required elevation of work.

Grade Line means a reference line representing the Grade in profile or longitudinal section established for the control of work.

Hand Tools means tools that are commonly called tools or implements of the trade and include small power tools. Individually, a tool shall be considered as a Hand Tool where the maximum cost is \$400.

Haul Road means any public road excluding the road under Contract that forms part of a Material haul route.

Highway means a common and public highway any part of which is intended for or used by the general public for the passage of vehicles and includes the area between the lateral property lines thereof.

Holdback for Finishing Work means the statutory holdback, equal to 10% of the Finishing Work, required to be retained pursuant to the *Construction Act*.

Inclement Weather means weather conditions or conditions that result immediately there from that prevents the Contractor from proceeding with the Controlling Operation.

Information Request means a request submitted to the Contract Administrator, in writing, seeking clarification of or information regarding the Contract Documents.

Inspector means any person, partnership, or corporation appointed by the Contract Administrator to participate in the inspection of the Work and the Material to be used in the Work.

Intellectual Property means any intellectual, industrial, or other proprietary right of any type in any form protected under the laws of Canada, any foreign country, or any political subdivision of any country, including, without limitation, any intellectual, industrial, or proprietary rights protected by legislation, by common law, or at equity.

Labour and Material Payment Bond means the type of security furnished to the Owner to guarantee payment of prescribed debts of the Contractor covered by the bond.

Lump Sum Item means a tender item indicating a portion of the Work for which payment shall be made at a single tendered price. Payment is not based on a measured quantity, although a quantity may be given in the Contract Documents.

Major Item means any tender item that has a value, calculated on the basis of its actual or estimated tender quantity, whichever is the greater, multiplied by its tender unit price, which is equal to or greater than the lesser of:

- a) \$200,000; or
- b) 5% of the total tender value calculated on the basis of the total of all the estimated tender quantities and the tender unit prices.

Manufacturer's Certificate of Conformance means a MTO form PH-CC-821 issued by an Engineer confirming that the fabrication and required testing has been carried out on a component or product in conformance with the Contract Documents.

Material means material, machinery, equipment, and fixtures forming part of the Work.

Newly Created Intellectual Property means any Intellectual Property created by the Contractor in the course of performance of the Contractor's obligations under this Contract.

Notice of Adjudication means as defined under Part II.1 of the *Construction Act*.

Notice to Proceed means a MTO form PH-CC-702 issued by the Contract Administrator notifying the Contractor to proceed to the next operation.

Owner means the party to the Agreement for whom the Work is being performed, as identified in the Agreement, and includes, with the same meaning and import, "Authority."

Pavement means a wearing course or courses placed on the Roadway and consisting of asphaltic concrete, hydraulic cement concrete, or other bituminous surfaces.

Performance Bond means the type of security furnished to the Owner to guarantee completion of the Work according to this Contract and to the extent provided in the bond.

Person means an individual, corporation, partnership, joint venture, association, trust, pension fund, union, governmental agency, board, tribunal, ministry, commission, or department and the heirs, beneficiaries, executors, legal representatives, or administrators of a person to whom the context can apply according to law.

Plan Quantity means that quantity as computed from within the boundary lines of the Work as shown in the Contract Documents.

Profile Grade means the required elevation of the surface of the Base.

Proper Invoice means as defined in the *Construction Act*, supported by quantity of Work completed sheets, and that complies with the requirements of the Contract Documents.

Quantity Sheet means a list of the locations, estimated design quantities, and other details of Work to be completed for tender items.

Quarried Rock means material removed from an open excavation made in a solid mass of rock that was integral with the parent mass prior to removal.

Quarry means a place where Aggregate has been or is being removed from an open excavation made in a solid mass of igneous, sedimentary, or metamorphic rock or any combination of these that was integral with the parent mass prior to removal.

Rate of Interest means the prejudgment interest rate determined according to subsection 127 (2) of the *Courts of Justice Act*.

Rationale means the reason(s) given to explain a Decision, response, or action.

Record Drawings mean marked-up Contract Drawings prepared by the Contractor that show all differences, design changes, and deviations from the original Contract Drawings.

Records mean any books, payrolls, accounts, or other information that relate to the Work or any Change in the Work or Claims arising there from.

Regional Operations Office means the Operations Office in the MTO Region administering the Contract.

Release from Warranty Certificate means the certificate prepared by the Owner releasing the Contractor from all warranty obligations at the end of the last expiring warranty period.

Request to Proceed means a MTO form PH-CC-701 issued by the Contractor notifying the Contract Administrator that a component or stage of the work has been completed in conformance with the Contract Documents.

Road Allowance means the lands acquired at any time for use as a Highway.

Roadbed means that part of the Work which is designed to support the Roadway.

Roadway means that part of the Highway designed or intended for use by vehicular traffic and includes the shoulders.

Rock Grade means the rock surface, whether in cut or fill, that has been prepared for the Base or Subbase.

Shoulder means that portion of the Roadway between the edge of the travelled lane and the top inside edge of the ditch or fill slope.

Special Provision means special direction within the Contract Documents containing requirements particular to the Work.

Standard means, when used alone, the generic term for Standard Specifications and Standard Drawings.

Standard Specification or **Standard Drawing** means a standard practice required and stipulated by the Owner for performance of the Work.

Statutory Bonds means the surety bonds executed by the Contractor and its Surety and required to be furnished by Part XI.1 of the *Construction Act*.

Subbase means a layer of material of specified type and thickness between the Subgrade and the Base.

Subcontractor means a person, firm, or corporation undertaking the execution of a part of the Work by virtue of a contract with the Contractor.

Subgrade means the Earth Grade or Rock Grade.

Substructure means all of that part of a structure, including backwalls, wingwalls, and wing protection railings, below:

- a) The bearings of single and continuous span bridges.
- b) Skewbacks of arches and tops of footings of rigid frame bridges.

Superintendent means the Contractor's authorized representative in responsible charge of the Work.

Superstructure means all that part of a structure, excluding backwalls, wingwalls, and wing protection railings, above:

- a) The bearing seat of single and continuous span bridges.
- b) Skewbacks of arches and tops of footings of rigid frame bridges.

Surety means the person, partnership, or corporation, other than the Contractor, executing a bond provided by the Contractor.

Time and Material means costs calculated according to subsection GC 8.03, Payment on a Time and Material Basis.

Total Bid Price means the price submitted by the Contractor at tender closing.

Utility means a facility maintained by a municipality, public utility authority, or regulated authority and includes sanitary sewer, storm sewer, water, electric, gas, steam, data, telephone, and cable television services.

Work means the total construction and related services required by the Contract Documents.

Working Area means all the land and all the easements owned or acquired by the Owner for the construction of the Work.

Working Day means any Day:

- a) Except Saturdays, Sundays, and statutory holidays.
- b) Except a Day as determined on which the Contractor is prevented by weather or conditions resulting immediately thereafter, from proceeding with a Controlling Operation. For the purposes of this definition, this shall be a Day during which the Contractor cannot proceed with at least 60% of the normal labour and equipment force effectively engaged on the Controlling Operation for at least 5 hours.
- c) Except a Day on which the Contractor is prevented from proceeding with the Controlling Operation by reason of:
 - i. Any breach of Contract or prevention by the Owner, by any other Contractor of the Owner, or by any employee of any one of them.
 - ii. Non-delivery of Owner supplied materials.
 - iii. Any cause beyond the reasonable control of the Contractor that can be substantiated by the Contractor.

Working Drawings or **Working Plans** means any drawings or plans prepared by the Contractor for the execution of the Work and may, without limiting the generality thereof, include falsework and formwork plans, roadway protection plans, shop drawings, shop plans, or erection diagrams.

Written Notice of Lien means a Written Notice of Lien in the prescribed form pursuant to the *Construction Act*, given by a Person with a lien that identifies the payer and identifies the premises, and states the amount that the Person has not been paid and is owed to the Person by the payer.

GC 1.08 Substantial Performance

.01 The Work is substantially performed:

- a) When the Work or a substantial part thereof has passed inspection and testing and is ready for use or is being used for the intended purposes; and
- b) When the Work to be performed under the Contract is capable of completion or, where there is a known defect, correction, at a cost of not more than:
 - i. 3% of the first \$1,000,000 of the Contract price;
 - ii. 2% of the next \$1,000,000 of the Contract price; and
 - iii. 1% of the balance of the Contract price.

.02 For the purposes of this Contract, when the Work or a substantial part thereof is ready for use or is being used for the purposes intended and the Owner and the Contractor agree not to complete the Work expeditiously, the price of the services or Materials remaining to be supplied and required to complete the Work shall be deducted from the Contract price in determining substantial performance.

GC 1.09**Interpretation of Certain Words**

- .01 The words "acceptable," "approval," "authorized," "considered necessary," "directed," "required," "satisfactory," or words of like import shall mean approval of, directed, required, considered necessary, or authorized by and acceptable or satisfactory to the Contract Administrator unless the context clearly indicates otherwise.
- .02 The words "Ministry of Transportation," "ministry," and "Owner" and the abbreviations "MTO" and "MTC" shall mean the Ontario Ministry of Transportation.

GC 1.10**Liens**

- .01 A lien is preserved when the claimant has given the Owner a copy of the claim for lien before the lien has expired pursuant to the *Construction Act*.
- .02 A preserved lien is perfected when the claimant commences an action in the courts to enforce the lien prior to the end of the period according to Section 36 of the *Construction Act*.
- .03 A preserved lien becomes a perfected lien by sheltering under a perfected lien in accordance with the rules of sheltering according to Subsection 36(4) of the *Construction Act*.
- .04 The Owner shall retain an amount sufficient to satisfy the amount of a lien set out in a Written Notice of Lien Form 1 of Ontario Regulation 303/18 of the *Construction Act* in accordance with Subsection 24(2) of the *Construction Act*.

SECTION GC 2.0 - CONTRACT DOCUMENTS

GC 2.01 Reliance on Contract Documents

- .01 The Owner warrants that the information furnished in the Contract Documents can be relied upon with the following limitations or exceptions:
 - a) The location of all mainline underground Utilities that affects the Work shall be shown to a tolerance of 1.0 m horizontal and 0.3 m vertical.
- .02 The Owner does not warrant interpretations of data or opinions expressed in any subsurface report available for the perusal of the Contractor and excluded from the Contract Documents
- .03 The Owner does not warrant any other information specifically excluded from this warranty.

GC 2.02 Order of Precedence

- .01 In the event of any inconsistency or conflict in the contents of the following documents, such documents shall take precedence and govern in the following order:
 - a) Agreement
 - b) Addenda
 - c) Special Provisions
 - d) Contract Drawings
 - e) Standard Specifications
 - f) Standard Drawings
 - g) Tender
 - h) MTO General Conditions of Contract
 - i) Working Drawings

Later dates shall govern within each of the above categories of documents.

- .02 In the event of any conflict among or inconsistency in the information shown on Contract Drawings, the following rules shall apply:
 - a) Dimensions shown in figures on a drawing shall govern where they differ from dimensions scaled from the same drawing.
 - b) Drawings of larger scale shall govern over those of smaller scale.
 - c) Detailed drawings shall govern over general drawings.
 - d) Drawings of a later date shall govern over those of an earlier date in the same series.
- .03 In the event of any conflict in the contents of Standards the following order of precedence shall govern:
 - a) Ontario Provincial Standard Specifications and Standard Drawings
 - b) Other Standards referenced by OPSSs and OPSDs (e.g., CSA, CGSB, ASTM, and ANSI)
- .04 The Contract Documents are complementary, and what is required by any one, shall be as binding as if required by all.

SECTION GC 3.0 - ADMINISTRATION OF THE CONTRACT

GC 3.01

Contract Administrator's Authority

- .01 The Contract Administrator shall be the Owner's representative during construction and until the issuance of the MTO form PH-CC-895, Release from Warranty Certificate. All instructions to the Contractor including instructions from the Owner shall be issued by the Contract Administrator. The Contract Administrator shall have the authority to act on behalf of the Owner only to the extent provided in the Contract Documents.
- .02 All Claims, disputes, and other matters in question relating to the performance and the quality of the Work or the interpretation of the Contract Documents shall be referred to the Contract Administrator in writing by the Contractor. The Contract Administrator shall give a decision in writing within a reasonable time.
- .03 The Contract Administrator may inspect the Work for its conformity with the Contract Drawings and Standard Specifications and all drawings, and to record the necessary data to establish payment quantities under the schedule of tender quantities and unit prices or to make an assessment of the value of the work completed in the case of a lump sum price Contract.
- .04 The Contract Administrator shall approve the amounts owing to the Contractor under this Contract and shall issue certificates for payment in such amounts as provided for in section GC 8.0, Measurement and Payment.
- .05 The Contract Administrator shall, with reasonable promptness, review and take appropriate action upon the Contractor's submissions such as Working Drawings, product data, and samples according to the Contract Documents. Unless specified otherwise, the Contract Administrator shall respond to submissions requiring approval according to the Contract as soon as possible but not longer than 5 Business Days excluding any requests for extensions of Contract Time.
- .06 The Contract Administrator shall investigate all allegations of a change in the character of the Work made by the Contractor and issue appropriate instructions.
- .07 The Contract Administrator shall prepare and issue Change Orders.
- .08 The Contract Administrator shall be, in the first instance, the interpreter of the Contract Documents and the judge of the performance there under by both parties to the Contract. Interpretations and decisions of the Contract Administrator shall be consistent with the intent of the Contract Documents.
- .09 The Contract Administrator shall have the authority to reject work or Material which does not conform to the Contract Documents.
- .10 Defective work, whether the result of poor workmanship, use of defective Material, or damage through carelessness or other act or omission of the Contractor and whether incorporated in the Work or not, that has been rejected by the Contract Administrator as failing to conform to the Contract Documents shall be removed promptly from the Work by the Contractor and replaced or re-executed promptly according to the Contract Documents at no additional cost to the Owner.
- .11 Any part of the Work destroyed or damaged by such removals, replacements, or re-executions shall promptly be made good at no additional cost to the Owner.
- .12 If, in the opinion of the Contract Administrator, it is not expedient to correct defective work or work not performed according to the Contract Documents, the Owner may deduct from monies otherwise due to the Contractor the difference in value between the work as performed and that specified in the Contract Documents, the amount of which shall be determined in the first instance by the Contract Administrator.
- .13 Notwithstanding any inspections made by the Contract Administrator or the issuance of any certificates or the making of any payment by the Owner, the failure of the Contract Administrator to reject any defective work or Material shall not constitute acceptance of defective work or Material.

- .14 The Contract Administrator shall have the authority to temporarily suspend the Work for such reasonable time as may be necessary to facilitate the checking of any portion of the Contractor's construction layout or the inspection of any portion of the Work. There shall not be any extra compensation for this suspension of work.

GC 3.02 Working Drawings

- .01 The Contractor shall arrange for the preparation of clearly identified and dated Working Drawings as specified in the Contract Documents.
- .02 The Contractor shall submit Working Drawings to the Contract Administrator with reasonable promptness and in orderly sequence so as to not cause delay in the Work. If either the Contractor or the Contract Administrator so requests, they shall jointly prepare a schedule fixing the dates for submission and return of Working Drawings. At the time of submission, the Contractor shall notify the Contract Administrator in writing of any deviations from the Contract requirements that exist in the Working Drawings.
- .03 The Contractor shall make any changes in Working Drawings that the Contract Administrator may require consistent with the Contract Documents and resubmit, unless otherwise directed by the Contract Administrator. When resubmitting, the Contractor shall notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
- .04 The Contractor shall keep one set of the Working Drawings at the site at all times.

GC 3.03 Right of the Contract Administrator to Modify Methods and Equipment

- .01 The Contractor shall, when instructed in writing, make alterations in the method, Equipment, or work force at any time the Contract Administrator considers the Contractor's actions to be unsafe or damaging to either the Work or existing facilities or the environment, at no additional cost to the Owner. The Contractor shall alter the sequence of operations on the Contract, when requested in writing, so as to avoid interference with other work.
- .02 Notwithstanding the foregoing, the Contractor shall ensure that all necessary safety precautions and protection are maintained throughout the Work.

GC 3.04 Emergency Situations

- .01 The Contract Administrator has the right to determine the existence of an emergency situation and when such an emergency situation is deemed to exist, the Contract Administrator may instruct the Contractor to take action to remedy the situation. If the Contractor does not take timely action or, if the Contractor is not available, the Contract Administrator may direct others to remedy the situation.
- .02 If the emergency situation was the fault of the Contractor, the remedial work shall be completed at no additional cost to the Owner. If the emergency situation was not the fault of the Contractor, the Owner shall pay for the remedial work.

GC 3.05 Working Area

- .01 The Contractor's sheds, site offices, toilets, other temporary structures, and storage areas for Material and Equipment shall be grouped in a compact manner and maintained in a neat and orderly condition at all times.
- .02 The Contractor shall confine construction operations to the Working Area so as not to interfere with public use. Should the Contractor require more space than that shown on the Contract Drawings, the Contractor shall obtain such space at no additional cost to the Owner.
- .03 The Contractor shall not enter upon or occupy any private property for any purpose, unless the Contractor has received prior written permission from the property owner.

GC 3.06**Extension of Contract Time or Interim Completion Dates**

- .01 An application for an extension of Contract Time or interim completion dates shall be made in writing by the Contractor on the MTO form PH-CC-756, Compensation Request, to the Contract Administrator, as soon as the need for such extension becomes evident. The application for an extension of Contract Time shall enumerate the reasons and impact on the critical path schedule and state the length of extension required.
- .02 Circumstances suitable for consideration include the following:
 - a) Delays: See subsection GC 3.07, Delays.
 - b) Changes in the Work: See clause GC 3.10.01, Changes in the Work.
 - c) Additional Work: See clause GC 3.10.02, Additional Work.
- .03 The Contract Time shall be extended for such additional time as approved by the Contract Administrator.
- .04 The terms and conditions of the Contract shall continue for such extension of Contract Time.

GC 3.07**Delays**

- .01 If the Contractor is delayed in the performance of the Work by:
 - a) War, blockades, or civil commotions; or
 - b) Errors in the Contract Documents; or
 - c) An act or omission of the Owner, Contract Administrator, other contractors, or anyone employed or engaged by them directly or indirectly, contrary to the provisions of the Contract Documents; or
 - d) A stop work order issued by a court or public authority, provided that such order was not issued as the result of an act or omission of the Contractor, or anyone employed or engaged by the Contractor directly or indirectly; or
 - e) The Contract Administrator giving notice under subsection GC 7.11, Suspension of Work; or
 - f) Abnormal Weather, provided that in the case of an application for an extension of Contract Time, due to the Abnormal Weather, the Contractor shall, with the Contractor's application, submit evidence from Environment Canada, together with detailed calculations in support of such application; or
 - g) Archaeological finds, or
 - h) The presence of species at risk as defined in the *Species at Risk Act* (S.C. 2002, c. 29) and/or the *Endangered Species Act*, S.O. 2007, c. 29 not otherwise identified in the Contract Documents,

then, the Contractor shall be granted an extension of Contract Time according to subsection GC 3.06, Extension of Contract Time or Interim Completion Dates, and shall be reimbursed by the Owner for reasonable costs incurred by the Contractor as the result of such delay.

- .02 To determine if the weather encountered during the term of the Contract constitutes Abnormal Weather, the weather records used for the calculation of the 25-year mean and standard deviation shall be from the Environment Canada weather station nearest to the location of the Work. The weather conditions measured in time periods of 3 consecutive Days within a 30-Day period, a calendar month, or 3 consecutive calendar months shall be used to determine the values for the calculations. No other time periods shall be considered.
 - a) For precipitation and snowfall, the values for each year shall be the total amount over the time period.
 - b) For wind and temperature, the values for each year shall be either the average highest or lowest value in the time period.
 - c) The same month or 3 month time period shall be used for each of the 25 years.

- d) For a consecutive 3-Day period within a 30-Day period, the 30-Day period shall begin 15 Days prior to the start of the weather event that is suspected to be abnormal. Only the highest or lowest 3-Day value within the same 30-Day period shall be used for each of the preceding 25 years.

- .03 If the Contractor is granted an extension of Contract Time, compensation for unabsorbed head office overhead shall be as follows:

$$HOOH = \left(\frac{Te(OCv \times 0.05)}{T} \right) - 0.05(FCv - OCv)$$

Where:

HOOH: means head office overhead payment

Te: means approved extension of Contract Time in Days less the Days between December 1 and May 15 inclusive (for Working Day Contracts elapsed Days for approved Working Days)

OCv: means Original Contract tender value in dollars

T: means original Contract Time less the Days between December 1 and May 15 inclusive (Days for completion date contracts or elapsed Days for Working Day Contracts)

FCv: means final Contract value in dollars excluding: incentive/disincentive payments, material bonus/penalty payments, asphalt cement index payments and fuel price adjustments

The head office overhead payment shall not be negative.

For the purposes of establishing the start date to calculate Contract durations, the date shown on the MTO form PH-CC-700, Permission to Start Work, shall be considered as the start date. No other payment shall be made for head office overhead.

Payment for unabsorbed head office overhead shall be made after the Contract Completion Certificate has been issued.

- .04 If the Work is delayed by labour disputes, strikes, or lock-outs, including lock-outs decreed or recommended to its members by a recognized contractor's association, of which the Contractor is a member or to which the Contractor is otherwise bound, which are beyond the Contractor's control, then:

- a) Where an industry-wide strike delays the Work, the Contractor shall be granted an extension of Contract Time but not financial compensation (i.e., the strike is considered to be an excusable and non-compensable delay). The Contractor shall make application and shall document the extent to which Controlling Operations were delayed by the strike.
- b) Incentives and disincentives shall apply to the revised interim and final completion dates.

- .05 If the Contractor's operations expose any items which may indicate an archaeological find, such as building remains, hardware, accumulations of bones, pottery, or arrowheads:

- a) The Contractor shall immediately notify the Contract Administrator and suspend operations within the area identified by the Contract Administrator.
- b) Work shall remain suspended within that area until otherwise directed by the Contract Administrator in writing, according to subsection GC 7.11, Suspension of Work.
- c) Any delay in the completion date of the Contract that is caused by such a cessation of construction operations shall be considered to be beyond the Contractor's control according to paragraph .01 of subsection GC 3.07, Delays.
- d) Any increases in the cost of the work to be done that are caused by such a cessation of construction operations shall be considered as a Change in the Work according to paragraph .01 of clause GC 3.10.01, Changes in the Work.
- e) Any work directed or authorized in connection with an archaeological find shall be considered as Changes in the Work according to clause GC 3.10.01, Changes in the Work.

- .06 If the Contractor encounters species at risk as defined in paragraph .01 of subsection GC 3.07, Delays, within the Working Area not otherwise identified in the Contract Documents, and that are likely to be impacted by the Contractor's operations:
- a) The Contractor shall immediately notify the Contract Administrator and suspend operations within the area identified by the Contract Administrator.
 - b) Work shall remain suspended within that area until otherwise directed by the Contract Administrator in writing, according to subsection GC 7.11, Suspension of Work.
 - c) Any delay in the completion date of the Contract that is caused by such a cessation of construction operations shall be considered to be beyond the Contractor's control according to paragraph .01 of subsection GC 3.07, Delays.
 - d) Any increases in the cost of the work to be done that are caused by such a cessation of construction operations shall be considered as a Change in the Work according to paragraph .01 of clause GC 3.10.01, Changes in the Work.
 - e) Any work directed or authorized in connection with the unexpected presence of species at risk shall be considered as Changes in the Work according to clause GC 3.10.01, Changes in the Work.

GC 3.08 Assignment of Contract

- .01 The Contractor shall not assign the Contract, either in whole or in part, without the written consent of the Owner.

GC 3.09 Subcontracting by the Contractor

- .01 The Contractor may subcontract any portion of the Work, but the total of all sublets shall not exceed 60% of the total tender value without the written consent of the Contract Administrator, subject to these MTO General Conditions of Contract and any limitations established by the Owner.
- .02 The Contractor shall notify the Contract Administrator, in writing on the MTO form PH-CC-742, Consent to Sublet, of the intention to subcontract where the subcontract comprises greater than 50% of the tender item value. Such notification shall identify the part of the Work, and the Subcontractor with whom it is intended.
- .03 The Contractor shall preserve and protect the rights of the parties under the Contract with respect to the work to be performed under subcontract and shall:
- a) Enter into agreements with the intended Subcontractors to require them to perform their work according to the Contract Documents; and
 - b) Be as fully responsible to the Owner for acts and omissions of the Contractor's Subcontractors and of persons directly or indirectly employed by them as for acts and omissions of persons directly employed by the Contractor.
- .04 Subcontracting shall not be construed to relieve the Contractor from any obligation under the Contract or to impose any liability upon the Owner. Nothing contained in the Contract Documents shall create a contractual relationship between a Subcontractor and the Owner.
- .05 The Contractor shall not subcontract any part of the Work to a Subcontractor that has submitted the lowest tender for the Contract, and has subsequently failed to enter into a Contract with the Owner. The Owner shall not be responsible or liable for any costs or damages of the Contractor arising from the need of the Contractor to substitute a Subcontractor.

GC 3.10 Changes in the Work and Additional Work

GC 3.10.01 Changes in the Work

- .01 The Owner or the Contract Administrator, where so authorized, may, by order in writing, make Changes in the Work without invalidating the Contract. The Contractor shall not be required to proceed with a Change in the Work until in receipt of a Change Order. Upon the receipt of such written order the Contractor shall proceed with the work and shall provide the Owner with a detailed cost estimate of the work described in the Change Order. The estimate shall identify the costs of salaries and wages, payroll burden, Equipment, Materials, and payments to Subcontractors. Alternatively, and with the agreement of the Contract Administrator, the Contractor may provide a cost estimate based on actual or revised Contract prices. The Contractor shall also estimate the impact on any incentives or disincentives.
- .02 The Contractor may apply for an extension of Contract Time according to the terms of subsection GC 3.06, Extension of Contract Time or Interim Completion Dates.
- .03 If the Changes in the Work relate solely to quantities, payment for the work shall be made according to the conditions specified in clause GC 8.01.02, Variations in Tender Quantities. If the Changes in the Work do not solely relate to quantities, then the Owner or the Contractor shall negotiate upwards or downwards the adjustment of the Contract price in respect of the Changes in the Work, or payment may be made according to subsection GC 8.03, Payment on a Time and Material Basis.
- .04 A Change Order price negotiation which remains unresolved more than 10 Days after the Contractor's submission of the detailed cost estimate for the Work described in the Change Order shall be resolved by the Contractor submitting a Compensation Request according to subsection GC 3.14, Compensation Request.
- .05 The undisputed value of Work performed as a result of a Change Order is eligible to be included in the progress payment certificate. The Owner shall compensate the Contractor for the direct cost of labour, Materials, Equipment and subcontracts. The interim payment shall be based on a mutually agreed lump sum pro-rated for the percentage of Work completed. In the case of a failure to reach agreement on the lump sum payment, the interim payment shall be calculated according to subsection GC 8.03, Payment on a Time and Material Basis.

GC 3.10.02 Additional Work

- .01 The Owner or Contract Administrator, where so authorized, may request the Contractor to perform Additional Work without invalidating the Contract. If the Contractor agrees to perform Additional Work, the Contractor shall proceed with such work upon receipt of a Change Order establishing the basis of payment, the price, and the adjustment of Contract Time.

GC 3.10.03 Price Agreement Form

- .01 If the Contractor and Contract Administrator agree on the basis of payment and price when appropriate, a price agreement, on the MTO form PH-CC-856, Price Agreement for Change in the Work, Extra Work, or Additional Work, shall be signed by both parties.

GC 3.10.04 Work Directive

- .01 When there is a dispute respecting a proposed Change in the Work, and the Contractor does not proceed with the Work, the Owner may issue a MTO form PH-CC-857, Work Directive. Upon receipt of a Work Directive the Contractor shall proceed with the Work. The Contractor may pursue resolution of the dispute according to subsection GC 3.15, Dispute Resolution.

GC 3.11 Change Proposals After Contract Award

GC 3.11.01 Definitions

For the purpose of this subsection, the following definitions apply:

Alternative Type of Material means a substitute for a specified type of Material to be incorporated into a product and would involve a change that does not adversely affect the performance of the product.

Design Change means an alteration to a specified physical feature of a product or to the construction staging requirements that does not adversely affect the performance of the facility, and may include the use of an Alternative Type of Material that changes the physical dimensions of a product.

Method Change means an alteration to the specified means or process used to produce a product.

GC 3.11.02 Sharing of Cost Savings

.01 The Contractor may propose cost-reducing Change Proposals after Contract award and gain a financial reward by receiving 50% of the savings resulting from a Change Proposal. If a Change Proposal is acceptable to the Owner, as determined by an Owner Change Proposal review team, the Contractor shall:

- a) Be reimbursed 100% for the agreed upon design/redesign cost as agreed upon at acceptance by the Owner in principle of a Change Proposal; and
- b) Receive payment of 50% of the net construction cost savings, as detailed in clause GC 3.11.05, Accepted Change Proposal Payment, resulting after preliminary design development at the Contractor's cost.

Items a) and b) are in addition to payment for the tendered cost for construction of a Change Proposal.

.02 Standard submission forms and guidelines for their completion are available from the Contract Administrator.

GC 3.11.03 Conditions of Change Proposals

GC 3.11.03.01 Processing, General

.01 Change Proposals under this provision shall be considered after award and when all applicable conditions are met. Change Proposals need not necessarily be completely equivalent to or meet specified requirements, except as otherwise specified in subsection GC 3.11, Change Proposals After Contract Award. Change Proposals shall be submitted on the applicable MTO forms and shall duplicate all the original text provided in the original standard forms.

.02 Acceptance or rejection of the Change Proposal shall be at the sole discretion of the Owner. The Owner shall advise the Contractor of the reasons for rejection of a Change Proposal according to clause GC 3.11.03.09, Time Periods for Review.

.03 Each proposed Change that affects a different set of Contract items shall be documented as a separate Change Proposal.

.04 Ongoing costs and future life costs shall be evaluated, as detailed and explained on the MTO forms, and shall be noted considering, as a minimum, a perpetual/infinite life cycle using present worth value analysis, using a constant dollars concept, and a discount rate of 6%.

- .05 Change Proposals that take advantage of any errors or omissions in the plans for the as-designed project, or discrepancies between the as-designed project and the Special Provisions covering alternate designs, shall not be accepted. In the event that any error, omission, or discrepancy is discovered, the Contractor shall immediately notify the Contract Administrator. Failure to notify the Owner shall constitute a waiver of all claims for misunderstandings, ambiguities, or other situations resulting from the error, omission, or discrepancy.
- .06 The Contractor shall be responsible for all costs arising in connection with errors in the quantities related to the Change Proposal.
- .07 The Owner shall not be liable to the Contractor for failure to accept or act upon any Change Proposal nor for any delays attributable to any such Change Proposal.
- .08 No extension of Contract Time shall be permitted unless detailed in a Change Proposal and accepted by the Owner.
- .09 The Contractor shall be responsible for obtaining all regulatory approvals resulting from any Change Proposal.
- .10 The Owner shall be the sole judge of whether any Change Proposal is consistent with Owner design policies and basic design criteria for the project.
- .11 The Contractor shall have no Claim against the Owner for any costs or delays due to the Owner's review or rejection of a Change Proposal, including but not limited to review for approval of designs, development costs, anticipated profits, or increased material or labour costs resulting from delays in the review of such Change Proposals.
- .12 If a Change Proposal is acceptable to the Owner, the Contractor shall construct the Change Proposal, and shall do the construction for the price bid for the Change Proposal identified by MTO as acceptable.
- .13 If the Change Proposal is acceptable in whole or in part, such acceptance shall be clarified by the Owner by means of a Change Order that shall specifically state that it is executed pursuant to subsection GC 3.11, Change Proposals After Contract Award.
- .14 Subcontractors may not submit a Change Proposal, except through the Contractor.
- .15 If the Owner accepts a design change, the Owner shall not give permission to proceed with such a Change Proposal until an agreement has been reached on the estimated value of the cost savings and on the Change Proposal design or redesign costs, or until there is a written agreement on a dispute resolution procedure to resolve any disagreement over the values. If a Change Proposal is rejected, no compensation shall be made for any costs associated with the Change Proposal, other than those accepted as part of a Change Proposal and/or other costs found to be acceptable to the Owner.
- .16 If the Owner already has under consideration certain revisions to the Contract or has approved certain changes in Standard Specifications or Standard Drawings for general use that are subsequently incorporated into a Change Proposal, the Owner shall reject the Change Proposal and shall proceed with such revisions, if the Owner so desires and without any obligation to the Contractor. At the Owner's discretion, such changes may be made under subsection GC 3.10, Changes in the Work and Additional Work.

GC 3.11.03.02 Incomplete Change Proposals

- .01 The Owner reserves the right to reject any Change Proposal if the Change Proposal does not contain all required information or is not presented clearly. Without prejudice to this right, the Owner may request clarification when the intent of a Change Proposal is unclear. If supporting data is insufficient or unclear, this shall also be grounds for rejection of a Change Proposal.

GC 3.11.03.03**Proposals for Design Changes**

- .01 When the Contract Documents do not contain a provision for a design change for a tender item, the Contractor's bid for the tender item shall be based on the specified/tendered design exclusive of any Change Proposal. Alternative designs presented under this provision may be proposed only after award. The Owner shall review the design Change Proposal and if the Change Proposal is acceptable to the Owner, the Contractor shall be responsible for the cost of all impacts on other construction item costs that are not included in the Change Proposal and for the schedule resulting from the Change Proposal.

GC 3.11.03.04**Design Changes**

- .01 The situations described below are covered in OPSSs, and shall be used by the Owner to determine how a Change Proposal shall be handled:
- a) When the Contract contains provisions for acceptable alternative designs (e.g., pipe sewers, cast-in-place vs. precast maintenance hole, and culverts), the Contractor may proceed with any one of them with no need to negotiate cost savings after award based on this provision.
 - b) When the Contractor is specifically permitted in the Contract Documents to design an alternative to the design specified in the Contract (e.g., track protection, work sequence, or staging requirements), the Contractor shall perform the design, and the associated cost shall be deemed to be included in the related Contract prices. The design shall be subject to Owner review and, if the alternative design is not acceptable, it shall be changed to meet the Owner's requirements at no additional cost to the Owner or revert to the original design as directed by the Owner.
 - c) When the Contractor is responsible for the design of temporary work and no design has been provided in the Contract Documents, or the design provided by the Owner is not sufficiently detailed to permit construction (e.g., formwork and falsework, dewatering, trench shoring, and roadway protection), it shall be understood that the costs for such work were included in the Contractor's original tendered bid, and the Contractor shall assume all the risk associated with bidding and constructing the design.

GC 3.11.03.05**Proposals for Method Changes**

- .01 When the Contract Documents do not contain a provision for a method change for the tender item, or when the Contractor proposes an alternative method to the specified method, the Owner shall, under this provision, receive, review, and accept or reject an alternate method only after award of the Contract. The Contractor shall assume all of the risk in bidding the tender item with an alternate method and in using the alternate method. If the alternative method is acceptable to the Owner, or is acceptable with modifications, the Contractor shall be paid according to the payment conditions of subsection GC 3.11, Change Proposals After Contract Award. If a Change Proposal is rejected, no additional compensation shall be made.
- .02 The Contractor shall not start work with a proposed method change until the Owner has given written permission.
- .03 When the Contractor proposes to change the construction staging scheme identified in the Contract Documents, and where these changes are deemed by the Contract Administrator to be a significant departure from the Contract Documents, the Contractor shall submit four copies of a traffic management plan that:
- a) Includes, as appropriate, the following documents:
 - i. Plan, profile, and cross-section drawings indicating the proposed changes to the horizontal and vertical alignment and any changes to the drainage; electrical; environmental; Pavement; structural; over-winter; work zone safety; and public safety, including pedestrian access, schemes for all affected construction and traffic stages.
 - ii. Revised signing and Pavement marking schemes.
 - iii. Revised detour, lane, or ramp closure schemes.
 - iv. A revised critical path schedule for the duration of the project.

- b) Maintains the minimum standards as used in the Contract Documents for:
 - i. Highway geometrics.
 - ii. Pavement structures (i.e., type, depth and granular depths).
 - iii. Illumination and traffic signals needs.
 - iv. Seasonal shutdown conditions.
 - v. Environmental protection (i.e., design measures, construction constraints and requirements and commitments in environmental documentation which may not be referred to in the Contract Documents).
- c) Clearly identifies geometric design criteria used for:

i. Design speed.	viii. Shoulder widths.
ii. Vertical grades.	ix. Grades for side slopes.
iii. Stopping sight distance.	x. Hazard offsets.
iv. Vertical curves.	xi. Barrier warrants.
v. Horizontal curves.	xii. Pavement crossfalls.
vi. Superelevation.	xiii. Shoulder crossfalls.
vii. Lane widths.	
- d) Identifies any changes to the construction staging or traffic operations affecting municipal roadways to the Contract Administrator who shall notify the affected municipality. A minimum of 10 Business Days shall be provided to the municipality for their response.
- e) Complies with the pavement marking and signing standards of the OTMs.
- f) Complies with permitted time periods for lane and ramp restrictions and closures as specified in the Contract Documents.
- g) Complies with environmental constraints and requirements specified in the Contract Documents.
- h) Meets current MTO Standards.

GC 3.11.03.06 Proposals for Alternative Types of Materials or Material Sources

- .01 The Contractor's Change Proposal for alternative types of Materials or Material sources shall include evidence that the Material or Material source meets the Owner's requirements in place at the time the Change Proposal is submitted.

GC 3.11.03.07 Proposal for a Combination of Design, Method, and Material Changes

- .01 When the Contract Documents do not contain a provision for a design change for a tender item, other than that permitted by a Change Proposal, and the proposed design change requires a different method from that specified in the Contract Documents, the Change Proposal including the proposed method shall be considered a design change, and all the requirements of clause GC 3.11.03.03, Proposals for Design Changes, shall apply.

GC 3.11.03.08 Ownership and Copyright

GC 3.11.03.08.01 Intellectual Property

GC 3.11.03.08.01.01 Ownership of Intellectual Property

- .01 The Owner shall be the sole proprietor of any Newly Created Intellectual Property. The Contractor irrevocably assigns to and in favour of the Owner, and the Owner accepts every right, title, and interest in and to all Newly Created Intellectual Property in the Change Proposal, immediately following the creation thereof, for all time and irrevocably waives in favour of the Owner all rights of integrity and other moral rights to all Newly Created Intellectual Property in the Change Proposal, immediately following the creation thereof, for all time. To the extent that the Change Proposal includes, in whole or in part, the Contractor's Intellectual Property, the Contractor grants to the Owner a licence to use that Contractor's Intellectual Property in the manner contemplated in clause GC 3.11.03.08.01, Intellectual Property, of these MTO General Conditions of Contract, the total consideration for which shall be a portion of the payment of the lump sum tender item price to the Contractor by the Owner.

GC 3.11.03.08.01.02 Presumption Governing Ownership

- .01 The presumption governing the Contract shall be that the Owner shall be the sole proprietor of any Intellectual Property in any form contained in the Change Proposal. If the Contractor's Intellectual Property forms any part of the Change Proposal, the Contractor shall notify the Owner in the Change Proposal. In the absence of any such notice, the presumption shall remain that the Owner is the sole proprietor of any Intellectual Property contained in the Change Proposal.

GC 3.11.03.08.01.03 Contractor's Grant of Licence

- .01 For those parts of the Change Proposal that are the Contractor's Intellectual Property, the Contractor grants to the Owner for the sole purposes of resolving or remedying any breach of the Contract Documents or this warranty by the Contractor or for the Owner to undertake maintenance, rehabilitation, reconstruction, or construction work, a perpetual, world-wide, non-exclusive, irrevocable, transferable, royalty-free, fully-paid-up right and licence to:
- a) Use, modify, reproduce, and distribute, in any form, the identified Intellectual Property; and
 - b) Authorize other Persons, including agents, contractors, or Subcontractors, to do any of the former on behalf of the Owner.
- .02 The Owner acknowledges and agrees that the Contractor's Intellectual Property is the property of the Contractor and is highly valuable, confidential, and material to the interests, business, and affairs of the Contractor and that disclosure thereof would be detrimental to the interests, business, and affairs of the Contractor. The Owner agrees to maintain the confidentiality of the Contractor's Intellectual Property and that, subject to a court order or except as specifically permitted by the terms of these provisions, the Owner shall not disclose the Contractor's Intellectual Property to any person for any reason whatsoever other than to those persons who actually need to have knowledge of the Contractor's Intellectual Property for the sole purposes of resolving or remedying any breach of the Contract Documents or this warranty or for the Owner to undertake maintenance, rehabilitation, reconstruction, or construction work. The confidentiality obligation of the Owner shall not apply to those elements of the Contractor's Intellectual Property that are currently or hereafter become generally available to the public, provided such public availability has not occurred as a result of the disclosure by the Owner in contravention of this provision.

GC 3.11.03.08.01.04 No Restrictive Materials in Change Proposal

- .01 The Contractor shall not incorporate into any Change Proposal anything that would restrict the right of the Owner to modify, further develop, or otherwise use the Change Proposal in any way that the Owner deems necessary, or that would prevent the Owner from entering into any contract with any contractor other than the Contractor for the modification, further development, or other use of the Change Proposal.

GC 3.11.03.08.01.05 Assurances Regarding Moral Rights

- .01 At the request of the Owner, at any time or from time to time, the Contractor shall execute and agree to cause its directors, officers, employees, agents, partners, affiliates, volunteers, or Subcontractors to execute an irrevocable written waiver of any moral rights or other rights of integrity in the applicable Change Proposal in favour of the Owner. Such waiver to be in the form provided by the Owner, and which waiver may be invoked without restriction by any person authorized by the Owner to use the Change Proposal.
- .02 The Contractor shall deliver such written waivers to the Owner within 10 Business Days of the receipt of the request from the Owner.

GC 3.11.03.08.01.06 Further Assurances Regarding Copyright

- .01 At the request of the Owner, at any time or from time to time, the Contractor shall execute and agree to cause its directors, officers, employees, agents, partners, affiliates, volunteers, or Subcontractors to execute a written assignment of copyright in the applicable Change Proposal to the Owner in the form provided by the Owner. The Contractor shall deliver such written assignments to the Owner within 10 Business Days of the receipt of the request from the Owner. The Contractor shall assist the Owner in preparing any Canadian copyright registration that the Owner considers appropriate. The Contractor shall obtain or execute any other document reasonably required by the Owner to protect the Intellectual Property of the Owner.

GC 3.11.03.08.01.07 Owner May Prescribe Further Compliance

- .01 The Owner reserves the right to prescribe the specific manner in which the Contractor shall perform its obligations relating to the Intellectual Property.

GC 3.11.03.08.01.08 Survival

- .01 The obligations contained in clause GC 3.11.03, Conditions of Change Proposals, shall survive the termination or expiry of the Contract.

GC 3.11.03.08.02 Owner Rights

- .01 In submitting a Change Proposal under this provision, the Contractor agrees to the following:
- a) All plans, drawings, design reports, procedures, and programs prepared, conceived of, or produced or caused to be prepared, conceived of, or produced and delivered by or on behalf of the Contractor as part of an acceptable Change Proposal (the "Proposal") shall be the sole property of the Owner, except as otherwise provided below. The Contractor covenants that the Owner shall be the sole owner of the Proposal, and that none of such Proposal shall infringe the copyright, patent, or other right of any other Person.

For the purposes of the *Copyright Act (Canada)*, the Contractor acknowledges that all Proposal shall be deemed to have been prepared under the direction and control of the Owner, and the copyright, except as otherwise provided below, shall belong to the Owner. The Contractor waives any moral rights it may have under the *Copyright Act (Canada)*, concerning the Proposal.

All patents, copyrights, and other industrial and Intellectual Property rights, including trade secrets, arising in relation to the Proposal, if any, are hereby assigned to the Owner for its use, excepting any third-party proprietary products, any licensed procedures, and any products licensed to a third-party. Change Proposals shall clearly identify any third-party proprietary products and licensed products and procedures to be used as a part of a Change Proposal. The Contractor shall take all reasonable steps, including the steps the Contractor takes to protect information, data, or other tangible and intangible property the Contractor owns and regards as proprietary or confidential, to ensure that such proprietary rights of the Owner are not violated.

The Contractor shall obtain all required assignments and releases of interest, acknowledgments, or waivers that the Owner considers necessary or advisable to transfer title and publication rights in and to the Proposal to the Owner, unless accepted otherwise.

- b) The Owner hereby grants the Contractor a non-exclusive, royalty-free licence to use the Proposal for any and all purposes.
- c) Without limitation, the Owner acknowledges that the Contractor shall have the right to use for the Contractor's own purposes outside of this Contract, any novel ideas and concepts developed by the Contractor.

- d) The Contractor shall not be liable in any manner whatsoever for the claims arising as a result of the use by the Owner of the Proposal in connection with projects other than this Contract. Further, the Contractor cannot warrant the fitness of or be responsible or liable for any Proposal that are only partially completed due to early termination or suspension of this Contract by the Owner, or if same have been altered, revised, modified, or amended without the written consent and knowledge of the Contractor or if such Proposal have been provided to the Owner on computer devices with removable storage and used on improper or incompatible computer processing equipment.
- e) The rights and privileges of the Owner, and the licence in favour of the Contractor provided for in these MTO General Conditions of Contract shall survive and shall not merge on the termination or other expiry of this Contract.

GC 3.11.03.09 Time Periods for Review

- .01 Any Change Proposal shall include/document the anticipated change in the construction schedule and shall account for and clearly indicate the desired and reasonable time period for review of same by the Owner. When there is no time period specified with the Change Proposal for review of designs, methods, or Working Drawings in the Contract Documents that are applicable to the Change Proposal, the Owner shall, unless it accepts the times suggested in the Change Proposal, review the Change Proposal expeditiously. The actual duration shall depend on the complexity of the Change Proposal; however, within 5 Business Days of receipt of the Change Proposal, the Owner shall notify the Contractor in writing:
 - a) If the Change Proposal requires clarification or further supporting information; and
 - b) Of the expected time period for review.
- .02 The Contractor shall be notified in writing of the acceptance or rejection of the Change Proposal not more than 20 Business Days after a fully documented and supported Change Proposal is received. If the Change Proposal is rejected, the reasons for the rejection shall be stated.
- .03 If the Owner fails to respond to the Change Proposals within the desired review time suggested in the Change Proposal or within the time stated in the notification in paragraph .01, b) of clause GC 3.11.03.09, Time Periods for Review, the Contractor shall consider the Change Proposal rejected, and shall have no claim against the Owner as a result thereof.

GC 3.11.03.10 Risk Sharing/Warranty

- .01 As part of a Change Proposal, the Contractor shall outline and thoroughly explain warranties and other measures offered to reduce the Owner's risks, thus encouraging adoption of a Change Proposal. Shared risks and all risks that the Contractor is not prepared to accept shall also be outlined.

GC 3.11.04 Submission of Change Proposals

- .01 The Contract Administrator shall be notified of the Contractor's intention to submit a Change Proposal at least 5 Business Days before a Change Proposal is submitted.
- .02 Change Proposals shall be identified as Change Proposals submitted under subsection GC 3.11, Change Proposals After Contract Award, and shall include a completed standard cover sheet, the MTO forms, and the following:
 - a) A description of the proposed Change Proposal, and the related design or redesign costs;
 - b) A detailed list of the Contract requirements that change, if the Change Proposal is adopted;
 - c) The tender items affected by the proposed changes, including any quantity variation, and any new items, applicable Standards, Special Provisions, and quantities;
 - d) A detailed estimate of the Contractor's cost of performing the work under the existing Contract, and under the proposed Change Proposals;
 - e) A description of the comparative advantages and disadvantages of the Change Proposals;
 - f) A revised construction schedule and an application for extension of Contract Time, if applicable; and

- g) Completed Owner's Standard Change Proposal Forms and procedures shall be used, and shall document and support, for acceptance/review purposes, any Change Proposals.
- .03 Any aspect of a Change Proposal that involves or may involve (e.g., preliminary Change Proposal designs prepared for approval in principle) doing work or an act that is within the practice of professional engineering shall be designed by an Engineer and shall bear the seal and signature of the Engineer. Whatever the Contract specifies regarding stamp occurrences for such design work, the same requirement shall apply to designs or redesigns for a Change Proposal.

GC 3.11.05 Accepted Change Proposal Payment

- .01 If a Change Proposal is acceptable to the Owner, the changes and payment related to the savings thereto shall be authorized by means of a Change Order to the Contract. Compensation to the Contractor shall be made as follows:
 - a) The Contractor's costs for development work (i.e., any preliminary work up to Owner acceptance in principle of a Change Proposal related to the Change Proposals) shall not be eligible for reimbursement.
 - b) The items for a Change Proposal shall become guaranteed maximum price items. Change proposal savings sharing shall be calculated as outlined in paragraph .01, c) of clause GC 3.11.05, Accepted Change Proposal Payment, and be shared equally between the Contractor and Owner; the Change Proposal design or redesign cost as agreed with MTO as acceptance in principle of the Change Proposal shall be fully reimbursed to the Contractor.
 - c) Change Proposal net construction cost savings change sharing payment shall be based on the following: the original directly related tendered construction price minus the price proposed (bid) to construct the Change Proposal and minus the cost of the Change Proposal design or redesign accepted by the Owner as a Change Proposal approval in principle. In addition to the shared savings payment total and the tendered price payment for the construction of redesigned Change Proposal work, the Contractor shall be reimbursed 100% for the price of the new Change Proposal design or redesign as agreed upon as acceptance of a Change Proposal in principle.
 - d) Unless otherwise specified in writing by the Contractor and agreed upon with the Owner, the Contractor's share of the change sharing savings shall be paid according to the following schedule: 50% of the Contractor's share of the agreed change sharing savings shall be paid as a part of the Owners progress payment following the Owner's acceptance of a Change Proposal in principle; the remaining Change Proposal costs shall be paid according to the percentage of Change Proposal work completed over the duration of the work of the Change Proposal. The Contractor shall indicate, as a part of the Change Proposal, what items shall be used for each Change Proposal, shall get agreement with the Owner regarding such items, and shall outline, in the Change Proposal, any payment schedule that differs from clause GC 3.11.05, Accepted Change Proposal Payment.
 - e) The Contractor may submit any Change Proposals for an approved Subcontractor provided that reimbursement shall be made by the Owner to the Contractor; the terms of the pass through to the Subcontractor shall have been satisfactorily negotiated between the Contractor and the Subcontractor, and be accepted by both before the Change Proposal is submitted to the Owner.

GC 3.12 Notices

- .01 The Contractor and the Owner shall provide each other with the mailing addresses, telephone numbers, facsimile terminal numbers, and email addresses for the Contract Administrator and the Superintendent at the commencement of the Work.
- .02 Any notice permitted or required to be given to the Owner or the Contractor shall be given according to the notice provision of the Agreement.
- .03 In the event of an emergency situation or other urgent matter the Contract Administrator or the Superintendent may give a verbal notice, provided that such notice is confirmed in writing.

- .04 Any document permitted or required to be given to the Contract Administrator or the Contractor in respect of the Work shall be deemed to have been given to and received by the addressee on the date of delivery, if delivered by hand or by electronic transmission, and on the third Business Day after the date of mailing, if sent by mail.

GC 3.13 Use and Occupancy of the Work Prior to Substantial Performance

- .01 Where it is not contemplated elsewhere in the Contract Documents, the Owner may use or occupy the Work or any part thereof prior to substantial performance, provided that at least 30 Days written notice has been given to the Contractor.
- .02 The use or occupancy of the Work or any part thereof by the Owner prior to substantial performance shall not constitute an acceptance of the Work or parts so occupied. In addition, the use or occupancy of the Work shall not relieve the Contractor or the Contractor's Surety from any liability that has arisen, or may arise, from the performance of the Work according to the Contract Documents. The Owner shall be responsible for any damage that occurs because of the Owner's use or occupancy. Such use or occupancy of any part of the Work by the Owner does not waive the Owner's right to charge the Contractor liquidated damages according to the terms of the Contract.

GC 3.14 Compensation Request

- .01 The Contractor shall submit a Compensation Request, to the Contract Administrator, on the MTO form PH-CC-756, Compensation Request, when the Contractor becomes aware of or ought to be aware of any of the following:
- a) A Change in the Work;
 - b) A need for an extension of Contract Time, according to subsection GC 3.06, Extension of Contract Time or Interim Completion Dates;
 - c) An unresolved Change Order price negotiation according to clause GC 3.10.01, Changes in the Work; or
 - d) Other compensation matters.
- .02 Notwithstanding that the Compensation Request is not resolved; the Contractor shall proceed with the Work in accordance with paragraph .01 of clause GC 7.01.08, Errors Relating to the Contract.
- .03 The Compensation Request shall include a description of the matter with specific references to the Contract Documents including the impacts to the Contractor.
- .04 If a Compensation Request relates to a submitted Information Request, the original Information Request shall be included with the Compensation Request submission.
- .05 If a Compensation Request is submitted as the result of an unresolved Change Order price agreement negotiation, the original Change Order shall be provided with the Compensation Request submission.
- .06 After the Compensation Request is submitted, the Contractor shall immediately:
- a) Begin to keep Daily Work Records relating to the Compensation Request as the Work is performed, according to clause GC 8.03.02, Daily Work Records.
 - b) Limit such Daily Work Records to the Work directly impacted by the Compensation Request.
 - c) Keep separate Daily Work Records for each individual Compensation Request.
- .07 The keeping of Daily Work Records by the Contractor and any process to review or comment on those records shall not be construed to be the Owner's acceptance of the Compensation Request to which the Daily Work Records relate.
- .08 Prior to the expiry of 60 Days from the date of receipt of the Compensation Request, the Contract Administrator shall issue a Decision.

- .09 If the Owner requests additional information from the Contractor to justify a Compensation Request, then the calculation of time set out to render a Decision shall cease from the date of the request, until the Contractor has provided the information or a statement that it does not intend to provide the information. This waiting period is limited to 10 Days. If no further information is received within that time frame, the Owner shall proceed with the review and issue the Decision; with the Contractor accepting the risk of the Owner making an adverse Decision by reason of the lack of the requested information.
- .10 If both parties mutually agree before the expiry of any time period specified for issuing a Decision, then the parties may extend such time to issue a Decision.
- .11 Where a Compensation Request Decision is not issued within the specified time period as may be extended by mutual agreement, the matter shall be assumed to be concluded, whereupon the Contractor may proceed to subsection GC 3.15, Dispute Resolution.
- .12 Upon receipt of a Compensation Request Decision, the matter shall be considered concluded, whereupon the Contractor may either accept the Decision or proceed to subsection GC 3.15, Dispute Resolution.
- .13 If the Contractor does not accept the Compensation Request Decision and elects to proceed to clause GC 3.15.01, Claim Review Process, the Compensation Request Decision becomes null and void for the purpose of the claim review process.

GC 3.15 Dispute Resolution

GC 3.15.01 Claim Review Process

- .01 In the event that a matter remains unresolved and the Contractor wishes to pursue a Claim through the claim review process, within 10 Days of receipt of the Contract Administrator's Decision regarding a Compensation Request, the Contractor shall provide a written notice of its intent to submit a Claim to the Manager, Contract Claims Office, Capital Program Delivery Branch (CPDB), Transportation Infrastructure Management Division (TIMD), which notice shall be referred to as the "initial notice".
- .02 Within 5 Days of receipt of the "initial notice" of Claim, the Manager, Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division, shall either begin the review of the Claim or submit a Notice of Adjudication.
- .03 Both parties shall conduct, without prejudice, negotiations as part of the claim review process, and they agree not to disclose in any subsequent legal proceeding, any statements made, and documents or information obtained during the process that is not otherwise required to be disclosed by law.
- .04 Notwithstanding the use of the claim review process to resolve a dispute, the Contractor shall proceed with the Work to completion with due diligence and in an expeditious manner and such action shall not prejudice the Contractor in respect of the Claim. The Contractor is not relieved from complying with any direction, order, Change Order, or Work Directive that relates to the Claim.
- .05 In the event that a Compensation Request Decision is not accepted, and the Contractor wishes to pursue a Claim review, then within 20 Days of receipt of the Compensation Request Decision, the Contractor shall submit a notice of claim to the Manager, Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division.
- .06 The notice of claim shall contain, as a minimum, enough information under the headings described below to permit a detailed review by the Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division:
 - a) Date on which the circumstances arose that gave rise to the Claim.
 - b) Detailed description of the nature of the Claim with dates, location, Materials, and Equipment involved and any other items relevant to the Claim.

- c) Relevant provisions of the Contract which support the Claim and the reasons these provisions are relevant, including work affected by the Claim, areas of work incurring additional costs and the change from the tendered Contract.
 - d) Originally submitted Compensation Request and any additional information that was submitted in response to Contract Administrator requests.
 - e) A detailed summary of critical path schedule impacts shall be included along with supporting critical path schedule updates that have been previously submitted.
 - f) Summary of proven actual or estimated additional costs, including direct labour, Material, Equipment and Subcontractor costs.
 - g) Summary of proven indirect costs or estimated indirect costs, including standby, site overhead, and impact costs.
 - h) Copies of all supporting documentation and records of the Contractor applicable to the Claim, including:
 - i. Instruction notices.
 - ii. Change Orders.
 - iii. Daily Work Records as set out in clause GC 8.03.02, Daily Work Records.
 - iv. Email correspondence between the Contract Administrator/Owner and the Contractor
 - v. Production rates.
 - vi. Minutes of meetings.
 - i) Any other information deemed necessary or appropriate by the Contractor.
- .07 After the Contractor has filed the notice of claim, they shall be permitted to submit the following:
- a) Additional information that supports the Claim.
 - b) Updated, actual or additional cost information of items contained in the original notice of claim as those costs become available during the Claim review.
- .08 When the Contractor completes the work associated with the Claim and the Claim remains unresolved, then the Contractor shall provide details of the actual costing of the items detailed in the notice of claim in writing to the Manager, Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division within 30 Days after completion of the affected work.
- .09 The Contractor is solely responsible for providing all the information required in the notice of claim.
- .10 The Contractor's failure to provide any notices as required shall result in the waiver of any Claim and the loss of compensation to the Contractor in respect of such Claim. However, if the Contractor provides the Owner with an explanation for the delay in providing this notice, which the Owner, in its sole discretion, can accept or reject for any reason, then, if the explanation is accepted, the Owner shall review the Claim according to the procedures set out herein. This provision shall not be interpreted so as to compel the Owner to review every Claim of the Contractor or any other person that does not comply with the requirements of the Contract, but rather is intended to allow the Owner the ability to consider those Claims that have failed to comply with the procedures and where the Owner, at its sole discretion, desires to consider such a Claim.
- .11 If the Manager, Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division, elects to review the Claim then prior to the expiry of 75 Days from the receipt of a complete notice of claim, the Manager, Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division, shall provide the Contractor with a written Decision.
- .12 If the Owner requests additional information from the Contractor to justify a Claim, then the calculation of time set out to render a Decision shall cease from the date of the request, until the Contractor has provided the information or a statement that it does not intend to provide the information. This waiting period is limited to 10 Days. If no further information is received within that time frame, the Owner shall proceed with the review and issue the Decision; with the Contractor accepting the risk of the Owner making an adverse Decision by reason of the lack of the requested information.

- .13 If both parties mutually agree before the expiry of any time period specified for issuing a Decision, then the parties may extend such time to issue a Decision.
- .14 Where a Decision is not issued within the specified time period as may be extended by mutual agreement, the matter shall be assumed to be denied, whereupon the dispute may proceed to Adjudication.
- .15 Upon receipt of the Claim Decision, the Contractor shall provide its written response to the Owner within 10 Days signifying a clear intention that they accept the Decision, disagree with the Decision and intend to pursue Adjudication or disagree with the Decision and intend to pursue further avenues of dispute resolution.

GC 3.15.02 Adjudication

- .01 The parties agree that for the purpose of section 13.5(1) (1.) (2.) and (7.) of the *Construction Act*, a dispute does not arise in respect of those matters, and therefore a Notice of Adjudication shall not be given, until:
 - a) A Decision has been issued on a Compensation Request or;
 - b) Time to issue the Decision on the Compensation Request has expired.
- .02 If the Contractor initiated the claim review process after receipt of the Compensation Request Decision, the parties agree that the Contractor shall not give a Notice of Adjudication until:
 - a) A Decision has been issued on a Claim; or
 - b) Time to issue the Decision on the Claim has expired.
- .03 Pursuant to Section 13.7 of the *Construction Act*, a Notice of Adjudication posted to the website that is set up for adjudication purposes that is to be given to the Owner shall be immediately downloaded from the website and emailed to the Contract Administrator, the Area Head of Claims, and the Manager, Contract Claims Office. If an email is returned with an out of office reply, the Notice of Adjudication shall be immediately forwarded by email to the alternate named in the out of office reply.
- .04 The parties agree that:
 - a) Further to Section 13.5 of the *Construction Act* the expiry of the Adjudication period shall be 3 months after Contract Completion.
 - b) Further to Section 13.11 of the *Construction Act*, the documents for Adjudication shall include the Compensation Request, and if applicable, the notice of claim. Any offer of compensation made in response to a Compensation Request or offer of settlement made in response to a notice of claim are made on a confidential and without prejudice basis and shall not be mentioned in the Notice of Adjudication and shall be excluded from the documents for Adjudication and any further dispute resolution or legal proceedings.
 - c) Further to Section 13.13 of the *Construction Act*, the deadline for the adjudicator's determination shall be extended by 20 Days.

GC 3.15.03 Further Avenues of Dispute Resolution

- .01 If the parties fail in their efforts to resolve the Claim, then the parties agree that prior to resorting to litigation they may explore further alternative dispute resolution methods that are acceptable to the Owner. The Contractor shall provide written notice to the Manager, Contract Claims Office, Capital Program Delivery Branch, Transportation Infrastructure Management Division, of the desire to explore further alternative dispute resolution methods within 20 Days of a Decision on a Claim. If the parties are unable to agree upon an alternative dispute resolution method and its terms within 75 Days of a request to explore alternative dispute resolution, then either party may resort to litigation.

SECTION GC 4.0 - OWNER'S RIGHTS AND RESPONSIBILITIES

GC 4.01 Working Area

- .01 The Owner shall acquire all property rights which are deemed necessary by the Owner for the construction of the Work, including temporary working easements, and shall indicate the full extent of the Working Area on the Contract Drawings.

GC 4.02 Management of Excess Materials

- .01 The Owner shall identify in the Contract Documents the materials to be moved within or removed from the Working Area, and any characteristics of those materials which shall necessitate special materials management and disposition.
- .02 The Owner shall be responsible for any additional costs of removal, management, and disposition of any material not identified in the Contract Documents, or where conditions exist that could not have been reasonably foreseen at the time of tendering.

GC 4.03 Construction Affecting Railway Property

- .01 When construction affects railway property, the Owner shall pay the costs of all flagging and other traffic control measures required and provided by the railway company within the Working Area.

GC 4.04 Default by the Contractor

- .01 The Contractor shall be in default of the Contract if:
 - a) The Contractor fails to commence the Work or execute the Work properly or otherwise fails to comply with the requirements of the Contract to a substantial degree; or
 - b) If the Contractor is adjudged bankrupt or makes a general assignment for the benefit of creditors because of insolvency or if a receiver is appointed because of insolvency.

GC 4.05 Notification of Default

- .01 The Owner shall give written notice of a default to the Contractor as soon as the Owner becomes aware of the alleged default, but failure to give such notice in a timely way shall not constitute acceptance of the default. The notice shall include instructions to correct the default within 5 Business Days.

GC 4.06 Contractor's Right to Correct a Default

- .01 The Contractor shall have the right within the 5 full Business Days following the receipt of a notice of default to correct the default and provide the Owner with satisfactory proof that appropriate corrective measures have been taken.
- .02 If the correction of the default cannot be completed within the 5 full Business Days following receipt of the notice, the Contractor shall not be in default if the Contractor:
 - a) Commences the correction of the default within the 5 full Business Days following receipt of the notice;
 - b) Provides the Owner with an acceptable schedule for the progress of such correction; and
 - c) Completes the correction according to such schedule.

GC 4.07 Owner's Right to Correct Default

- .01 If the Contractor fails to correct the default within the time specified in subsection GC 4.06, Contractor's Right to Correct a Default, or subsequently agreed upon, the Owner, without prejudice to any other right or remedy the Owner may have, may correct such default and deduct the cost thereof, as certified by the Contract Administrator, from any payment then or thereafter due to the Contractor.

GC 4.08**Termination of Contractor's Right to Continue the Work**

- .01 Where the Contractor fails to correct a default within the time specified in subsection GC 4.06, Contractor's Right to Correct a Default, or subsequently agreed upon, the Owner, without prejudice to any other right or remedy the Owner may have, may terminate the Contractor's right to continue the Work in whole or in part by giving written notice to the Contractor.
- .02 If the Owner terminates the Contractor's right to continue with the Work in whole or in part, the Owner shall be entitled to:
- a) Take possession of the Working Area or that portion of the Working Area devoted to that part of the Work terminated;
 - b) Use the Contractor's Material within the Working Area which is intended to be incorporated into the Work, the whole subject to the right of third parties;
 - c) Withhold further payments to the Contractor with respect to the Work or the portion of the Work withdrawn from the Contractor until the Work or portion thereof withdrawn is completed;
 - d) Charge the Contractor the additional cost over the Contract price of completing the Work or portion thereof withdrawn from the Contractor, as certified by the Contract Administrator, and any additional compensation paid to the Contract Administrator for such additional service arising from the correction of the default;
 - e) Charge the Contractor a reasonable allowance, as determined by the Contract Administrator, to cover correction to the Work performed by the Contractor that may be required under subsection GC 7.18, General Warranty; and
 - f) Charge the Contractor for any damages the Owner may have sustained as a result of the default.

GC 4.09**Final Payment to Contractor**

- .01 If the Owner's cost to correct and complete the Work in whole or in part is less than the amount withheld from the Contractor under subsection GC 4.08, Termination of Contractor's Right to Continue the Work, the Owner shall pay the balance to the Contractor as soon as the final accounting for the Contract is complete.

GC 4.10**Termination of the Contract**

- .01 Where the Contractor is in default of the Contract, the Owner may, without prejudice to any other right or remedy the Owner may have, terminate the Contract by giving written notice of termination to the Contractor, the Surety, and any trustee or receiver acting on behalf of the Contractor's estate or creditors.
- .02 If the Owner elects to terminate the Contract, the Owner shall provide the Contractor and the trustee or receiver with a complete accounting to the date of termination.
- .03 If the Contract is terminated, the Owner shall publish the statutory notice of termination prescribed by Form 8 of Ontario Regulation 303/18 of the *Construction Act*, in the *Daily Commercial News* and the date of the termination of the Contract shall be the date specified in the statutory notice of termination for the Contract.

GC 4.11**Continuation of Contractor's Obligations**

- .01 The Contractor's obligation under the Contract as to quality, correction, and warranty of the Work performed prior to the time of termination of the Contract or termination of the Contractor's right to continue with the Work in whole or in part shall continue to be in force after such termination.

GC 4.12**Use of Performance Bond**

- .01 If the Contractor is in default of the Contract and the Contractor has provided a Performance Bond, the Owner may rely upon the Performance Bond and its conditions along with the Contract Documents.

GC 4.13**Owner Audit**

- .01 The Owner may inspect, review, and audit all Records associated with the Contract, including the Contractor's and Subcontractor's Records relating to the Work and Changes in the Work and Claims, at any time up to 24 months after releasing payment of the final holdback. The Contractor shall complete and submit to the Contract Administrator, the MTO form PH-CC-762, Subcontractor's Consent to Audit, for each Subcontractor employed by the Contractor.
- .02 The Contractor shall supply certified copies of any part of the Contractor's Records whenever requested by the Owner.
- .03 Where the inspection, review, and audit reveals discrepancies in payment, the Contractor shall be advised immediately. The Contractor shall have the opportunity to dispute these discrepancies by immediately submitting a MTO form PH-CC-750, Request for Clarification.
- .04 Upon agreement with the results, any monies payable to the Contractor shall be payable within 28 Days. Interest back to the time the amount became payable shall not be paid.
- .05 Upon agreement with the audit results, any monies due to the Owner shall be payable within 28 Days together with interest due from the time the amount was over paid.

SECTION GC 5.0 - MATERIAL

GC 5.01 Supply of Material

- .01 All Material necessary for the proper completion of the Work, except that listed as being supplied by the Owner, shall be supplied by the Contractor. The Contract prices for the appropriate tender items shall be deemed to include full compensation for the supply and delivery of such Material.

GC 5.02 Quality of Material

- .01 All Material provided by the Contractor shall be new, unless otherwise specified in the Contract Documents.
- .02 Material shall be supplied from sources identified in the MTO DSM available on TRA website <http://www.roadauthority.com> that is current at the time of supply of the product. If there are revisions to the DSM, these shall be posted on TRA website on the first Business Day of the months of February, April, June, August, October, and December. Material for which there is no category in the DSM shall be supplied according to the Contract Documents. Material which is not specified shall be of a quality best suited to the purpose required and the use of such Material shall be subject to the approval of the Contract Administrator.

Sources in the DSM have demonstrated their ability to produce material according to specified material specifications. However, the MTO does not warrant that these sources shall produce acceptable or sufficient Material for any contract. The Contractor shall make such independent investigation and examination as the Contractor deems necessary, to satisfy the Contractor as to the quality and quantity of the Material available from these sources, and to ensure that all Material supplied by them satisfies the requirements of the Contract Documents.

- .03 When specified in the Contract Documents or requested by the Contract Administrator, the Contractor shall make available for inspection or testing a sample of any Material to be provided by the Contractor.
- .04 The Contractor shall obtain for the Contract Administrator the right to enter upon the premises of the Material manufacturer or supplier to carry out such inspection, sampling, and testing as specified in the Contract Documents or as requested by the Contract Administrator.
- .05 The Contractor shall complete and submit, on MTO form PH-A-106, List of Materials from Designated Sources, to the Contract Administrator indicating where the Contractor intends to obtain the designated source materials for the Contract. The Contractor shall notify the Contract Administrator of the sources of supply of all Material sufficiently in advance of the Material shipping dates to enable the Contract Administrator to perform the required inspection, sampling, and testing.
- .06 The Owner shall not be responsible for any delays to the Contractor's operations where the Contractor fails to give sufficient advance notice to the Contract Administrator to enable the Contract Administrator to carry out the required inspection, sampling, and testing before the scheduled shipping dates.
- .07 Where the Standards require the Contractor to supply a Material designated by a trade or other name, the tender shall be based only upon supply of the Material so designated, which shall be regarded as the standard of quality required by the Standard.
- .08 Prior to the commencement of Work, the Contractor shall provide to the Contract Administrator a list of those products controlled under the Workplace Hazardous Material Information System (WHMIS) that the Contractor expects to use on the Contract. Related Material Safety Data Sheets shall accompany the submission. All containers used in the application of products controlled under WHMIS shall be labelled. The Contractor shall notify the Contract Administrator of changes to the list in writing and provide relevant Material Safety Data Sheets.

- .09 When a Material or Material source is deleted from the DSM list of pre-qualified Materials or Material sources after the tender opening date, the Owner shall be responsible for the extra costs of Material supply only, unless the Material production or Material source is controlled by the Contractor or Subcontractor. If the type of Material or Material source is pre-qualified after the date of tender opening, permission to use the Materials or Material sources shall not be given until an agreement has been reached on the estimated value of the cost savings to the Owner.
- .10 Within 24 hours written notice, the Contractor shall provide the Owner and/or the Contract Administrator full access to quality control laboratories at any time, and copies of all original inspection records, test results (including but not limited to, all supporting readings, measurements, laboratory worksheets and calculations), and other quality control documents.

GC 5.03 Rejected Material

- .01 Rejected Material shall be removed from the Working Area expeditiously after the notification to that effect from the Contract Administrator. Where the Contractor fails to comply with such notice, the Contract Administrator may cause the rejected Material to be removed from the site and disposed of in what the Contract Administrator considers to be the most appropriate manner, and the Contractor shall pay the costs of disposal and the appropriate overhead charges.

GC 5.04 Owner Supplied Material

GC 5.04.01 Ordering of Excess Material

- .01 Where Material is supplied by the Owner and where this Material is ordered by the Contractor in excess of the amount specified to complete the Work, such excess Material shall become the property of the Contractor on completion of the Work and shall be charged to the Contractor at cost plus 10% for administration.

GC 5.04.02 Care of Material

- .01 The Contractor shall, in advance of receipt of shipments of Material supplied by the Owner, provide adequate and proper storage facilities acceptable to the Contract Administrator; and, on the receipt of such Material, promptly place it in storage except where it is to be incorporated forthwith into the Work.
- .02 The Contractor shall be responsible for acceptance of Material supplied by the Owner, at the specified delivery point and for its safe handling and storage. If such Material is damaged while under the control of the Contractor, it shall be replaced or repaired by the Contractor at no expense to the Owner, and to the satisfaction of the Contract Administrator. If such Material is rejected by the Contract Administrator for reasons which are not the fault of the Contractor, it shall remain in the care and at the risk of the Contractor until its disposition has been determined by the Contract Administrator.
- .03 Where Material supplied by the Owner arrives at the delivery point in a damaged condition or where there are discrepancies between the quantities received and the quantities shown on the bills of lading, the Contractor shall immediately report such damage or discrepancies to the Contract Administrator who shall arrange for an immediate inspection of the shipment and provide the Contractor with a written release from responsibility for such damage or deficiencies. Where damage or deficiencies are not so reported, it shall be assumed that the shipment arrived in good order and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner.
- .04 The full amount of Material supplied by the Owner in each shipment shall be accounted for by the Contractor and such Material shall be at the risk of the Contractor after taking delivery. Such Material shall not be used by the Contractor for purposes other than the Work under the Contract.
- .05 Empty reels, crates, containers, and other types of packaging from Material supplied by the Owner shall become the property of the Contractor when they are no longer required for their original purpose and shall be disposed of by the Contractor, unless otherwise specified in the Contract Documents.

- .06 The Contractor shall provide the Contract Administrator, immediately upon receipt of each shipment, copies of bills of lading, or such other documentation the Contract Administrator may require, to substantiate and reconcile the quantities of Material received.
- .07 Where Material supplied by the Owner is ordered and stockpiled prior to the award of the Contract, the Contractor shall, at no extra cost to the Owner, immediately upon commencement of operations, check the Material, report any damage or deficiencies to the Contract Administrator, and take charge of the Material at the stockpile site. Where damage or deficiencies are not so recorded by the Contractor, it shall be assumed that the stockpile was in good order when the Contractor took charge of it and any damage or deficiencies reported thereafter shall be made good by the Contractor at no extra cost to the Owner.

SECTION GC 6.0 - INSURANCE, PROTECTION, AND DAMAGE

GC 6.01 Protection of Work, Persons, and Property

- .01 The Contractor, the Contractor's agents, and all workers employed by or under the control of the Contractor, including Subcontractors, shall protect the Work, persons, and property from damage or injury, and shall be responsible for all losses and damage which may arise as the result of the Contractor's operations under the Contract unless indicated to the contrary below.
- .02 The Contractor is responsible for the full cost of any necessary temporary provisions and the restoration of all damage, where the Contractor damages the Work or property in the performance of the Contract. If the Contractor is not responsible for the damage that occurs to the Work or property the Contractor shall restore such damage, and such work shall be administered according to these MTO General Conditions of Contract.
- .03 The Contractor shall immediately inform the Contract Administrator of all damage and injuries which occur during the term of the Contract.
- .04 The Contractor shall not be responsible for loss and damage that occurs as a result of:
 - a) War;
 - b) Blockades and civil commotion;
 - c) Errors in the Contract Documents;
 - d) Acts or omissions of the Owner, the Contract Administrator, the Owner's agents, officers, and employees, or others not under the control of the Contractor but are within the Working Area with the Owner's permission.
- .05 The Contractor and the Contractor's Surety or Sureties shall not be released from any term or provision of any responsibility, obligation, or liability under the Contract or waive or impair any of the rights of the Owner, except by a release duly executed by the Owner.

GC 6.02 Indemnification

GC 6.02.01 General

- .01 The Contractor shall indemnify and hold harmless the Owner and the Contract Administrator, the Owner's agents, officers, and employees from and against all claims, demands, losses, expenses, costs, damages, actions, suits or proceedings by third parties, hereinafter called "claims", directly or indirectly arising or alleged to arise out of the performance of or the failure to perform the Work, provided such claims are:
 - a) Attributable to bodily injury, sickness, disease, or death or to damage to or destruction of tangible property;
 - b) Caused by negligent acts or omissions of the Contractor or anyone for whose acts the Contractor may be liable; and
 - c) Made in writing within a period of 6 years from the date of substantial performance of the Work as set out in MTO form PH-CC-799, Certificate of Substantial Performance or, where so specified in the Contract, from the date of the Contract Completion Certificate.
- .02 The Contractor shall indemnify and hold harmless the Owner from all and every claim for damages, royalties, or fees for the infringement of any patented invention or copyright occasioned by the Contractor in connection with work performed or Material furnished by the Contractor under the Contract.
- .03 The Owner expressly waives the right to indemnity for claims other than those stated in paragraphs .01 and .02 of clause GC 6.02.01, General (Indemnification).

- .04 The Owner shall indemnify and hold harmless the Contractor, their agents, officers, and employees from and against all claims, demands, losses, expenses, costs, damages, actions, suits, or proceedings arising out of the Contractor's performance of the Contract that are attributable to a lack of or defect in title or an alleged lack of or defect in title to the Working Area.
- .05 The Contractor expressly waives the right to indemnity for claims other than those stated in paragraph .04 of clause GC 6.02.01, General (Indemnification).

GC 6.03 Contractor's Insurance

GC 6.03.01 General

- .01 Without restricting the generality of subsection GC 6.02, Indemnification, the Contractor shall provide, maintain, and pay for the insurance listed in these MTO General Conditions of Contract and specifically described under clause GC 6.03.02, Commercial General Liability Insurance, and clause GC 6.03.03, Automobile Liability Insurance, and such other insurance as may be specified in the Contract Documents.

GC 6.03.02 Commercial General Liability Insurance

- .01 Commercial general liability insurance on an occurrence basis for third-party bodily injury, personal injury, and property damage shall have an inclusive limit of not less than \$5,000,000 per occurrence with \$2,000,000 products and completed operations aggregate. The policy is to include the following:
- a) The Owner and the Contract Administrator as additional insured's with respect to liability arising in the course of performance of the Contractor's obligations under or otherwise in connection with the Contract Documents.
 - b) Contractual liability coverage.
 - c) Cross-liability clause.
 - d) Employer's liability coverage.
 - e) 30 Day written notice of cancellation, termination, or material change.
 - f) Non-owned automobile coverage, including standard contractual liability endorsement, with blanket coverage for hired automobiles.
- .02 The Contractor shall provide the Owner with proof of insurance required by these MTO General Conditions of Contract in the form of valid certificates of insurance acceptable to the Owner that references the Contract and confirms the required coverage, on or before the commencement of this Contract, and any renewal replacements on or before the expiry of any such insurance.
- .03 The Contractor shall submit annually on the anniversary of the execution of the Agreement to the Owner the proof of the continuation of the insurance as described in these MTO General Conditions of Contract or elsewhere in the Contract Documents in the form of valid certificates of insurance acceptable to the Owner that references the Contract and confirms the required coverage.
- .04 If the Contractor decides not to employ Subcontractors for operations requiring the use of explosives for blasting, pile driving or caisson work, or removal or weakening of support of property building or land, the certificate of insurance shall include the appropriate endorsements.
- .05 "Claims Made" insurance policies shall not be permitted.

GC 6.03.03 Automobile Liability Insurance

- .01 Automobile insurance in respect of licensed vehicles as per statutory requirements in Ontario shall have limits of not less than \$5,000,000 inclusive per occurrence for bodily injury, death, and damage to property, including accident benefits in the standard owner's form automobile policy providing third-party liability and accident benefits insurance and covering licensed vehicles owned or operated by the Contractor and endorsed to provide the Owner with not less than 30 Days written notice in advance of any cancellation, change, or amendment restricting coverage.

GC 6.03.04 Payment for Loss or Damage

- .01 The Contractor shall be entitled to receive from the Owner, in addition to the amount due under the Contract, the amount at which the Owner's interest in restoration of the Work has been appraised, such amount to be paid as the restoration of the Work proceeds and according to the requirements of section GC 8.0, Measurement and Payment. In addition, the Contractor shall be entitled to receive from the payments made by the insurer the amount of the Contractor's interest in the restoration of the Work.
- .02 The Contractor shall be responsible for deductible amounts under the policies except where such amounts may be excluded from the Contractor's responsibility by the terms of this Contract.
- .03 In the event of loss or damage to the Work arising from the action of others, the Owner shall pay the Contractor the cost of restoring the Work as the restoration of the Work proceeds and according to the requirements of section GC 8.0, Measurement and Payment.

GC 6.03.05 Insurance Requirements and Duration

- .01 Unless specified otherwise, the insurance shall be maintained continuously from the commencement of the Work until 10 Days following the date of Contract Completion Certificate, and with respect to completed operations coverage for a period of not less than 24 months from the date of Contract Completion Certificate, and thereafter to be maintained for a further period of 4 years.
- .02 The Contractor shall provide the Owner, on a form acceptable to the Owner, proof of insurance prior to commencement of the Work, signed by an officer of the Contractor and either the underwriter or the broker.
- .03 The Contractor shall, on request of the Owner, promptly provide the Owner with a certified true copy of each insurance policy exclusive of information pertaining to premium or premium bases used by the insurer to determine the cost of the insurance. The certified true copy shall include a signature by an officer of the Contractor and in addition, a signature by an officer of the insurer or the underwriter or the broker.
- .04 Unless specified otherwise the Contractor shall be responsible for the payment of deductible amounts under the policies.
- .05 If the Contractor fails to provide or maintain insurance as required in these MTO General Conditions of Contract or elsewhere in the Contract Documents, then the Owner shall have the right to provide and maintain such insurance and give evidence thereof to the Contractor. The Owner's cost thereof shall be payable by the Contractor to the Owner on demand.
- .06 If the Contractor fails to pay the cost of the insurance placed by the Owner within 30 Days of the date on which the Owner made a formal demand for reimbursement of such costs, the Owner may deduct the costs thereof from monies which are due or may become due to the Contractor.

GC 6.04 Bonding

GC 6.04.01 General

- .01 If the Total Bid Price is \$500,000 or more, the Contractor shall furnish the Owner with Statutory Bonds, being a Performance Bond and Labour and Material Payment Bond in accordance with the *Construction Act*.
- .02 Such Statutory Bonds shall be obtained from a Surety that is an insurer licensed under the *Insurance Act* to write surety and fidelity insurance.
- .03 The Contractor shall furnish the Owner with Contract Bonds as prescribed in the Contract Documents and satisfactory to the Owner.

- .04 Such Contract Bonds shall be obtained from a Surety that is an insurer licensed under the *Insurance Act* to write surety and fidelity insurance.

GC 6.04.02 Performance Bond

- .01 With respect to the Statutory Bond for a Performance Bond, the Contractor shall furnish a Performance Bond using Form 32 of Ontario Regulation 303/18 of the *Construction Act* that is conditioned on the due performance of the terms of the Contract for the amount of 50% of the Total Bid Price.

GC 6.04.03 Labour and Material Payment Bond

- .01 With respect to the Statutory Bond, the Contractor shall furnish a Labour and Material Payment Bond using Form 31 of Ontario Regulation 303/18 of the *Construction Act* that extends or guarantees payment protections to the Subcontractor and Persons supplying labour and Material to the Contract for the amount of 50% of the Total Bid Price.

SECTION GC 7.0 - CONTRACTOR'S RESPONSIBILITIES AND CONTROL OF THE WORK

GC 7.01 General

GC 7.01.01 Site Visit

- .01 The Contractor warrants that the site of the Work has been visited during the preparation of the tender and the character of the Work and all local conditions which may affect the performance of the Work are known.

GC 7.01.02 Commencement of Work

- .01 The Contractor shall not commence the Work nor deliver anything to the Working Area until the Contractor has received written permission, on MTO form PH-CC-700, Permission to Start Work, duly signed by the Contract Administrator.

GC 7.01.03 Control and Responsibility

- .01 The Contractor shall have complete control of the Work and shall effectively direct, supervise, and undertake quality control activities for the work so as to ensure conformity with the Contract Documents. The Contractor shall be responsible for construction means, methods, techniques, sequences, and procedures and for coordinating the various parts of the Work.
- .02 The Contractor shall have the sole responsibility for the design, erection, operation, maintenance, and removal of temporary structures and other temporary facilities and the design and execution of construction methods required in their use.
- .03 Notwithstanding paragraph .02 of clause GC 7.01.03, Control and Responsibility, where the Contract Documents include designs for temporary structures and other temporary facilities or specify a method of construction in whole or part, such facilities and methods shall be considered to be part of the design of the Work, and the Contractor shall not be held responsible for that part of the design or the specified method of construction. The Contractor shall, however, be responsible for the execution of such design or specified method of construction in the same manner that the Contractor is responsible for the execution of the Work.
- .04 Any Notice to Proceed by the Owner or its Contract Administrator of the Work and Materials of the Contractor does not relieve the Contractor from any responsibility or obligation for the proper performance of the Work in conformity with the requirements of the Contract Documents. As well, the Notice to Proceed imposes no liability upon the Owner or its Contract Administrator and is not to be interpreted as an approval or acceptance of the Work or the Materials by the Owner that the Work and Materials was completed or supplied in conformance with the Contract Documents.

GC 7.01.04 Compliance with the Occupational Health and Safety Act

- .01 The Contractor shall execute the terms of the Contract in strict compliance with the requirements of the *Occupational Health and Safety Act*, R.S.O. 1990, c. O.1 (*the Act*) and Ontario Regulation 213/91 (*Construction Projects*) and any other regulations under *the Act (the Regulations)* which may affect the performance of the Work, as the Constructor or employer, as the case may be. The Contractor shall ensure that:
- a) Worker safety is given first priority in planning, pricing, and performing the Work;
 - b) The Contractor's officers and supervisory employees have a working knowledge of the duties of a Constructor and employer under the Act and the provisions of the Regulations applicable to the Work, and a personal commitment to comply with them;
 - c) A copy of the most current version of the Act and the Regulations are available at the Contractor's office within the Working Area or, in the absence of an office, in the possession of the Superintendent responsible for the performance of the Work;

- d) Workers employed to carry out the Work possess the knowledge, skills, and protective devices required by law or recommended for use by a recognized industry association to allow them to work in safety;
 - e) The Contractor's supervisory employees carry out their duties in a diligent and responsible manner with due consideration for the health and safety of the workers; and
 - f) All Subcontractors performing part of the Work and their employees are properly protected from injury while they are at the work place.
- .02 When requested, the Contractor shall provide the Owner with a copy of its health and safety policy and program at the pre-start meeting and shall respond promptly to requests from the Owner for confirmation that its methods and procedures for carrying out the Work comply with *the Act* and *the Regulations*. The Contractor shall cooperate with representatives of the Owner and Ministry of Labour inspectors appointed to enforce *the Act* and *the Regulations* in any investigations of worker health and safety in the performance of the Work. The Contractor shall indemnify and save the Owner harmless from any additional expense that the Owner may incur to have the Work performed as a result of the Contractor's failure to comply with the requirements of *the Act* and *the Regulations*.
- .03 The Contractor shall immediately, upon receipt, provide the Owner a copy of all correspondence from the Ministry of Labour including but not limited to Project Forms, Stop Work Orders, or Certificates of Offence.
- .04 For work inside confined spaces, including box girder bridges, detailed written procedures addressing the confined space requirements of *the Act* and *Construction Projects*, shall be clearly posted at the project site and available to all personnel, including the Contractor's workers, the Contract Administrator, MTO personnel, and Ministry of Labour inspectors. The procedures shall include the rescue procedures to be followed during a rescue or evacuation of all personnel from an unsafe condition or in the event of personal injury. The Contractor shall have personnel trained in rescue procedures readily available on site.
- .05 Whenever the Contractor proposes to suspend a multi-support point work platform system from a permanent structure, the Contractor shall retain an Engineer to evaluate the structural adequacy of the permanent structure taking into account the loadings imposed by the work platform system and the actual condition of the structure during construction. The Engineer retained by the Contractor shall be deemed responsible for the structural integrity of the permanent structure in fulfilling the requirements of *the Act* and *the Regulations*.

Structural evaluation shall be according to CSA S6:19 and all Owner policies and standards. The design and operation of the multi-support point work platform system shall not have an adverse impact on the long-term durability of the structure and shall meet all operational constraints specified in the Contract Documents.

Two weeks prior to the installation of the multi-support point work platform system, the Contractor shall submit the following to the Contract Administrator for information purposes only:

- a) Three sets of Working Drawings of the work platform system signed and sealed by two Engineers. The loading imposed by the work platform system on the permanent structure shall be clearly shown on the Working Drawings.
- b) Three copies of the evaluation report of the permanent structure bearing the seal and signature of two Engineers. The evaluation report shall include a letter from the Engineers certifying that the permanent structure can safely carry the load imposed by the work platform system together with any other dead and live load that the structure is carrying during construction.

The Contractor shall not make any permanent alterations to the structure as part of the work platform system installation without written permission from the Owner.

GC 7.01.05**Contractor's Representatives**

- .01 The Contractor shall have an authorized representative on the site while any work is being performed, to act for or on the Contractor's behalf. Prior to commencement of construction, the Contractor shall notify the Contract Administrator of the names, addresses, positions, and telephone numbers of the Contractor's representatives who can be contacted at any time to deal with matters relating to the Contract.
- .02 The Contractor shall designate a person to be responsible for traffic control and highway work zone safety. The designated person shall be a competent worker who is qualified because of:
 - a) Knowledge, training, and experience to perform the duties;
 - b) Is familiar with Book 7 of the OTM; and
 - c) Has knowledge of all potential or actual danger to workers and motorists.

Prior to the commencement of construction, the Contractor shall notify the Contract Administrator of the name, address, position, and telephone number of the designated person. The designated person may have other responsibilities, including other construction sites, and need not be present in the Working Area at all times.

- .03 The Contractor shall maintain a daily, hard bound diary of the signs in use for temporary and long-term traffic control. The diary shall be submitted with the final payment documents. For the duration of the Contract and within 24 hours of a request by the Contract Administrator, the Contractor shall provide the Contract Administrator full access to the diary. The following information shall be included in the diary:
 - a) A schematic of the location of each existing sign by station, offset, and height above pavement.
 - b) A schematic of the placement and re-location of all construction signs by station, offset, and height above pavement.
 - c) Traffic accidents, including time of inspection, location of incident, and photographs.
 - d) Time and date of daily sign inspections.

GC 7.01.06**Assistance to the Contract Administrator**

- .01 The Contractor shall, at no additional cost to the Owner, furnish all reasonable aid, facilities, and assistance required by the Contract Administrator for the proper inspection and examination of the Work or the taking of measurements for the purpose of payment.
- .02 The Contractor shall submit quantities of Work completed to the Contract Administrator on a weekly basis, as a minimum, to facilitate reconciliation of quantities of Work completed.

GC 7.01.07**Critical Path Schedule**

- .01 Initial and updated critical path schedules shall be prepared and submitted as detailed below:
 - a) Two paper copies and one electronic copy in the format of the scheduling software and readable by the scheduling software of the initial construction schedule shall be submitted to the Regional Operations Office within 7 Business Days of receipt of the acceptance of the tender.
 - b) One hard copy of the initial construction schedule shall also be submitted to the Contract Management Office, St. Catharines, with the executed copies of the Contract.
 - c) Where the Contractor has revised the initial construction schedule prior to the first site meeting, the revised construction schedule shall be submitted to the Contract Administrator at least 3 Business Days prior to the meeting.

- d) Two paper copies and one electronic copy in the format of the scheduling software and readable by the scheduling software of an updated schedule shall be prepared and submitted to the Contract Administrator not less than 3 Business Days prior to all regularly scheduled site meetings. All revisions shall be highlighted on the updated schedule. Updated schedules submitted shall reflect actual progress of the Work and any additions, deletions, or revisions to the Work that have arisen since the previous update. At regularly scheduled site meetings, the Contractor shall explain the revisions and any increase or decrease in resources required to complete the Work on time. At the Contract Administrator's request, and at no additional cost to the Owner, the Contractor shall submit an updated schedule within 7 Business Days of any major increase or decrease in quantities, or major change in the staging or perceived change in character of the Work.
- e) All copies shall be legible and shall show the date the schedule was prepared.

.02 The requirements for the construction schedule are detailed below:

- a) The critical path method shall be used to prepare and update the construction schedule. The initial and updated construction schedules shall consist of a time scaled network diagram with its related bar charts or a time scaled linear diagram.
- b) For Contracts with a specified number of Working Days, the construction time shown on the initial schedule shall not exceed the specified number of Working Days. The activities on the critical path shall assist the Contract Administrator in determining the Controlling Operation for the purpose of the charging of Working Days. The construction schedule shall include all non-working periods and appropriate allowances for Inclement Weather.
- c) For Contracts which specify a Contract Completion date, the construction time shown on the initial construction schedule shall not extend beyond the specified Contract Completion date. The construction schedule shall include all non-working periods and appropriate allowances for Inclement Weather.
- d) The construction schedule shall reflect operational constraints, interim completion dates, and other scheduling requirements specified in the Contract Documents.
- e) A delay for an activity shall be deemed to have occurred when the activity is not complete on its late finish date established by the construction schedule or it exceeds the specified number of Working Days or specified Completion Date for the Contract.

.03 The requirements for diagrams and bar charts are detailed below:

- a) The Contractor may select to submit initial and updated construction schedules in either logic diagram format with accompanying time scaled bar charts or time scaled linear diagrams.
- b) The Contractor shall select the activities so that the Work is identifiable and the progress of each activity can be determined. The Owner reserves the right to limit or increase the number of activities on the diagram.
- c) Each activity in the initial and updated construction schedules shall include a description of the operation and the number of Days allocated or actually used for it. When the duration of an activity is dependent on weather conditions, the number of Days allocated shall include an allowance for normal frequency of Inclement Weather. In addition, for Contracts which specify the number of Working Days for the Contract Time, the expected number of Working Days shall be shown for the activities on the critical path that may be subject to Working Day charges. When the activity has an associated tender item quantity, the approximate quantity shall also be shown.
- d) The construction schedule shall show the sequence and interdependence of all activities required to complete the Work under the Contract, including time for review of Working Drawings and mix design submissions, early start date, early finish date, and float times. All network connections used to create a logical schedule and the corresponding durations shall be shown. Activities on the critical path shall be identified clearly on the diagram.
- e) The time scale of the construction schedule may be divided into Days or weeks.

.04 The Contractor shall not be permitted to start work until a construction schedule, conforming to clause GC 7.01.07, Critical Path Schedule, is received by the Contract Administrator.

- .05 If, for any reason, the Contractor cannot produce an acceptable construction schedule within 30 Business Days of initial submission of the construction schedule, the Contractor shall be in default of the Contract.

GC 7.01.08 Errors Relating to the Contract

- .01 Where the Contractor finds any errors, inconsistency, or omissions relating to the Contract, the Contractor shall not proceed with the activity affected until receiving direction from the Contract Administrator.
- .02 The Contractor shall promptly report by an Information Request to the Contract Administrator on MTO form PH-CC-755, Information Request, as soon as the Contractor becomes aware of the need for information or clarification of the following:
- a) A situation that is different than represented in the Contract Documents;
 - b) A situation where the Contractor requires additional information; or
 - c) A situation where the Contractor believes the Contract Documents to be ambiguous.
- .03 The Information Request shall include a clear description of the situation with specific references to the Contract Documents.
- .04 Notwithstanding the submission of an Information Request, the Contractor shall proceed with the Work according to paragraph .01 of clause GC 7.01.08, Errors Relating to the Contract.
- .05 Prior to the expiry of 20 Days from the date of receipt of the Information Request or such longer time as the Contractor and the Owner may mutually agree, the Contract Administrator shall provide a written response to the Contractor.

GC 7.01.09 Utilities

- .01 The Contractor shall arrange with the appropriate Utility authorities for the stake out of all underground Utilities and service connections that may be affected by the Work. For ministry owned Utilities, the Contractor shall arrange with the Contract Administrator to have locates completed by the ministry or its agents at the start of the Work, and on Contracts lasting more than one construction season, at the end of seasonal shutdown periods. Locates of ministry owned Utilities at other times shall be the responsibility of the Contractor and at the Contractor's cost. The Contractor shall be responsible for any damage done to the underground Utilities by the Contractor's forces during construction. The Contractor shall also be responsible for any damage done to the service connections. The Contractor shall attend such meetings with the Contract Administrator to ensure coordination of activities among the Contractor and the Utility authorities for each Utility affected by the Contract.
- .02 In the case of damage to, or interference with any Utilities, pole lines, pipe lines, conduits, farm tiles, or other public or privately owned works or property, the Contractor shall immediately notify the Owner and the Contract Administrator of the location and details of such damage or interference.

GC 7.01.10 Public Ceremony

- .01 Only the Owner shall be permitted to make the first public announcements or hold the first public ceremonies about the award or acceptance of the Contract, project milestones, and Contract Completion. The Contractor shall not hold any public ceremony or make any public announcements about the above matters prior to the Owner doing so, without first obtaining the prior written approval of the Owner. The Contractor shall refer all media inquiries regarding such initial announcement and ceremonies to the Owner.
- .02 In paragraph .01 of clause GC 7.01.10, Public Ceremony, "project milestones" means any significant event in the completion of the Work, which includes the completion of a major component of the Work; the opening or closing of lanes, ramps, and structures; and any Work associated with incentives and disincentives described in the Contract Documents.

GC 7.02**Layout**

- .01 Prior to commencement of construction, the Contract Administrator and the Contractor shall locate on site those property bars and benchmarks that are necessary to delineate the Working Area and to lay out the Work, as shown on the Contract Drawings.
- .02 The Contractor shall be responsible for the preservation of all property bars while the Work is in progress, except those property bars that require removal to facilitate the Work. Any property bars disturbed, damaged, or removed by the Contractor's operations shall be replaced under the supervision of an Ontario Land Surveyor, at no cost to the Owner.
- .03 The Contractor shall provide qualified personnel to layout and establish all lines and grades necessary for construction. The Contractor shall notify the Contract Administrator of any layout work carried out.
- .04 The Contractor shall assume full responsibility for alignments, elevations, and dimensions of each and all parts of the Work.
- .05 All stakes, marks, and reference points provided by the Contract Administrator shall be carefully preserved by the Contractor. In the case of their destruction or removal, such stakes, marks, and reference points shall be replaced by the Contractor at no cost to the Owner.
- .06 The Contract Administrator shall provide a grading report to establish grading cross-sections. During the progress of the work the Contractor shall notify the Contract Administrator forthwith of any errors, omissions, or inconsistencies in the geometric information and the controls provided by the Owner. This report contains all necessary information relating to distance and elevation for each station necessary for the construction of the Work.
- .07 Certification shall be required for the layout of the following components of the Work:
 - a) Bridges;
 - b) Retaining walls;
 - c) Culverts having a span of 5 m or more;
 - d) Tunnelling, excluding augered tunnels;
 - e) Sewers of 2 m diameter or more.

For each of the identified components above, the Contractor shall provide to the Contract Administrator, on MTO form PH-CC-811, Certification of the Component, over the seal and signature of either an Engineer or an Ontario Land Surveyor, the following:

- a) Certification of the final pile location before proceeding with footings.
 - b) Certification that the footings have been constructed to the designated lines and grades before proceeding with any work above the footings.
 - c) Final elevations of bridge seats and certification of span dimensions before proceeding with any work on the superstructure of each bridge.
 - d) Actual profiles on the beams before proceeding with any work on the deck of each bridge.
 - e) Certification of the final screed rail elevations before proceeding with the deck placement.
 - f) Certification that each of the identified components of the Work has been constructed to the designated lines and grades before the Contract Completion Certificate.
- .08 The Contractor shall supply the Owner with all as-constructed horizontal and vertical data related to the layout of the Work before the Contract Completion Certificate.
 - .09 The Contractor shall advise the Contract Administrator of the intended layout schedule at the weekly meeting by identifying the survey activities planned for the following week, including any miscellaneous surveying items.

- .10 For the grading layout, stakes 25 mm x 50 mm x 600 mm, minimum, shall be installed left and right of centreline at or near the right-of-way limits and in the areas where additional staking is required, (e.g., intersections, bridges, and on horizontal and vertical curves). Staking intervals shall be as specified in Table 7.02-1 and Table 7.02-2. The only data to be shown on these stakes shall be profile grade, off-set distance from centreline, and station location. The Contractor shall erect butterfly rods or batter boards at grade stake locations.
- .11 The Contractor shall provide a complete set of off-set stakes with finished grade and stations for the following components of the Work:
 - a) Drainage Items - Sewers, road culverts, entrance culverts, maintenance hole, and similar items.
 - b) Pavement Items - Concrete base, concrete pavement, stabilized base, asphalt, Pavement, and similar items. Fine grading stakes shall be used for this work when Pavement items form part of grading or granular work.
 - c) Miscellaneous Items - Sidewalk, curb and gutter, slope paving, structures, fencing, noise barrier, lighting, guide rail barrier, rip-rap, and similar items as required by the Owner.
- .12 For fine grading layout, including paving, fine grading stakes 25 mm x 50 mm x 600 mm in size shall be installed left and right of the control line at or near the Subgrade Shoulder break. These stakes shall be installed at an interval of 30 m or less where the Contract Administrator deems appropriate, on horizontal and vertical curves, widening of intersections, and similar locations. The only data to be shown on these stakes shall be Profile Grade, elevation, off-set distance from the control line, and station.
- .13 For resurfacing layout, offset stakes shall be installed left or right of the control line and at or near the edge of Shoulder at an interval of 50 m or less. The only data to be shown on the stake shall consist of the final Pavement elevation, off-set distance from the control line, and station.

GC 7.03 Damage by Vehicles or Other Equipment

- .01 If at any time, in the opinion of the Contract Administrator, damage is being done or is likely to be done to any Roadway or any improvement thereon, within or outside the Working Area, by the Contractor's vehicles or other Equipment, whether licensed or unlicensed, the Contractor shall, on the direction of the Contract Administrator and at no extra cost to the Owner, make changes or substitutions for such vehicles or Equipment, alter loadings, or in some other manner, remove the cause of such damage to the satisfaction of the Contract Administrator.

GC 7.04 Excess Loading of Motor Vehicles

- .01 Where a vehicle is hauling Material, in whole or in part upon a Highway, and where motor vehicle registration is required for such vehicle, the Contractor shall not cause or permit such vehicle to be loaded beyond the legal limit specified in the *Highway Traffic Act*, whether such vehicle is registered in the name of the Contractor or otherwise, except where there are designated areas within the Working Area where overloading is permitted. The Contractor shall bear the onus of weighing disputed loads.
- .02 Vehicles hauling Materials shall be accompanied by an MTO form SR-E-121, Record of Allowable Gross Weight certificate. The legal limit shall be the vehicle's registered gross weight or the allowable gross weight, whichever is less. The Contractor shall ensure that a copy of the Record of Allowable Gross Weight form is left with the weigh person for Owner use.

GC 7.05**Use of Construction Equipment and Unlicensed Vehicles**

- .01 Unlicensed vehicles and construction equipment, with the exception of rock trucks, shall not travel, work, or stop within 4 m of a lane carrying traffic, except where construction operations necessitates the Working Area be less than 4 m from the traffic in which case, the Contractor shall erect delineators along the edge of the travelled lane, according to paragraph .01 of subsection GC 7.08, Maintaining Roadways and Detours.
- .02 The use of unlicensed rock trucks on facilities open to public traffic shall be permitted only when hauling rock material within the construction zone and subject to the following:
 - a) For unlicensed rock trucks that are less than 3.2 m wide and equipped with foot operated brakes, headlights, and front and rear turn signals, flagging is required at entrance and exit points to warn public traffic.
 - b) For all other unlicensed rock trucks, flagging is required at entrance and exit points and either pilot vehicles or flagging is required along the route to warn public traffic and control movement.
- .03 The use of unlicensed vehicles and construction equipment on bridges under construction and bridges within the Working Area shall be subject to the following requirements:
 - a) Loading shall not exceed the limits specified elsewhere in the Contract Documents.
 - b) Unlicensed vehicles and construction equipment that comply with the legal load limits specified in the *Highway Traffic Act* may be used. Except as noted in paragraph .03, c) of subsection GC 7.05, Use of Construction Equipment and Unlicensed Vehicles, the Contractor shall not cause or permit such vehicles to be loaded beyond the legal limit specified in the *Highway Traffic Act*, including bridge postings and load restrictions. The Contractor shall provide proof of load weight to the Contract Administrator for any disputed loads.
 - c) Unlicensed vehicles and construction equipment that is overloaded in terms of the *Highway Traffic Act* or track propelled equipment greater than 30 tonnes, which the Contractor proposes to drive over bridges under construction and bridges within the Working Area shall be subject to approval. The Contractor shall submit to the Contract Administrator a description and detailed configuration of every such equipment and a certificate, signed and sealed by an Engineer. The certificate shall list the site numbers of every bridge that may be traversed by the subject equipment and state that each Engineer has evaluated, according to the requirements of CSA S6:19, every bridge listed, and that each bridge can safely support all loads.
- .04 Unless specified otherwise in the Contract Documents, pile driving equipment shall not be permitted to operate on bridges.

GC 7.06**Carrier Safety Compliance****GC 7.06.01****Contractor Operation of a Commercial Motor Vehicle**

- .01 Where the Contractor is a Commercial Vehicle Operator's Registration (CVOR) Holder who intends to operate a Commercial Motor Vehicle in the performance of the Contract or in the haulage of Materials to, on, or from the Working Area, the Contractor shall provide to the Owner a copy of the Contractor's CVOR Abstract as follows:
 - a) The first CVOR Abstract shall be provided to the Owner before the Contractor operates a Commercial Motor Vehicle in the performance of the Contract or in the haulage of Materials to, on, or from the Working Area, and
 - b) CVOR Abstracts shall be submitted to the Owner:
 - i. Annually in October.
 - ii. Periodically upon request anytime during the period of the Contract.

The search date recorded on any CVOR Abstract shall not exceed 30 Days from the date that it is provided to the Contract Administrator.

- .02 If at any time the Contractor holds an unsatisfactory or conditional CVOR rating, the Contractor shall advise the Contract Administrator within 72 hours:
- a) The Contractor's Commercial Motor Vehicles shall not operate in the performance of the Contract or in the haulage of materials to or from the Working Area while the Contractor holds an unsatisfactory CVOR rating.
 - b) The Contract Administrator may permit a Contractor with a Conditional CVOR rating to operate their vehicles in the performance of the Contract or in the haulage of materials to or from the Working Area, subject to the following performance criteria:
 - i. Within 10 Days of having a Conditional CVOR Rating, the Contractor produces an approved plan confirming that drivers and vehicles safety programs are in place to ensure compliance with the safety rating requirement, the *Highway Traffic Act*, and *National Safety Code*; and
 - ii. Achieve a satisfactory, satisfactory unaudited, or excellent safety rating under the MTO Carrier Safety Rating Program and have a violation rate of under 70% within 12 months of the date the plan is submitted to the Owner, or show improvement in the Carrier's Safety Performance over the term of the Contract by reducing the Carrier's pointable accidents, pointable convictions and out of service inspections.

Where a Contractor fails to achieve the performance criteria outlined above, the Contract Administrator may require the Contractor to subcontract all work requiring a CVOR Certificate and the Contractor's bidding privileges on future work with the Owner may be affected.

Paragraph .02, b), i. and ii. of clause GC 7.06.01, Contractor Operation of a Commercial Motor Vehicle, are in addition to any carrier interventions or sanctions imposed through the MTO CVOR program.

GC 7.06.02 Subcontractor and Other Operation of a Commercial Motor Vehicle

- .01 Prior to any CVOR Holder operating a Commercial Motor Vehicle in the performance of the Contract or in the haulage of material to, on, or from the Working Area, the Contractor shall examine the CVOR Abstract of every CVOR Holder with whom the Contractor intends to subcontract, directly or indirectly, to operate a Commercial Motor Vehicle in the performance of the Contract or in the haulage of materials to, on, or from the Working Area. The Contractor shall provide the Contract Administrator with the CVOR Holder's name and CVOR Certificate number of all Subcontractors.

The search date of any CVOR Level 1 Abstract shall not exceed 30 Days from the date that it is provided to the Contractor.

The Contractor shall retain copies of all CVOR Abstracts for examination by the Owner, upon request.

- .02 The CVOR Holder shall not hold a dormant or inactive CVOR certificate at any time during the period of the Contract.

The Contractor shall, at all times throughout the duration of the Contract, ensure that no CVOR Holder with an unsatisfactory CVOR rating works, directly or indirectly, for the Contractor in the operation of a Commercial Motor Vehicle in the performance of the Contract or in the haulage of materials to, on, or from the Working Area. The Contractor shall require Subcontractors, in turn, to require compliance with subsection GC 7.06, Carrier Safety Compliance, from any Person with whom they contract.

If a CVOR Holder holds an unsatisfactory CVOR rating at any time during the period of the Contract, the Contractor shall inform the Contract Administrator, in writing, within 72 hours of becoming aware, having exercised all due diligence, of such CVOR Holder having an unsatisfactory CVOR rating.

The Contract Administrator may permit a Subcontractor with a conditional CVOR rating to operate their vehicles subject to the following:

- a) Within 10 Days of having a conditional CVOR record, the Subcontractor produces an approved plan confirming that drivers and vehicles safety programs are in place to ensure compliance with the safety rating requirement, the *Highway Traffic Act*, and *National Safety Code*; and

- b) Achieve a satisfactory, satisfactory unaudited, or excellent safety rating under the ministry's Carrier Safety Rating Program and have a violation rate of under 70% within 12 months of the date the plan is submitted to the Owner, or show improvement in the Carrier's Safety Performance over the term of the contract by reducing the Carrier's pointable accidents, pointable convictions, and out of service inspections.

Where a Subcontractor fails to achieve the performance criteria above the Contractor shall within 1 month replace the Subcontractor or CVOR Holder and the Contractor's bidding privileges on future work with the Owner may be affected.

Paragraph .02, a) and b) of clause GC 7.06.02, Subcontractor and Other Operation of a Commercial Motor Vehicle, are in addition to any carrier interventions or sanctions imposed through the MTO CVOR program.

GC 7.07 Condition of the Working Area

- .01 The Contractor shall maintain the Working Area in a tidy condition and free from the accumulation of debris, other than that caused by the Owner or others.
- .02 During night work, the Contractor shall ensure that the work zone is adequately illuminated to the Contract Administrator's satisfaction for work operations and inspections and the advance warning to traffic.
- .03 The Contractor shall take such steps as may be necessary to control dust resulting from the Contractor's operations or by public traffic, where it is the Contractor's responsibility to maintain a road through the Work, such that it does not:
 - a) Affect traffic;
 - b) Enter surface waters; or
 - c) Escape beyond the right-of-way to cause a nuisance to residents, businesses, or Utilities.

GC 7.08 Maintaining Roadways and Detours

- .01 Where an existing Roadway is affected by construction, it shall be kept open to traffic, and the Contractor shall, except as otherwise provided in subsection GC 7.08, Maintaining Roadways and Detours, be responsible for providing and maintaining a road through the Work for the duration of the Work, whether along an existing Highway, including the road under construction, or on detours within or adjacent to the Highway according to the OTM.
- .02 The Contractor shall not be required to maintain a Roadway through the Working Area before the Contractor has commenced the Work, or during seasonal shutdown or within any sections of the Roadway where a 12-month general warranty period has commenced. Responsibility for maintenance shall be transferred between the Contractor and the Owner at the commencement of the Work, and the start and end of each seasonal shutdown period. A MTO form PH-CC-771-A, Highway Maintenance Transfer Agreement - Ministry to Contractor and MTO form PH-CC-771-B, Highway Maintenance Transfer Agreement - Contractor to Ministry, prepared by the Contract Administrator, which identifies the date and time that responsibility for maintenance shall be transferred between parties shall be executed by both the Contract Administrator and Contractor prior to the actual turnover date. The Contractor shall not be required to commence any maintenance activities until the turnover date identified on the executed Highway Maintenance Transfer Agreement.

If there is an emergency situation within the Working Area, the Owner may request a third-party maintenance Contractor to provide traffic control and other work necessary to allow reopening of the Roadway to traffic. The Contractor shall coordinate work with the maintenance Contractor and assist as needed.

A minimum of 5 Business Days prior to an anticipated transfer date of responsibility for maintenance, the Contract Administrator, Contractor, and a representative of the Owner's maintenance contractor shall perform a pre-turnover field inspection. The pre-turnover field inspection shall identify deficiencies within the right-of-way and the anticipated timeframe for correction. The Contract Administrator shall be the sole judge on whether or not the noted deficiencies require correction prior to, or after, the turnover date. Provided that the Contractor was given advance written notice of the pre-turnover inspection date, the Contractor shall not delay commencement of the Work or the assumption of responsibility for maintenance because of the existence of deficiencies.

Where work under the Contract is discontinued for any extended period including seasonal shutdown, the Contractor shall, when directed by the Contract Administrator, open and place the Roadway and detours in a passable, safe, and satisfactory condition for public travel. The Contractor shall not be responsible for snow, ice, and frost control on the travelled lanes of the Highway. The Contractor shall be responsible for any snow or ice removal necessary to proceed with the work including behind temporary barriers or other devices, and accumulations that are a result of the Ministry's snow, ice, and frost control measures. The Contractor agrees that snow, ice, and frost control activities of the Ministry's maintenance contractors shall take precedence over the construction within the work zone and agrees not to obstruct any snow, ice, and frost control activities of the Ministry's maintenance contractors.

- .03 The Contractor shall ensure that the Roadway affected by construction is clear of debris. All debris on the travelled portion of the Roadway shall be removed as soon as possible after detection. Debris on the Shoulder shall be removed within 24 hours.
- .04 Where only localized and separated sections of the Highway are affected by the Contractor's operations, the Contractor shall not be required to maintain intervening sections of the Highway until such times as these sections are located within the limits of the Highway affected by the Contractor's general operations under the Contract.
- .05 The Owner shall bear the cost of maintaining, in a satisfactory condition for public traffic, a Roadway through the Working Area. The Contractor shall bring any defects to the attention of the Contract Administrator as soon as they are identified. Such defects include potholes, distortions, pavement edge loss, washouts, drop-offs, and soft or wet areas. Compensation for all labour, Equipment, and Materials to address such defects shall be at the Contract prices appropriate to the work and, where there are no such prices, at negotiated prices. Notwithstanding the foregoing, the cost of providing an operated grader, required to maintain the surface of such Roadways, shall be deemed to be included in the prices bid for the various tender items and no additional payment shall be made.
- .06 Compliance with the foregoing provisions shall in no way relieve the Contractor of obligations under subsection GC 6.01, Protection of Work, Persons, and Property, dealing with the Contractor's responsibility for losses and damage.
- .07 The Contractor shall ensure that earth, mud, aggregate, and other construction debris are not tracked onto the Roadway by construction vehicles.

GC 7.09 Access to Properties Adjoining the Work and Interruption of Utility Services

- .01 At all times, the Contractor shall provide the following to properties adjoining the Working Area at no additional cost to the Owner:
 - a) Pedestrian and vehicular access; and
 - b) Continuity of Utility services.
- .02 At all times, the Contractor shall provide access to fire hydrants and water and gas valves located in the Working Area at no additional cost to the Owner.
- .03 Where any interruptions in the supply of Utility services are required and are authorized by the Contract Administrator, the Contractor shall give the affected property owners notice according to subsection GC 7.13, Notices by the Contractor, and shall arrange such interruptions so as to create a minimum of interference to affected property owners.

GC 7.10 Approvals and Permits

GC 7.10.01 General

- .01 Except as specified in paragraph .02 of clause GC 7.10.01, the Contractor shall obtain any permits, licenses, certificates, and registrations required for the performance of the Work that are in force at the date of tender closing.
- .02 The Owner shall obtain and pay for the necessary plumbing and building permits.
- .03 The Contractor shall arrange for all necessary inspections.

GC 7.10.02 Water Taking

- .01 The Owner has obtained from the Ministry of the Environment, Conservation and Parks (MECP) one or more draft Permits to Take Water required by the *Ontario Water Resources Act*, R.S.O 1990, c O.40, and these shall be posted under "Contract Attachments" in the Registry, Appraisal and Qualification System (RAQS) listing of the Contract, as applicable.
- .02 When water taking activities are eligible for registration on the MECP Environmental Activity and Sector Registry (EASR) in accordance with O. Reg. 63/16 - Registrations under Part II.2 of the *Environmental Protection Act* - Water Taking, required supporting technical reports shall also be posted under "Contract Attachments" in the RAQS listing of the Contract, as applicable. Some water taking activities eligible for registration on the MECP EASR may have been included in draft permit(s) and as such no supporting technical reports shall be required or provided.
- .03 No later than 5 Business Days after the pre-work meeting, the Contractor shall submit all information required by MECP according to the cover letter attached to draft permit(s) to the attention of the applicable MECP Regional Office Water Resources Supervisor.
- .04 MECP will issue the permit(s) and Director's Orders under the *Environmental Protection Act*, R.S.O. 1990, c. E.19, exempting water taking activities from registration when they have been included in a permit, as applicable, within 15 Business Days of receipt of all required information from the Contractor.
- .05 The Contractor shall be responsible for the registration of any other water taking activities on the EASR, the acquisition of additional Permits to Take Water, and any required supporting technical reports not provided by the Owner, except when required due to a Change in the Work.
- .06 No later than 2 Business Days prior to the commencement of water taking, the Contractor shall submit a copy of the appropriate Permits to Take Water and Director's Orders, as applicable, and shall provide confirmation of registration of any water taking activities, to the Contract Administrator.

GC 7.11 Suspension of Work

- .01 The Contractor shall upon written notice from the Contract Administrator, discontinue or delay any or all of the Work. The Work shall not resume until the Contract Administrator issues such written direction. Delays in these circumstances, shall be administered according to subsection GC 3.07, Delays.

GC 7.12 Contractor's Right to Stop the Work or Terminate the Contract

- .01 If the Owner is adjudged bankrupt or makes a general assignment for the benefit of creditors because of insolvency or if a receiver is appointed because of insolvency, the Contractor may terminate the Contract, without prejudice to any other right or remedy the Contractor may have, by giving the Owner or receiver or trustee in bankruptcy written notice.

- .02 If the Work is stopped or otherwise delayed for a period of 30 Days or more under an order of a court or other public authority and provided that such order was not issued as the result of an act or fault of the Contractor or of any Person directly employed or engaged by the Contractor, the Contractor may terminate the Contract, without prejudice to any other right or remedy the Contractor may have, by giving the Owner written notice.
- .03 The Contractor may notify the Owner in writing, with a copy to the Contract Administrator, that the Owner is in default of contractual obligations if the Owner fails to comply with the requirements of the Contract to a substantial degree.
- .04 The Contractor's written notice to the Owner shall advise that if the default is not corrected in the 7 Days immediately following the receipt of the written notice the Contractor may, without prejudice to any other right or remedy the Contractor may have, stop the Work or terminate the Contract.
- .05 If the Contractor terminates the Contract under the conditions set out in subsection GC 7.12, Contractor's Right to Stop the Work or Terminate the Contract, the Contractor shall be entitled to be paid for all work performed according to the Contract Documents and for any losses or damage as the Contractor may sustain as a result of the termination of the Contract.

GC 7.13 Notices by the Contractor

GC 7.13.01 Advance Notice

- .01 Before any or all of the Work is carried out that may affect the property or operations of any owner or agency of government or any individual, company, partnership or corporation, including a municipal corporation or any board or commission thereof, and in addition to such notices of the commencement of specified operations as are prescribed elsewhere in the Contract Document, the Contractor shall give at least 48 hours advance written notice of the date of commencement of such work to the individual person, company, partnership, corporation, board, or commission so affected.

GC 7.13.02 Environmental Incident Management Under Legislation Protecting the Environment and Natural Resources

- .01 The Contractor shall be in strict compliance with the requirements of the following legislation, as amended, regarding Environmental Incidents under the control of the Contractor or that are a result of the Contractor's operations:
 - a) *Environmental Protection Act*, R.S.O. 1990, c. E.19
 - b) *Fisheries Act*, R.S.C. 1985, c. F.14
 - c) *Technical Standards and Safety Act*, 2000, S.O. 2000, c. 16
 - d) *Pesticides Act*, R.S.O. 1990, c. P.11
 - e) *Ontario Water Resources Act*, R.S.O. 1990, c. O.40
 - f) *Transportation of Dangerous Goods Act*, 1992 (S.C.1992, c. 34)
- .02 The requirements of the legislation listed in paragraph .01 of clause GC 7.13.02, Environmental Incident Management Under Legislation Protecting the Environment and Natural Resources, include but are not restricted to:
 - a) Immediate containment of the material, pollutant, contaminant, deleterious substance, or dangerous good;
 - b) Immediate notification of the Environmental Incident to the proper authority; and
 - c) Cleanup and restoration of the environment to preconditions.
- .03 The Contractor shall possess a plan demonstrating that Environmental Incidents shall be managed to satisfy the requirements of paragraphs .01 and .02 of clause GC 7.13.02, Environmental Incident Management Under Legislation Protecting the Environment and Natural Resources.

- .04 The Contractor shall also be responsible for informing the Contract Administrator forthwith of:
 - a) An Environmental Incident when it occurs; and
 - b) Any actions taken or intended to be taken by the Contractor regarding the Environmental Incident.
- .05 Within 48 hours of an Environmental Incident, the Contractor shall provide to the Contract Administrator, on MTO form PH-CC-818, Incident Notification Form, details of such incident.
- .06 The Contractor shall indemnify and save the Owner harmless from any additional expense that the Owner may incur to have the Work performed as a result of the Contractor's failure to comply with the requirements of the legislation listed in paragraph .01 of clause GC 7.13.02, Environmental Incident Management Under Legislation Protecting the Environment and Natural Resources.

GC 7.14 Obstructions

- .01 Except as otherwise noted in these MTO General Conditions of Contract, the Contractor assumes all the risks and responsibilities arising out of any obstruction encountered in the performance of the Work and any traffic conditions, including traffic conditions on any Highway or road giving access to the Working Area caused by such obstructions, and the Contractor shall not make any claim against the Owner for any loss, damage, or expense occasioned thereby.
- .02 Where the obstruction is an underground Utility such as a telephone cable, watermain, gas main or sewer or other man-made object, the Contractor shall not be required to assume the risks and responsibilities arising out of such obstruction, unless the location of the obstruction is shown on the plans or described in the specifications and the location so shown is within the tolerance specified in paragraph .01, a) of subsection GC 2.01, Reliance on Contract Documents, or unless the presence and location of the obstruction has otherwise been made known to the Contractor or could have been determined by the visual site investigation made by the Contractor according to these MTO General Conditions of Contract.
- .03 During the course of the Contract, it is the Contractor's responsibility to consult with Utility companies or other appropriate jurisdictions for further information in regard to the exact location of these Utilities, to exercise the necessary care in construction operations, and to take such other precautions as are necessary to safeguard the Utilities from damage.

GC 7.15 Limitations of Operations

- .01 Except for such work as may be required by the Contract Administrator to maintain the Working Area in a safe and satisfactory condition, the Contractor shall not carry on operations under the Contract on Sundays without permission in writing from the Owner.
- .02 The Contractor shall cooperate with other contractors, Utility companies, and the Owner and they shall be allowed access to their work or plant at all reasonable times.

GC 7.16 Cleaning Up Before Contract Completion

- .01 Upon attaining substantial performance of the Work, the Contractor shall remove surplus materials, Hand Tools, Equipment not required for the performance of the remaining work. The Contractor shall also remove all temporary works and debris other than that caused by the Owner or others and shall leave the Work and Working Area clean and suitable for occupancy by the Owner unless otherwise specified.
- .02 The Work shall not be deemed to have reached Contract Completion until the Contractor has removed surplus materials, Hand Tools, Equipment. The Contractor shall also have removed debris, other than that caused by the Owner or others.

GC 7.17 Record Drawings

- .01 The Contractor shall provide three hard copies and one digital file, in PDF format, of Record Drawings prior to Contract Completion.

- .02 Record Drawings shall show all differences, design changes, and deviations from the original Contract Drawings in red with references to the Contractor's survey and quality control inspection records beside each entry.

GC 7.18 General Warranty

- .01 Unless otherwise specified in the Contract Documents for certain Materials or components of the Work, the Contractor shall be responsible for the proper performance of the Work only to the extent that the design and specifications permit such performance. The onus is on the Contractor to show through engineering analysis that the design and specifications are deficient for the proper performance of the Work.
- .02 Subject to the previous paragraph, the Contractor shall correct promptly at no cost to the Owner, defects or deficiencies in the Work that appear during the period of 12-months after the date of substantial performance as set out in the Certificate of Substantial Performance or such longer periods as may be specified for certain Materials or components of the Work. The Owner shall promptly give the Contractor written notice of observed defects or deficiencies. The Contractor shall submit a comprehensive repair proposal, including traffic control measures, to the Owner within 15 Days of receiving written notification of the defects or deficiencies.

Notwithstanding the above, on Contracts lasting more than 1 construction season, the Owner shall allow the 12 month general warranty period to commence prior to the date of substantial performance for complete sections of Roadways that have been completed in their entirety, have a value of greater than \$5,000,000, and are in use by public traffic. In such cases, the Contractor shall apply in writing to the Owner for approval of the start dates of the general warranty for the selected sections of completed Roadways. The written request shall be submitted to Contract Administrator no later than 10 Days prior to the proposed general warranty start dates and include details as to the limits, location, and start date requested. If a request is granted, the Contractor shall correct promptly at no cost to the Owner, defects or deficiencies in the completed section of Roadway, which appear during the period of 12-months after the date of commencement of the warranty on the completed section of Roadway

- .03 The Contractor shall correct or pay for damage resulting from corrections made under the requirements of paragraph .02 of subsection GC 7.18, General Warranty.

GC 7.19 Accounts Payable

- .01 The Contractor shall pay the Rate of Interest after 28 Days on accounts payable to the Owner at the Rate of Interest.

GC 7.20 Stockpiling of Material

- .01 The Contractor shall not stockpile material weighing more than 1.5 kPa on spans of bridges in which concrete removal has commenced for rehabilitation.
- .02 In cases other than stipulated in paragraph .01 of subsection GC 7.20, Stocking of Material, the Contractor shall not stockpile material weighing more than:
 - a) 5 kPa on decks of highway bridges unless specified otherwise in the Contract Documents.
 - b) 2 kPa on decks of pedestrian bridges unless specified otherwise in the Contract Documents.

SECTION GC 8.0 - MEASUREMENT AND PAYMENT

GC 8.01 Measurement

GC 8.01.01 Quantities

- .01 Quantities for progress payments shall be construed and held to be approximate. The final quantities for the issuance of the Contract Completion Certificate shall be based on the measurement of the Work completed.
- .02 Measurement of the quantities of the Work shall be either by Actual Measurement or by Plan Quantity as indicated in the Contract Documents. Adjustments to Plan Quantities shall normally be made by modifying boundary lines and grades of the work on the plans to calculate new adjusted Plan Quantities but may, where appropriate, be made using Actual Measurements. Those items identified on the tender by the notation (P) in the unit column shall be paid according to the Plan Quantity. Items where the notation (P) does not occur shall be paid according to Actual Measurement or lump sum.

GC 8.01.02 Variations in Tender Quantities

- .01 When it appears that the quantity of work to be done or Material to be supplied by the Contractor or both under a unit price tender item may exceed or be less than the tender quantity, the Contractor shall proceed to do the work or supply the Material or both required to complete the tender item and payment shall be made for the actual amount of work done or Materials supplied or both at the unit prices stated in the tender except as provided below:
 - a) In the case of a Major Item, when the quantity of work performed or Material supplied by the Contractor or both exceeds the tender quantity by more than 15%, either party to the Contract may make a written request to the other party to negotiate a revised unit price for that portion of the Work performed or Material supplied or both which exceeds 115% of the tender quantity. The negotiation shall be carried out as soon as reasonably possible. Any revision of the unit price shall be based on the actual cost of doing the work or supplying the Material or both under the tender item plus a reasonable allowance for profit and applicable overhead.
 - b) In the case of a Major Item, when the quantity of work performed or Material supplied by the Contractor or both is less than 85% of the tender quantity, the Contractor may make a written request to negotiate payment for the portion of actual overheads and fixed costs applicable to the amount of the underrun in excess of 15% of the tender quantity. For purposes of the negotiation, the overheads and fixed costs applicable to the item are deemed to have been prorated uniformly over 100% of the tender quantity for the item. Overhead costs shall be confirmed by a statement certified by the Contractor's senior financial officer or auditor and may be audited by the Owner.

Alternatively, where both parties agree, an allowance equal to 10% of the unit price on the amount of the underrun in excess of 15% of the tender quantity shall be paid. Written requests for compensation shall be received no later than 180 Days after Contract Completion.
- .02 When it appears that the amount of work to be done or Material to be supplied by the Contractor or both under a lump sum concrete item may exceed or be less than the amount shown in the Contract Documents, the Contractor shall proceed to do the work or supply the Material or both required to complete the tender item and payment shall be made on the basis of the lump sum price shown in the tender except as provided below:
 - a) Where the theoretical quantity as determined from the design dimensions of the structure components exceeds the estimated quantity of concrete stated in the Contract Documents by more than 3% and when such increase does not result from a change in design made according to paragraph .01 of clause GC 3.10.01, Changes in the Work, then the Contractor may make a written request to the Contract Administrator to negotiate the compensation payable for that portion of the concrete that exceeds 103% of the estimated quantity. The negotiation shall be carried out as soon as reasonably possible. Any increase in the compensation shall be based on the actual cost of supplying and placing that portion of the concrete which exceeds 103% of the estimated quantity plus a reasonable allowance for profit and overhead.

- b) Where the theoretical quantity as determined from the design dimensions of the structure components is less than 97% of the estimated quantity of concrete stated in the Contract Documents and where such difference does not result from a change in design made according to paragraph .01 of clause GC 3.10.01, Changes in the Work, then the Contract Administrator may make a written request to the Contractor to negotiate the compensation payable for the item to reflect the change in quantity. The negotiation shall be carried out as soon as reasonably possible. Any decrease in compensation shall be based on the estimated value of the amount of underrun in excess of 3% of the estimated quantity and shall include a reasonable allowance for profit and overhead.

- .03 The Contractor or the Contract Administrator may dispute the quantity that is specified for payment on a Plan Quantity basis. The dispute shall be supported by calculations, drawings, and any other evidence indicating why the Plan Quantity is believed to be in error. If the Plan Quantity is found to be in error, payment shall be made according to the adjusted Plan Quantity.

GC 8.02 Payment

GC 8.02.01 Non-Resident Contractor

- .01 The Contractor shall obtain all necessary approvals, consents, permits, licences, certificates, registrations, and other authorizations prior to execution of the Contract.
- .02 The Contractor shall ensure that all Subcontractors the Contractor proposes to use for carrying out any of the Work required by the Contract and who are non-resident in Ontario have obtained all necessary approvals, consents, permits, licences, certificates, registrations, and other authorizations prior to execution of the subcontract.

GC 8.02.02 Price for Work

- .01 Prices for the Work shall be full compensation for all labour, Equipment, and Material required to do the work. The term "all labour, Equipment, and Material" shall include Hand Tools, supplies, and other incidentals.
- .02 Payment for work as shown or detailed in the Contract Documents not specifically detailed as part of any one item and without specified details of payment shall be deemed to be included in the item with which it is associated.
- .03 Payment adjustments determined according to the Contract Documents shall be applied to the payment due to the Contractor.

GC 8.02.03 Advance Payments for Material

- .01 The Owner shall make advance payments for Material intended for incorporation in the Work upon the written request of the Contractor and according to the following terms and conditions:
 - a) In advance of receipt of the shipment of the Material, the Contractor shall, arrange for adequate and proper storage facilities and notify the Contract Administrator of the location of the facilities.
 - b) The value of Aggregates, processed and stockpiled, shall be assessed by the following procedure:
 - i. **Sources Other Than Commercial**
 - (A) Granular A, B, and M shall be assessed at the rate of 60% of the tendered unit price.
 - (B) Coarse and fine aggregates for hot mix asphalt and surface treatment shall be assessed at the rate of 25% of the tendered unit price multiplied by the tonnage of each Aggregate in stockpile. Prior to payment, the Contractor shall provide test results and mix designs to demonstrate that the materials are capable of producing a mix design conforming to the Contract Documents.
 - ii. **Commercial Sources** - Payment for separated coarse and fine aggregates shall be considered at the same rate as sources other than commercial, when such Materials are stockpiled at a commercial source. Advance payments for other materials located at a Commercial Source shall not be made.

- c) Payment for all other Materials, unless specified otherwise elsewhere in the Contract Documents, shall be based on an invoice identifying the Contract and marked as "paid" and signed by the Material supplier. In the event of Materials supplied by a Subcontractor, the Contractor shall provide the original Material supplier invoice marked as paid and signed by the Material supplier and an invoice from the Subcontractor marked as paid and signed by the Subcontractor.
- d) The payment for all Materials shall be prorated against the appropriate tender item by paying for sufficient units of the item to cover the value of the Material. Such payment shall not exceed 80% of the tendered unit price for the item.
- e) All Materials for which the Contractor wishes to receive advance payment shall be placed in the designated storage location within the Province of Ontario, immediately upon receipt of the Material and shall thenceforth be held by the Contractor in trust for the Owner as collateral security for any monies advanced by the Owner and for the due completion of the Work. The Contractor shall not exercise any act of ownership inconsistent with such security or remove any Material from the storage locations, except for inclusion in the Work, without the consent of the Contract Administrator, in writing. The Contractor shall arrange for a lease agreement with any private property owner where such Material is to be stored on MTO form PH-CC-733, Owner Tenancy and Access Agreement, granting the Owner tenancy and access for any storage location on private property for the sum of \$1.
- f) Such Materials shall remain at the risk of the Contractor who shall be responsible for any loss, damage, theft, improper use, or destruction of the Material, however so caused.

GC 8.02.04 Certification and Payment

GC 8.02.04.01 Progress Payment Certificate

- .01 The Contractor shall submit an application for progress payment monthly after starting the Work on the Contract. The application for progress payment shall be for Work completed at the agreed to monthly Cut-off Date.

Within 7 Days following the agreed to monthly Cut-off Dates, the Contractor shall submit an updated application to the Contract Administrator.

The updated application shall contain two parts as follows:

Part 1 - A Proper Invoice which shall contain:

- a) Contractor's name and address;
- b) Date of the Proper Invoice and the period for Work performed;
- c) Information identifying the Owner and Contract number for Work performed;
- d) A description, including quantity where appropriate, of Work performed;
- e) The amount payable for the Work performed and the payment terms;
- f) The name, title, telephone number, and mailing address of the Person to whom payment is to be sent; and
- g) Tender item numbers, description, unit of measurement, original tender quantity, agreed upon changes to the tender quantity, total quantity completed to date, quantity completed previous Proper Invoice, quantity completed this period, unit price, dollars this period, and total dollars to date.

Subtotals shall be detailed for tender items, approved Change Orders, and payment adjustments as specified in the Contract Documents.

The tender item information appearing on the Proper Invoice shall conform exactly with those as shown in the bid tender document.

Part 2 - Quantity of Work Completed Sheets detailing:

- a) Tender item numbers, sub-item numbers, unit of measurement, location description, original tender quantity, agreed upon changes to the quantity, total quantity completed to date, quantity completed previous Proper Invoice, quantities completed and reconciled with the Contract Administrator for this period.

The tender item information appearing on the quantity of Work completed sheets shall conform exactly with those provided in the bid tender document. The quantity of Work completed sheet information shall be sufficient to allow the Contract Administrator to verify and confirm the Work on the Proper Invoice for payment.

Proper Invoices and quantity of Work completed sheets shall be submitted in hard-copy or digital format. For payment purposes, the Contract Administrator shall review the updated application for progress payment within 7 Days of receipt for completeness and to verify the quantities of Work have been completed as specified in the Contract Documents.

Applications for progress payments containing deficiencies, errors, or non-compliance with the Contract Documents shall be deemed to contain an invoice that does not meet the requirements of a Proper Invoice and shall be returned to the Contractor for correction.

The Owner shall pay the Proper Invoice no later than 28 Days after receiving the Proper Invoice.

GC 8.02.04.02 Payment Adjustment for Changes in the Fuel Price Index

- .01 The Owner shall adjust the payment to the Contractor based on changes to the Owner's fuel price index. The fuel price index shall be calculated by the Ontario Ministry of Energy and shall be based on the rack price, including taxes, of diesel fuel. The fuel price index shall be published monthly in the Owner's Contract Bulletin for each calendar month and shall reflect the previous month's prices. The Contractor shall use this index when calculating flow through to truckers, Subcontractors, and shippers and suppliers.
- .02 A payment adjustment, excluding any payments for Changes in the Work and Additional Work, shall be calculated monthly and applied to the monthly progress payment.
- .03 It is agreed by the parties to the Contract that it is impracticable and difficult to ascertain actual fuel consumed on the Contract, and the parties hereto agree that for the purpose of calculating the total fuel price adjustments, the amount of fuel consumed shall be determined using the rates in Table 8.02.04.02-1. The payment provided for the items listed in Table 8.02.04.02-1 shall be deemed to be for all Work.
- .04 Payments provided under clause GC 8.02.04.02, Payment Adjustment for Changes in the Fuel Price Index, shall be used to compensate all trucks, Subcontractors, and shippers and suppliers performing any Contract Work or delivering material for the Contract including items not listed in Table 8.02.04.02-1.
- .05 The compensation provided through this provision shall also be used for the purpose of providing fuel price adjustment compensation to suppliers and shippers. Should the Contractor be required by a supplier to negotiate and provide fuel price adjustment compensation to any party providing Materials to the Contract, the Owner shall not provide any compensation for this purpose in addition to that provided through these MTO General Conditions of Contract.
- .06 Fuel Price Adjustment Calculation
 - a) The Contractor's payment adjustment for each month shall be calculated using the following formula:

$$Cfpa = (Ctem) \times \frac{(I - Bc)}{100}$$

Where:

Cfpa = fuel price adjustment paid to Contractor or Owner, in dollars

Ctem = total estimated monthly fuel consumption

I = progress payment month fuel price index (for the month that the work was completed in)

Bc = fuel price index in the month that the Contract was advertised for tender

- b) The progress payment month fuel index shall be published the first Friday of every month in the Owner's Contract Bulletin.
- c) The total monthly fuel consumption shall be calculated by multiplying the consumption rates in Table 8.02.04.02-1 by the work accomplished in the current month for each applicable item and totalling the volume in litres.
- d) Only tender item quantities or work done at the tender item price shall be included in the calculation.

.07 Payment Certificate Documentation

- a) When (I-Bc) (progress payment month fuel price index - advertising month fuel price index) is positive, the Contractor shall receive a payment.
- b) When (I-Bc) (progress payment month fuel price index - advertising month fuel price index) is negative the Owner shall receive a credit.
- c) The Contractor shall show the fuel price adjustment as a line item on each progress payment certificate and the final payment certificate. The item shall be called fuel price adjustment.

.08 Fuel Price Adjustment Flow Through

- a) The Contractor agrees to adjust the payment to each trucker hired directly by the Contractor for execution of part of the Work according to the following formula:

$$Tfpa = (Tmpp) \times \frac{(I - Bt)}{Bt} \times 0.17$$

Where:

Tfpa = fuel price adjustment paid to trucker, in dollars

Tmpp = monthly payment to trucker, in dollars

Bt = fuel price index in the month that the Contract with the trucker was entered into either verbally or in writing

I = progress payment month fuel price index (for the month that the work was completed in)

The fuel price adjustment paid to each trucker (Tfpa) shall be calculated for each calendar month and may be positive or negative.

- b) The Contractor agrees to adjust the payment to each Subcontractor according to the following formula:

$$Sfpa = (Smpp) \times \frac{(I - Bs)}{Bs} \times \frac{Fn}{100}$$

Where:

Sfpa = fuel price adjustment paid to the Subcontractor, in dollars

Smpp = monthly progress payment to the Subcontractor, in dollars

Bs = fuel price index in the month that the Contract with the Subcontractor was entered into either verbally or in writing

I = progress payment month fuel price index (for the month that the work was completed in)

Fn = fuel consumption factor as negotiated between the Contractor and the Subcontractor as a percentage of the value of the subcontract

- c) The Contractor shall report the negotiated fuel consumption factor (Fn) on MTO form PH-CC-744, Fuel Consumption Listing Subcontractor, listing all subcontracts, and the corresponding negotiated fuel consumption factor. The form shall be updated monthly or as changes and additions arise.
- d) The Contractor also agrees that each subcontract shall contain a requirement that the Subcontractor shall make a fuel price adjustment to each trucker hired directly by the Subcontractor for execution of part of the work according to the same formula and conditions used by the Contractor to make fuel price adjustments to truckers, and provide such confirmation on MTO form PH-CC-745, Fuel Consumption Tracking Subcontractor, for each trucker.

GC 8.02.04.03 Certification of Subcontract Completion

- .01 Before the Work has reached the stage of substantial performance; the Contractor may notify the Contract Administrator, in writing that a subcontract is completed satisfactorily and ask that the Contract Administrator certify the completion of the subcontract.
- .02 The Contract Administrator shall determine if the subcontract has been satisfactorily completed with all required inspections and testing required for the subcontract work and, if the Contract Administrator so determines, shall certify completion using MTO form PH-CC-797, Certificate of Completion of Subcontract.
- .03 Within 7 Days of the date the subcontract is certified complete, the Contract Administrator shall give a copy of the certificate to the Contractor and to the Subcontractor concerned.

GC 8.02.04.04 Subcontract Statutory Holdback Release Certificate and Payment

- .01 At the time of issuance of the Certificate of Completion of Subcontract, the Contract Administrator shall:
 - a) Prepare a subcontract completion payment certificate showing:
 - i. The final prices for items;
 - ii. The amount of holdback monies;
 - iii. The amount due the Contractor.
 - b) Provide to the Contractor, the subcontract completion payment certificate within 10 Days of the date the subcontract was certified complete, for the Contractor to sign and return within 5 further Days. The Contract Administrator shall release to the Subcontractor through the Contractor the 10% holdback retained by the Owner in respect of the work covered by the said subcontract after being certified completed and providing that all lien claims that may be claimed against the holdback for the subcontract work have been expired or been satisfied or discharged, or otherwise provided for according to the *Construction Act*, and providing that the Contractor has furnished to the Contract Administrator a statutory declaration in a form supplied by the Owner that the said Subcontractor has discharged all liabilities incurred by the Subcontractor in carrying out the said subcontract.
- .02 The Contractor shall make payment of the said subcontract to the Subcontractor concerned pursuant to the *Construction Act*.
- .03 Release of holdback monies by the Owner in respect of a subcontract according to the foregoing shall not relieve the Contractor or its Surety of any of their responsibilities.
- .04 Payment for subcontracts certified complete pursuant to the Contract and the *Construction Act*, including the payment of the statutory holdback, shall be made no later than 120 Days of the date on which the Work was certified complete, when all the liens have been satisfied according to Section 25 of the *Construction Act*.

GC 8.02.04.05**Certificate of Substantial Performance**

- .01 Application for substantial performance by the Contractor shall be submitted in the form of a letter, accompanied with:
- a) An application for payment at substantial performance in a form satisfactory to the Contract Administrator for all work to date, the amount of the 10% holdback, and the amount due.
 - b) A release, on MTO form PH-CC-817, Application for Substantial Performance/Contract Completion, by the Contractor releasing the Owner from all further claims related to the Contract qualified by stated exceptions such as outstanding work or matter arising out of subsection GC 3.14, Compensation Request, or subsection GC 3.15, Dispute Resolution.
 - c) A statutory declaration, on MTO form PH-CC-817, Application for Substantial Performance/Contract Completion, that all liabilities incurred by the Contractor and the Subcontractors in carrying out the Contract have been discharged except for the statutory holdbacks properly retained.
 - d) A satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board.
- .02 Upon written application by the Contractor for substantial performance, the Contract Administrator shall conduct an inspection of the Work to determine if the Work is substantially performed and the date for substantial performance. The Contractor's application shall detail non-conformances, defects to be rectified, and Work yet to be completed. After inspection, the Contract Administrator shall provide a list of deficiencies and Work yet to be completed in addition to the Contractor's list. The Contractor's list of non-conformances, defects, and Work yet to be completed together with the Contract Administrator's list of same shall be combined and referred to as Finishing Work. All deficiencies and Work to be completed from the Finishing Work Deficiency List shall be completed prior to Contract Completion. Any additional defects and deficiencies for Work previously accepted as substantially performed shall be completed within 60 Days of Contract Completion, unless prevented by winter weather conditions; in such case, the defects and deficiencies shall be corrected by June 15th of the following year. Defects and deficiencies on Work completed after substantial performance shall be completed prior to Contract Completion.
- .03 Upon verifying that the Contract has been substantially performed, the Contract Administrator shall issue a Certificate of Substantial Performance and shall set out in the Certificate of Substantial Performance the date on which the Contract was substantially performed and within 7 Days after the signing the said certificate the Contract Administrator shall provide a copy to the Contractor.
- .04 Upon receipt of a copy of the Certificate of Substantial Performance, the Contractor shall arrange to have the certificate published in a construction trade newspaper and the Contractor shall provide to the Contract Administrator proof that the certificate was published. Where the Contractor fails to publish a Certificate of Substantial Performance within 7 Days of receiving the certificate, the Owner shall publish the certificate in the *Daily Commercial News* and charge the Contractor \$1,000 for the costs of advertising and administration. Subject to the *Construction Act*, the 60-Day lien period shall start on the date the Certificate of Substantial Performance is published.
- .05 Except as otherwise provided for in Section 31 of the *Construction Act*, the 60-Day lien period prior to the payment of statutory holdback shall commence from the date of publication of the Certificate of Substantial Performance as provided for in paragraph .04 of clause GC 8.02.04.05, Certificate of Substantial Performance.

GC 8.02.04.06**Substantial Performance Payment and Statutory Holdback Release Payment**

- .01 Upon receipt of the application for payment at substantial performance, the Contract Administrator shall check the application and advise the Contractor of any discrepancies. Any of these discrepancies that are unresolved prior to the expiry of the lien period shall be treated as set-offs.
- .02 Subject to any outstanding liens and permissible set-offs, the Owner shall issue payment, including the release of the Basic Holdback on the Work completed, within 28 Days, where all the liens have expired or been satisfied, discharged or otherwise provided for pursuant to the *Construction Act*.

- .03 In addition to any permissible set-offs, Holdback for Finishing Work shall be retained at the rate of 10%, on all Work performed after the date of the Certificate of Substantial Performance.
- .04 If the Contract provides for a completion schedule that is longer than 1 year, Total Bid Price is greater than \$10,000,000 and there are no outstanding liens, the Contractor may request payment of the retained Basic Holdback on an annual basis. When a request is received, the Owner shall issue payment to reduce the holdback on work done from 10% to 2½%, plus the amount of the Owner's set-offs, provided that the Contract had not been substantially performed and the estimated value of the work performed is greater than 60% of the original tender value for a Contract having an expected duration of two construction seasons or less, or 40% for a Contract having an expected duration of more than two construction seasons.
- .05 The holdback may not be released to the Contractor within the timeline according to clause GC 8.02.04.06, Substantial Performance Payment and Statutory Holdback Release Payment, when Form 6 of Ontario Regulation 303/18 of the *Construction Act* is provided to the Contractor to indicate notice of non-payment of holdback and published by the Owner in the *Daily Commercial News* as provided in Section 27.1 of the *Construction Act*. The Contract Administrator shall notify the Contractor, in writing, of its publication no later than 3 Days after the publication of the notice of non-payment.
- .06 Within 3 Days after receiving Form 6 of Ontario Regulation 303/18 of the *Construction Act* from the Contract Administrator, the Contractor shall notify the affected Subcontractor(s) providing a copy of the notice.
- .07 Payments for Work certified as substantially performed, including release of holdback, shall be made no later than 135 Days of the date of publication of substantial performance. The Owner shall release the holdback at the end of the 60-Day lien period providing all liens are expired or been satisfied, discharged or otherwise provided according to the *Construction Act*. This payment shall be made within 28 Days of the expiry of the 60-Day lien period and subject to Subsection 26.1 of the *Construction Act*.

GC 8.02.04.07 Certificate of Contract Completion

- .01 Application for Contract Completion may be requested by the Contractor once all services and Material required by the Contract have been supplied, exclusive of any warranties, and shall be submitted in the form of a letter, accompanied with:
 - a) An application for payment at Contract Completion in a form satisfactory to the Contract Administrator for all work to date, the amount of the 10% holdback, and the amount due the Contractor.
 - b) A release, on the MTO form PH-CC-817, Application for Substantial Performance/Contract Completion, by the Contractor to the Contract Administrator releasing the Owner from all further claims related to the Contract qualified by stated exceptions (e.g., outstanding submissions or matters arising out of subsection GC 3.14, Compensation Request, or subsection GC 3.15, Dispute Resolution).
 - c) A statutory declaration, on MTO form PH-CC-817, Application for Substantial Performance/Contract Completion, by the Contractor to the Contract Administrator that all liabilities incurred by the Contractor and Subcontractors in carrying out the Contract have been discharged, except for the statutory holdbacks properly retained.
 - d) A satisfactory Certificate of Clearance from the Workplace Safety and Insurance Board.
- .02 Upon confirming the Contract is complete, the Owner shall issue a Certificate of Contract Completion on the MTO form PH-CC-890, Certificate of Contract Completion, and shall set out in the form the date on which the Contract was completed (date of Contract Completion) and within 7 Days after the signing the said certificate, the Owner shall provide a copy to the Contractor. A Certificate of Substantial Performance shall also be provided, if not previously requested by the Contractor.

- .03 If the Contractor has not applied for or received a Certificate of Substantial Performance, upon receipt of a copy of the Certificate of Contract Completion and the Certificate of Substantial Performance, the Contractor shall arrange to have the Certificate of Substantial Performance published in a construction trade newspaper and the Contractor shall provide to the Contract Administrator proof that the certificate was published. When the Contractor fails to publish a Certificate of Substantial Performance within 7 Days of receiving the certificate, the Owner shall publish the certificate in the *Daily Commercial News* and charge the Contractor \$1,000 for the costs of advertising and administration. Subject to the *Construction Act*, the 60-Day lien period shall start on the date the certificate is published.
- .04 The Certificate of Contract Completion may be issued although not all required Contractor submissions have been provided. The Contractor shall provide all outstanding submissions (e.g., test results, Record Drawings, and manuals) within 20 Business Days of the date of Certificate of Contract Completion. It is anticipated the Owner shall incur damages after such time should the submissions not be received within the above time. The parties agree that liquidated damages of \$400 per Day shall be charged to the Contractor for each Day after 20 Business Days of the date of Certificate of Contract Completion until all submissions have been received.
- .05 Upon receipt of the application for payment at Contract Completion, the Contract Administrator shall check the application and advise the Contractor of any discrepancies. Any of these discrepancies that are unresolved prior to the expiry of the 60-Day lien period shall be treated as a set-off.
- .06 Subject to any outstanding liens and permissible set-offs, the Owner shall issue payment, including the release of any Holdback for Finishing Work on the Work completed, within 28 Days, where all the liens have expired or been satisfied, discharged or otherwise provided for pursuant to the *Construction Act*.

GC 8.02.04.08 Interest

- .01 Interest due the Contractor is based on simple interest and is calculated using the applicable Rates of Interest.

GC 8.02.04.09 Interest for Late Payment

- .01 When the Contractor has complied with the requirements of the Contract and when payment by the Owner to the Contractor for Work performed, monies to be paid upon the determination resulting from an Adjudication, or for release of the statutory holdback is delayed by the Owner, then the Contractor shall be entitled to interest upon the late payment for Work performed or for the release of the statutory holdback at the Rate of Interest.

GC 8.02.04.10 Interest for Compensation Requests and Claims

- .01 Where a Compensation Request and any subsequent Claims are submitted according to the time limits and/or procedure according to subsections GC 3.14, Compensation Request, and GC 3.15, Dispute Resolution, the Owner shall pay the Contractor the Rate of Interest on the amount of the agreed upon price for the Work or on the amount of the settled Claim. The Rate of Interest shall commence from a date 28 Days following the established Cut-off Date which immediately follows the completion of the Work to which the negotiation applies

GC 8.02.04.11 Owner's Set-Off

- .01 Subject to Section 26 and Subsection 27.1 of the *Construction Act* and pursuant to Section 12 of the *Construction Act*, the Owner shall retain from monies owing to the Contractor under the Contract an amount sufficient to cover all debts, claims, or damages related to the Contract, any outstanding or disputed liabilities the cost to remedy deficiencies, the reduction in value of substandard portions of the Work, claims for damages by third-parties that have not been determined in writing by the Contractor's insurer, undetermined claims by the Owner according to paragraph .01, a), and paragraph .02, a), of clause GC 8.01.02, Variations in Tender Quantities, and any assessment due the Workplace Safety and Insurance Board.
- .02 Under these circumstances the Owner shall give the Contractor notice.

GC 8.02.04.12

Contract Completion, Statutory Holdback Release and Final Payment

- .01 The Owner shall release the statutory holdback so as to discharge all claims in respect of the statutory holdback where all liens that may be claimed against the Holdback for Finishing Work have expired or been satisfied, discharged or otherwise provided according to the *Construction Act*.
- .02 Final payment including payment of statutory holdback shall be made no later than 120 Days from the date of Contract Completion upon the expiry of all liens or upon the liens being satisfied, discharged or otherwise provided for pursuant to the *Construction Act*.

GC 8.03

Payment on a Time and Material Basis

GC 8.03.01

Definitions

For the purpose of subsection GC 8.03, Payment on a Time and Material Basis, the following definitions apply:

Actual Payroll Burden means the payments in respect of the following list of items. No other items shall be permitted in the calculation of the Contractor's Actual Payroll Burden.

- a) **Vacation** means the Contractor's paid time off for vacation earned in each year calculated at salary cost, including overtime, according to the Contractor's policy.
- b) **Sick Leave** means the Contractor's paid time off due to sickness, accident, or injury or specific personal and family issues such as bereavement leave, jury duty, and similar leaves. Such paid time off is according to Contractor's policy and calculated at salary cost.
- c) **Statutory Holidays** means the Contractor's paid time off according to Ontario law and established custom.
- d) **Training** means the Contractor's paid time for employees to maintain and increase their level of skills pertaining to their position.
- e) **Employment Insurance** means the Contractor's portion of employment insurance premiums incurred according to the Employment Standards Act.
- f) **Group Life Insurance** means the premium paid by the Contractor to employee group life and short and long term disability insurance plans.
- g) **Employer Health Tax** means the premium incurred by the Contractor for the year according to the Employer Health Tax Act of Ontario.
- h) **Group Medical Plan** means the premium paid by the Contractor for group health insurance plans providing coverage of health care costs not covered by the basic government health plan.
- i) **Workplace Safety and Insurance Board** means the WSIB premium incurred by the Contractor for the year according to Workplace Safety and Insurance Act.
- j) **Contractor Pension Plan** means the Contractor's pension plan cost, including the cost of funding the pension benefits earned by employees and cost of services of third-parties incurred for the pension plan.
- k) **Canada Pension Plan** means the Contractor's portion of Canada pension plan contribution incurred according to the Canada Pension Plan Act or its equivalent for non-residents.
- l) **Union Contributions** means the premium paid by the Contractor to a union according to active collective agreements. Items such as Industry Funds paid to a Trustee and Legal Benefits identified in such agreements are to be included under this item.

Cost of Labour means the amount of wages, salary, travel expenses, travel time, room and board, and Actual Payroll Burden paid or incurred directly by the Contractor to or in respect of labour and supervision actively and necessarily engaged on the Work on a Time and Material Basis based on the recorded time and hourly rates of pay for such labour and supervision but shall not include any payment or costs incurred for general supervision, administration, or management time spent on the entire Work or on any wages, salary, or Actual Payroll Burden for which the Contractor is compensated by any payment made by the Owner for Equipment.

Travel expenses, travel time, and room and board shall be justified by the Contractor and, if requested, the Contractor shall supply the Owner with proof of the expenditure. Reasonable costs for room and board shall only be paid if the Work on a Time and Material Basis extends the time that the Contractor's labour is on-site or if the Contractor hires labour that is not normal to the Contract and room and board is charged.

Cost of Material means the cost of Material purchased or supplied from stock and valued at current market prices for the purpose of carrying out Work on a Time and Material Basis by the Contractor or by others when such arrangements have been made by the Contractor for completing the Work on a Time and Material Basis, as shown by itemized invoices.

Mark-Up means the amount of administrative overhead and project overhead costs incurred by the Contractor and an amount for profit. Administrative overheads and project overheads include but are not limited to the following:

Advertising, amortization, association and convention fees, audit and accounting fees, bad debt, bank charges and interest, building repairs - head office, capital tax, computer costs, donations, freight and express, insurance - liability and property, interest on long term debt, licences and permits - non Equipment related, management bonuses, management fees subcontracts, management salaries, municipal taxes, office and land - rent or lease, performance, labour and Material bonds, pit rehabilitation - commercial, plans, postage, printing and stationary, promotions, radio, Hand Tools or equipment that are tools of the trade, clothing allowance, sundry, supplies - operation, Utilities: telephone, heat, light, and water, and vehicles repairs - light trucks and autos.

Operated Rented Equipment means Rented Equipment rented or leased for which an operator is provided by the supplier of the Equipment and for which the rent or lease includes the cost of the operator.

Rented Equipment means Equipment that is rented or leased from an individual, firm, or corporation that is not a related entity or associated corporation with common ownership to the Contractor as defined by the *Income Tax Act*, [R.S.C., 1985, c. 1 (5th Supp.)], and is accepted by the Contract Administrator.

Standby Time means any period of time that is not considered Working Time and that together with the Working Time does not exceed 10 hours in any one Working Day and during which time a unit of Equipment cannot practically be used on other Work and remains on the site in order to continue with its assigned task and during which time the unit is in fully operable condition.

The 127 Rate means the rate for a unit of equipment as listed in OPSS 127, Schedule of Rental Rates for Construction Equipment, Including Model and Specification Reference, which is current at the time the Work is carried out or, for Equipment that is not so listed, the rate that has been calculated by the Owner, using the same principles as used in determining The 127 Rates.

Work on a Time and Material Basis means Changes in the Work and Additional Work approved by the Contract Administrator for payment on a Time and Material basis. The Work on a Time and Material Basis shall be subject to all the terms, conditions, Standards, and provisions of the Contract.

Working Time means each period of time during which a unit of Equipment of necessity and is actively engaged on a specific operation and the first 2 hours of each immediately following period, during which the unit is not so engaged but during which the operation is otherwise proceeding and during which time the unit cannot practically be transferred to other Work and remains on the site in order to continue with its assigned tasks and during which time the unit is in a fully operable condition.

GC 8.03.02 Daily Work Records

- .01 Daily Work Records reporting the labour and Equipment employed and the Material used shall be prepared by the Contractor's representative. The Daily Work Records shall be signed each Day by both the Contractor's representative and the Contract Administrator. The Contract Administrator will note disagreements on the Daily Work Record prior to signing and return a copy to the contractor. These records shall be used for the basis of payment.

- .02 Daily Work Records shall report the labour and Equipment employed, both working time and downtime, and the Material used on MTO form PH-CC-754, Daily Work Record. Daily Work Records shall include a brief description of the work being carried out and location of such work.
- .03 For each Day that a Daily Work Record is required under these provisions, the Contractor shall deliver daily to the Contract Administrator's representative at the working area a Contractor signed copy of the Daily Work Record.
- .04 The Contractor's failure to keep or deliver Daily Work Records or to keep complete Daily Work Records may limit the Contractor's ability to recover its costs.

GC 8.03.03 Payment for Work

- .01 Payment as herein provided shall be full compensation for all labour, Equipment, and Material to do the Work on a Time and Material Basis, except where there is agreement to the contrary prior to the commencement of the Work on a Time and Material Basis.
- .02 Payment for labour, rented Equipment, and operated rented Equipment intended for use on other Work but has been idled due to the circumstances giving rise to the Work on a Time and Material Basis shall be negotiated according to subsection GC 3.14, Compensation Request. Consideration shall be given to removing the labour and Equipment from the site until the idled Work can be resumed.

GC 8.03.04 Payment for Labour

- .01 The Owner shall pay the Contractor for labour used on each Time and Material basis at 100% of the Cost of Labour. Payroll Burden shall not be applied to room and board and or travel expenses when calculating the Cost of Labour.
- .02 Payments in respect of Payroll Burden shall be made at the following rates:
 - a) Union workers - 40% of the wages and salary portion of the Cost of Labour.
 - b) Non-union workers - 30% of the wages and salary portion of the Cost of Labour.
 - c) Alternatively, the Contractor's external auditor shall complete, sign, and submit a copy of the Contractor's Actual Payroll Burden. The following shall apply when this option is used:
 - i. Actual Payroll Burden shall be calculated using MTO form PH-CC-819, Actual Payroll Burden, and only those items stated under clause GC 8.03.01, Definitions, shall be included.
 - ii. MTO form PH-CC-819, Actual Payroll Burden, shall be completed by the Contractor's external auditor and filed with the Contract Management Office, St Catharines.
 - iii. The Actual Payroll Burden shall be filed annually and shall be applied from April 1 of each year to March 31 of the following year. The Actual Payroll Burden can be adjusted once annually upon submission of a revised MTO form PH-CC-819, Actual Payroll Burden, completed by the Contractor's external auditor.
 - iv. The Owner shall apply union workers or non-union workers Payroll Burden whichever is applicable, to Contractors failing to provide an annual update by April 1 of the current year. Once MTO form PH-CC-819, Actual Payroll Burden, is received, the Owner shall apply the new rate from the date of receipt of an acceptable Actual Payroll Burden to March 31 of the following year.
 - v. The Contractor's Actual Payroll Burden rate shall apply universally to all labour areas across the province.
 - d) At the Owner's discretion, a review of the Actual Payroll Burden may be conducted, in which case, the Actual Payroll Burden so determined at the time of the review shall be applied to all Work on a Time and Material Basis affected. Upon request, the Contractor shall make available all records in support of the Actual Payroll Burden calculation submitted.

GC 8.03.05 Payment for Material

- .01 The Owner shall pay the Contractor for Material at 100% of the cost of the Material.

GC 8.03.06 Payment for Equipment

GC 8.03.06.01 Working Time

- .01 The Owner shall pay the Contractor for the Working Time of all Equipment other than Rented Equipment and Operated Rented Equipment used on the Work on a Time and Material Basis at The 127 Rate.
- .02 The Owner shall pay the Contractor for the Working Time of Rented Equipment used on the Work on a Time and Material Basis at 110% of the Rented Equipment invoice price. The Contractor shall obtain approval from the Contract Administrator prior to the use of the Rented Equipment, if 110% of the invoice price is greater than The 127 Rate.
- .03 The Owner shall pay the Contractor for the Working Time of Operated Rented Equipment used on the Work on a Time and Material Basis at 110% of the Operated Rented Equipment invoice price. The Contractor shall obtain approval from the Contract Administrator prior to the use of the Operated Rented Equipment, if 110% of the invoice price is greater than The 127 Rate.
- .04 When Equipment is transported solely for the purpose of the Work on a Time and Material Basis to or from the Working Area on a Time and Material basis, payment shall be made by the Owner only in respect of the transporting units. When Equipment is moved under its own power it shall be deemed to be Working. The method of moving Equipment and the rates shall be subject to the approval of the Contract Administrator.

GC 8.03.06.02 Standby Time

- .01 The Owner shall pay the Contractor for Standby Time of all Equipment other than Rented Equipment and Operated Rented Equipment at 50% of The 127 Rate.
- .02 The Owner shall pay for Rented Equipment and Operated Rented Equipment at 100% of the invoice price where it is necessary to retain Equipment in the Working Area for extended periods agreed to by the Contract Administrator.

GC 8.03.06.03 Payment for Work by Subcontractors

- .01 Where the Contractor arranges for Work on a Time and Material Basis, or a part of it, to be performed by Subcontractors on a Time and Material basis and has received approval prior to the commencement of the Work according to the requirements of subsection GC 3.09, Subcontracting by the Contractor, the Owner shall pay the cost of Work on a Time and Material Basis by the Subcontractor calculated as if the Contractor had done the work on a Time and Material basis.

GC 8.03.06.04 Mark-Up on Work on a Time and Material Basis

- .01 Payment for Mark-Up on Work on a Time and Material Basis shall be made at the following rates:
 - a) Contractor Mark-Up
 - 15% applied to the total payment for labour, Rented Equipment, Operated Rented Equipment, and Material when the Work on a Time and Material Basis was completed by the Contractor.
 - b) Subcontractor Mark-Up
 - 15% applied to the total payment for labour, Rented Equipment, Operated Rented Equipment, and Material when the Work on a Time and Material Basis was completed by the Subcontractor.
 - c) Contractor Mark-Up on Subcontractors Work on a Time and Material Basis:
 - 10% mark-up allowed on Subcontractor's total labour, Equipment, and Material after Subcontractor Mark-Up is applied. If Work on a Time and Material Basis is assigned or sublet to a related entity or associated corporation with common ownership to the Contractor as defined by the *Income Tax Act* [R.S.C., 1985, c. 1 (5th Supp.)], then the Contractor Mark-Up is not permitted. The application of associated rules under the *Income Tax Act* [R.S.C., 1985, c. 1 (5th Supp.)] is extended to include partnerships.

GC 8.03.06.05**Submission of Invoices**

- .01 At the start of the Work on a Time and Material Basis, the Contractor shall provide the applicable labour and Equipment rates not already submitted to the Contract Administrator during the course of the Work. The Contractor shall provide documented proof of labour and Equipment rates when requested by the Contract Administrator.
- .02 A separate MTO form PH-CC-796, Time and Material Summary for Payment, shall be completed for Contractor and Subcontractor Work on a Time and Material Basis. Each completed form shall include the Change Order number and covering dates of the Work on a Time and Material Basis and shall itemize separately payment for labour, payment for Materials, and payment for Equipment. Invoices for Materials, Rented Equipment, and other charges incurred by the Contractor on the Work on a Time and Material Basis shall be included with each summary.
- .03 Each month the Contract Administrator shall include with the monthly progress payment certificate, the costs of the Work on a Time and Material Basis incurred during the preceding month all according to the Contract administrative procedures and the Contractor's invoice of the Work on a Time and Material Basis.
- .04 The final MTO form PH-CC-796, Time and Material Summary for Payment, shall be submitted by the Contractor within 60 Days after the completion of the Work on a Time and Material Basis.

GC 8.04**Release from Warranty**

- .01 At the expiry of the last warranty period and after correction of all deficiencies, the Owner shall issue to the Contractor the MTO form PH-CC-895, Release from Warranty Certificate.

GC 8.05**Records**

- .01 The Contractor shall maintain and keep accurate Records relating to the Work, Changes in the Work, and Claims arising there from in sufficient detail to support the total cost of the Work, Changes in the Work, and Claims. The Contractor shall preserve all such original Records until 12 months after the Release from Warranty Certificate is issued or until all claims have been settled, whichever is longer. The Contractor shall require that Subcontractors preserve all original Records pertaining to the Work, Changes in the Work, and Claims arising there from for a similar period of time.
- .02 If, in the opinion of the Contract Administrator, Daily Work Records are required, the Contractor shall complete such Daily Work Records for the Work or such specific part of the Work requested.

GC 8.06**Taxes and Duties**

- .01 Where a change in Canadian Federal or Provincial taxes occurs after the date of tender closing for this Contract, and this change could not have been anticipated at the time of bidding, the Owner shall increase or decrease Contract payments to account for the exact amount of tax change involved.
- .02 Claims for compensation for additional tax cost shall be submitted by the Contractor to the Contract Administrator on MTO form, PH-CC-725, Tax Change Statement. Such claims for additional tax costs shall be submitted not later than 30 Days after the date of completion of the Work.
- .03 Where the Contractor benefits from a change in Canadian Federal or Provincial taxes, the Contractor shall submit a statement of such benefits to the Contract Administrator on MTO form, PH-CC-725, Tax Change Statement. This statement shall be submitted not later than 30 Days after the date of completion of the Work.
- .04 The Contract Administrator reserves the right to make deductions from regular progress payments to compensate for the estimated benefit from decreased tax costs. Such deductions shall be set-off from Contract payments pending receipt of the statement itemizing the benefits that have resulted from a decrease in tax costs at which time the final payment adjustment shall be determined.

.05 The Contractor shall add the HST to all invoices and Proper Invoices

GC 8.07 Liquidated Damages

.01 When liquidated damages are specified in the Contract and the Contractor fails to complete the Work according to the Contract, the Contractor shall pay such amounts as are specified in the Contract Documents.

GC TABLES - List of Tables

TABLE 7.02-1
Layout Intervals and Measurement Accuracy for Construction Survey - Layout

Activity	Interval	Measurement Accuracy
Layout: - Rock - Earth (With the exception of plus sections, layout is normally at the same interval as the cross-sections/grade calculations. This may be varied when extreme changes in horizontal and vertical alignment are encountered.)	10 m 25 m	-
Maximum for setting structure footing grades	10 m	-
Set structure grades	-	1 mm
Adjustment to slope stake distances to allow for grubbing losses	-	300 mm
Set grades for earth grading	-	10 mm
Set grades for granular	-	5 mm
Layout stake offset for curb and gutter (2 m but may be varied to suit conditions.)	-	-
Stake layout for curb and gutter (May be necessary to reduce for very sharp curves.)	10 m	-
Set curb and gutter grades	-	1 mm
Staking maximum for layout of a radius, intersections	3 m	-
Layout stake (2 m offset) for concrete pavement	-	-
Set concrete pavement grades	-	1 mm

TABLE 7.02-2
Layout Intervals and Measurement Accuracy for Construction Survey - Cross-Sections

Activity	Interval	Measurement Accuracy
Backsight and foresight readings	-	1 mm
Maximum allowable error between adjacent Benchmarks	-	5 mm
Intermediate road readings: - earth cut - rock cut; rock cut with overburden - muskeg excavation; borrow pits - fills with stripping, sub-excavation, or ditching - transition from cut to fill; fills; earth or rock fills	25 m 10 m 25 m 25 m 25 m	10 mm
Maximum transverse interval for cross-section elevations: - earth - rock - borrow	25 10 25	-
Measure offset distances	-	100 mm

**TABLE 8.02.04.02-1
Fuel Consumption Rates**

	Item Description	Notes	Diesel Fuel Consumption Rates
1	Clearing including Close Cut Clearing		237 l/ha
2	Grubbing		163 l/ha
3	Earth Excavation and Earth Borrow	1	1.7 l/m ³
4	Rock Excavation	2	0.6 l/m ³
5	Rock Embankment		1.6 l/m ³
6	Rock Face		1.2 l/m ²
7	Select Subgrade Material (SSM)		1.0 l/t
8	Granular A, B, O, and RSS Backfill	9	1.9 l/t
9	All Asphalt Pavement, except Superpave FC2 Pavement	10	11.5 l/t
10	Superpave FC2 Pavement	10	14.3 l/t
11	Concrete Pavement		4.9 l/m ²
12	Structural Concrete	3	5.5 l/m ³
13	Tall Wall, any non-precast barrier wall, including asymmetric		3.2 l/m
14	Milling by m ² Items	4	0.4 l/m ²
15	Milling by tonne Items	5	3.0 l/t
16	Pulverize		0.2 l/m ²
17	Cold In Place Recycling		0.4 l/m ²
18	Concrete Removal, all complete structural concrete	6	1.0 l/m ³
19	Concrete Removal, concrete base and pavements		0.9 l/m ²
20	Asphalt Removal	7	0.4 l/m ²
21	Piling & Caissons		5.0 l/m
22	Sewers & Drainage	8	8.0 l/m
23	Rock Supply		1.4 l/m ³

Notes:

1. Also includes the tender item Earth Excavation for Structures when the quantity is greater than 100 m³.
2. If the Contract has a Rock Excavation item but not the Rock Embankment item, the diesel fuel consumption rate for Rock Excavation shall be 2.2 l/m³.
3. Structural concrete is normally a lump sum item that has no quantity listed in the Contract Documents. The Contract Administrator shall calculate the quantity for this item or get concrete ticket summary sheets for this item. This item does not include deck joint assemblies or modifications, concrete patches, or precast units. Includes the following items:
 - concrete in deck
 - concrete in substructure
 - concrete in culverts
 - high performance concrete in deck
 - concrete in footing, structure
 - concrete in substructure and retaining wall
 - high performance concrete in sub structures
 - concrete in structure
 - concrete in approach slab
 - high performance concrete in barrier walls
 - concrete in parapet walls
4. Includes the following items:
 - removal of asphalt pavement from concrete surfaces
 - removal of asphalt pavement, partial depth
 - removal of asphalt pavement from concrete surfaces on structures
 - reclaim asphalt pavement, full depth
 - remove asphalt pavement and salvage; full depth
 - reclaim asphalt pavement, full depth over concrete
5. Includes the following items:
 - reclaim asphalt pavement, partial depth
 - remove asphalt pavement and salvage, partial depth
6. Includes the following items:
 - removal of bridge structures
 - concrete removal, full depth
 - concrete removal, complete deck
7. Includes the following items:
 - removal of asphalt pavement
8. Sewers and drainage is to be applied to sewers that are 300 mm in diameter or larger. Subdrains do not receive compensation. Catchbasins with a single stub outlet receive no compensation nor do flexible pipe culverts.
9. 60% of the Diesel Fuel Consumption Rate shall apply to the production and stockpiling of Granular A, B, O, and RSS Backfill. 40% of the Diesel Fuel Consumption Rate shall apply to Granular A, B, O, and RSS Backfill supplied from existing stockpiles that are the property of the Owner.
10. When measurement for payment of asphalt is by square metre, for the purpose of fuel price index payment adjustment calculation, square metre asphalt quantities shall be converted to tonnage (T_{mix}) using the following formula, rounded to one decimal according to LS-100:
$$T_{mix} = [BRD_s \times (TD/1000) \times A_{mix}]$$
Where:
 - $BRD_s = 2.50 \text{ t/m}^3$
 - $TD = \text{average asphalt thickness from core measurements, mm}$
 - $A_{mix} = \text{quantity of asphalt placed, m}^2$



GENERAL SPECIFICATION FOR ELECTRICAL WORK

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106.01 SCOPE

This specification covers the general requirements for electrical work and is applicable to all electrical work in the Contract.

106.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 609	Grounding
OPSS 611	Installation of Underpass Luminaires
OPSS 614	Installation of Power Supply Equipment
OPSS 617	Installation of Roadway Luminaires
OPSS 620	Traffic Signal Equipment
OPSS 621	Electrical Traffic Control Devices
OPSS 622	Installation of Traffic Signal Controllers
OPSS 623	Traffic Actuation Equipment
OPSS 630	Installation of Sectional Steel High Mast Lighting Poles

Ontario Ministry of Transportation Publications

Electrical Engineering Manual, Volume 2, Electrical Maintenance

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

106.03 DEFINITIONS

For the purpose of this specification, definitions in the Ontario Electrical Safety Code and the following definitions apply:

Cable means a solid or stranded, bare or insulated metal conductor (wire) or group of conductors enclosed in a common jacket or twisted to form a group.

Down Time means the time during which an electrical system is de-energized or not under full operation.

Duct means a circular pipe or conduit for the mechanical protection of cables.

Electrical Chamber means a chamber for placing and maintaining conductors, cables, ducts, or electrical equipment. A general name for electrical maintenance holes and handholes.

Electrical Maintenance Hole means a subsurface chamber large enough for a person to enter that allows facilities for placing and maintaining underground conductors, cables, and associated apparatus.

Electrical Work means any work associated with the installation, modification, removal, inspection, or testing of electrical system components, including work required for all auxiliary concrete, mechanical, metallic, or non-electrical components required for the work.

Electrician means a person in possession of a certificate of qualification for the trade of Electrician, Construction and Maintenance, 309A, issued by the Ministry of Training, Colleges and Universities, Ontario.

Emergency Maintenance or Emergency Repairs means an activity required to repair unexpected failure of electrical equipment components that requires immediate action and takes precedence over routine maintenance activities for the duration of the emergency.

Energized means electrically live.

ESA means Electrical Safety Authority.

High Mast Lighting Equipment means high mast poles complete with luminaire raising and lowering devices consisting of ring assemblies complete with tenon arms, shrouds, external or internal drive mechanisms, and pole anchorage assemblies.

Highway Lighting System means a system of luminaires, poles, sign luminaires, underpass illumination, cables, power supply equipment, control system, and all associated materials required to provide illumination on a highway, roadway, or associated appurtenances.

IMSA means International Municipal Signal Association.

Luminaire means a complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Nighttime means the time during which the ambient natural horizontal illuminance at ground level is less than 15 lux.

Non-Routine Maintenance means activity required to repair unexpected failure of equipment components. It requires immediate action.

Pad means a concrete footing with a level surface used to mount electrical equipment or for a temporary installation that could be made of wood.

Power Supply Equipment means electrical equipment installed to provide a source of power for electrical systems and includes transformation, switching, and control equipment.

Power Distribution System means the electrical system comprised of electrical cables, conduit, maintenance chambers, enclosure (with switching and control devices) and associated equipment that distribute electrical power from the utility provider or power generating equipment (e.g. solar, wind, UPS and portable generator) to the electrical equipment.

Routine Maintenance means ongoing preventive maintenance activities according to the manufacturer's recommendations and the Owner's maintenance standards and includes the periodic adjustment of the electrical system components to correct deviations from the system specifications resulting from normal operation of the system.

Service Manuals means the full literature, drawings, directives, instructions, and procedures issued by the supplier or manufacturer of any system component for the purposes of assembly, installation, operation, preventive maintenance, or emergency maintenance of the system component.

Signalized Intersection means an intersection or junction of roadways or crosswalks or both where the vehicular and pedestrian traffic is controlled by a traffic signal system.

Switchover means the act of closing down an electrical system and bringing a new or modified electrical system into operation.

System Components means all hardware and software components, devices, parts, and materials included in the electrical work supplied and installed under a Contract, including all spare parts supplied by the Contractor.

Temporary means work that is done to serve a specific function and removed on the same Contract as it was placed.

Traffic Signal System means a system of traffic signal equipment, poles, traffic signal controllers, traffic signal actuation and interconnection equipment, and all associated materials required to regulate vehicular and pedestrian traffic.

Underpass Illumination means any work required for the installation of luminaires on the ceilings, walls, beams, abutments, or piers of a bridge or retaining walls.

106.04 DESIGN AND SUBMISSION REQUIREMENTS

106.04.01 Submission Requirements

106.04.01.01 Electrical Equipment Working Drawings

Working Drawings shall be submitted for the electrical equipment as specified in Table 1.

Six sets of Working Drawings (three hardcopy and three digital copy) shall be submitted to the Contract Administrator. The digital copies shall be provided in PDF format, unlocked, printable, and editable. Each digital copy shall be provided on a USB mass storage device (e.g. USB flash drive).

Working Drawings for luminaires shall consist of manufacturer's catalogue information and photometric data. Working Drawings for all other items shall include all information required in the Contract Documents.

Working Drawings for all items shall include all information required in the applicable Owner's material specification.

Materials and dimensions shown on the final Working Drawings shall not be changed without approval of the Contract Administrator. Resubmission of Working Drawings showing any changes to the final Working Drawings is required.

106.05 MATERIALS

All electrical materials, equipment, components, or completed assemblies of components shall be approved according to the Ontario Electrical Safety Code.

106.07 CONSTRUCTION

106.07.01 Qualification of Workers

106.07.01.01 Contractor's Representative

A representative, who is experienced in the electrical work to be performed, shall be appointed to represent the Contractor.

The Contractor's representative shall attend such meetings required by the Owner to coordinate services affected by the Contract.

106.07.01.02 Contractor's Workers

The Contractor or electrical subcontractor shall be a licensed electrical contractor according to the Electricity Act and shall use workers qualified to do the electrical work according to the following:

- a) All electrical and advanced traffic management system work shall be performed by or under the direct personal supervision of an electrician.
- b) Traffic signal and traffic signal control equipment installation, inspection, and testing shall be performed by an electrician who has successfully completed one of the following:
 - i. Levels 1 and 2 of the IMSA Traffic Signal Technician Certification Program
 - iii. 170-332 IMSA/MTO Certification Program

- c) All high mast lighting installation, inspection, and testing shall be performed by an electrician who has successfully completed training from the manufacturer(s).
- d) All locates for electrical systems and advanced traffic management systems shall be performed by a licenced electrician who has successfully completed cable locate training.
- e) All electrical testing and inspection work shall be performed by an electrician.

Effective April 1, 2023, all roadway lighting installation, inspection, and testing shall be performed by an electrician who has successfully completed the IMSA Roadway Lighting Technician Level 1 certification program.

The Contract Administrator may request at any time that the Contractor provide proof that the individual performing or supervising the electrical work is an electrician. If such a person is not present, the Contract Administrator may direct the Contractor to cease all electrical work until an electrician, with proof of such, is on site to perform or supervise the electrical work.

106.07.01.03 High-Voltage Work

High-voltage work shall be performed by qualified personnel.

106.07.02 Work to be Inspected by Electrical Safety Authority

All electrical work is subject to inspection by the ESA. The Contractor shall perform all work associated with inspection or re-inspection by the ESA. This work includes, but is not limited to the following:

- a) Arranging and coordinating all visits to the construction site by the ESA's inspectors.
- b) Correcting all defects identified by the ESA.
- c) Submitting all applications for inspection.
- d) Obtaining all permits.
- e) Obtaining all certificates.
- f) Obtaining all connection authorizations from the ESA.
- g) Payment of fees.
- h) Performing any other work that may be required under the Ontario Electrical Safety Code.

106.07.03 Work to be Coordinated with Others

MTO is not a member of Ontario One Call and Ontario One Call shall not be relied upon to provide any information regarding the ministry's electrical systems and advanced traffic management systems.

The Contractor shall coordinate for the following work:

- a) Electrical power supply connection and disconnection by the electrical power supply authority.
- b) Communication connection and disconnection by the communication provider(s).
- c) Mounting of any electrical equipment on a pole or any structure owned by or under the jurisdiction of a Utility authority.

- d) Mounting of any electrical equipment in close proximity to or requiring modification of any plant owned by a Utility authority, private person, or other company.

The Contractor shall notify the Contract Administrator in writing at least 15 Business Days prior to commencing the above work. A detailed breakdown of the required Utility work and the corresponding Utility cost to complete the work, along with a Utility contact name, address, and telephone number, shall be provided to the Contract Administrator.

Utility invoices shall be paid by the Contractor. The Contractor shall submit proof of payment and the Utility invoices for the above noted work to the Contract Administrator for reimbursement.

Obtaining all connection authorizations and layouts shall be completed by the Contractor.

The Contractor shall provide two copies of all Utility service layouts to the Contract Administrator.

The Contract Administrator and the Owner's electrical coordinator shall be notified a minimum of 72 hours in advance of all service layout meetings with an electrical power supply authority. The Contractor shall obtain electrical power supply billing account details from the Contract Administrator and provide them to the electrical power supply authority.

The Contractor shall locate all of the electrical systems and advanced traffic management systems within the limits of the Contract. The Contractor shall complete all locates on the Owner's electrical systems and advanced traffic management systems required for the Contractor to do the Work. The Contractor shall not rely on the Owner to complete the locates.

106.07.04 Traffic Signal Systems

106.07.04.01 General

Testing of signal displays and switch on for operation of traffic signals shall be under police supervision. Switch on and switchover for operation is not permitted on Mondays, Fridays, Saturdays, Sundays, and statutory holidays.

106.07.04.02 Existing Traffic Signal Systems

Except when the Contract requires modifications to existing traffic signal systems, the Contractor shall perform the operations with the existing traffic signal systems undisturbed and fully operational. When traffic signal systems are to be installed and the existing traffic signal system is to be removed or modified, the new traffic signal system shall be installed independently of the existing system such that short duration switchover from one system to the other is effected without appreciable down time.

106.07.04.03 New Traffic Signal Systems Activation

A new traffic signal system at a location not previously signalized shall be initially switched on for operation according to the following requirements:

- a) For the testing of circuitry and components, operation of the system shall take place with signal head covers in place.
- b) The Contract Administrator shall be given a minimum of five Days notice of when the system shall be ready for operation and 24 hours notice prior to completion of the work. Confirmation is to be given that the work shall be done as scheduled.
- c) The Contractor shall complete all preliminary system testing as specified in the Contract Documents and all repairs or replacement of defective components prior to final energizing.

106.07.04.04**Traffic Signal Systems Switchover**

A new traffic signal system installed to replace an existing traffic signal system shall be initially switched on for operation according to the following requirements:

- a) The Contract Administrator shall be given a minimum of three Days notice of when the system switchover shall be done, and 24 hours notice prior to completion of the work. Confirmation is to be given that the work shall be done as scheduled.
- b) All preliminary system testing shall be completed as specified in the Contract Documents and all adjustments or replacement of defective electrical equipment in the new system completed prior to system switchover.
- c) For the testing of circuitry and components, operation of the new signal system shall take place with the covers for the new signal head in place and the existing signal system operational.
- d) Signal heads of the existing traffic signal system shall be covered and covers shall be removed from the new signal heads with both systems de-energized. Traffic shall be under police supervision during this operation.

106.07.04.05**Maintenance of Traffic Signal Systems****106.07.04.05.01****General**

All routine, non-routine, and emergency maintenance work shall be performed as required on all traffic signal systems for public use within the limits of the Contract.

The initial traffic signal timing shall be programmed into the traffic signal controller as directed by the Contract Administrator up to a maximum of four times. The traffic signal controller shall be set up by performing all programming, setting all timing controls and switch settings, and setting any other controller operational parameters obtained from the Contract Administrator. The Contractor shall verify to his own satisfaction that the revised signal timing is consistent and complete.

At any time during the Contract, the Contract Administrator reserves the right to review the timing and operations of the traffic signal system and the Contractor shall implement any changes to the operation settings and timings requested by the Contract Administrator.

All traffic signal system components shall be maintained in good working condition according to the Contract Documents and all routine maintenance and emergency repairs shall be provided as required.

On call local emergency repair service shall be provided 24-7 for the duration of the Contract, including seasonal shutdown. Emergency repairs shall be required whenever there is a failure or cessation of the operation of any component or components of the traffic signal system.

Each time emergency repair work is performed on a traffic signal system, the Contractor shall notify the Contract Administrator within 72 hours of the completion of the emergency repair work.

Any traffic signal timing not included in the original Contract Documents shall be approved by the Owner before it is installed in a traffic signal controller.

Routine, non-routine, and emergency maintenance shall be according to the manufacturers' recommendations and the Electrical Engineering Manual, Volume 2.

106.07.04.05.02**Notification and Record Keeping - Traffic Signal Systems**

The Contractor shall clearly identify in writing the designated contact person and alternate for liaison with the Contract Administrator. The Contract Administrator shall designate representatives and alternates as contact persons for the Owner.

A logbook shall be maintained and kept in the traffic signal field cabinet or at a location agreed upon with the Owner. The logbook shall record any fieldwork performed on the traffic signal system, including the replacement of any hardware, changes to the software, or changes to the configuration, phasing, or timing parameters. The time and date of each entry in the logbook shall be signed by the individual making the entry.

106.07.04.06**Traffic Signal Pre-Activation Meeting**

A minimum of 48 hours prior to the planned activation of each set of traffic signals, the Contractor shall coordinate and attend an on-site quality control meeting with the Contract Administrator. As a minimum, the following individuals shall attend the meeting:

- a) Contractor's on-site representative
- b) Pavement marking sub-contractor representative
- c) Electrical sub-contractor representative
- d) Contract Administrator
- e) Contract Administrator's electrical inspection staff
- f) Contractor's person responsible for traffic control and highway work zone safety
- g) Owner's electrical coordinator, traffic representative, and electrical quality assurance representative

The purpose of this meeting is to ensure that the Contractor clarifies the roles and responsibilities of all parties involved in the traffic signal activation, that all advanced work is complete, and to confirm that all required arrangements have been made in order to ensure that the activation proceeds smoothly and expeditiously. The Contractor shall prepare the agenda for the meeting and record the minutes to be distributed to all attendees.

As a minimum agenda, the following shall be addressed:

- a) General
 - i. Confirm the name and position of the person responsible for coordinating traffic control during the signal activation.
 - ii. Confirm that arrangements have been made with the appropriate police authority to provide traffic control.
 - iii. Confirm that all the work has been constructed as specified in the Contract Documents and is in accordance with the signed legal drawing (PHM-125). Any deficiencies shall be brought to the attention of the Contract Administrator.
 - iv. Confirm the date and time of the traffic signal activation.
- b) Pavement Marking
 - i. Confirm the name and position of the person responsible on site for carrying out the pavement markings.

- ii. Confirm that the pavement markings have been pre-marked as specified in the Contract Documents and are according to the signed legal drawing (PHM-125).
- iii. Review the Contract Drawings for the pavement markings that shall be in place on the day of signal activation.

c) Electrical

- i. Confirm that the Contract Administrator shall be in receipt of all traffic signal inspection and test reports prior to the activation of the signals.
- ii. Confirm that all vehicle detection is positioned as required and functioning correctly.
- iii. Confirm that all accessible pedestrian signals and actuation are positioned as required and functioning correctly.

106.07.05 Maintenance of Highway Lighting Systems

106.07.05.01 General

All routine, non-routine, and emergency maintenance work shall be performed on all highway lighting systems for public use within the limits of the Contract, until the issuance of the Contract Completion Certificate by the Contract Administrator.

The Contractor shall maintain all lighting systems located within the limits of the Contract in full nighttime operation. The Contractor shall perform all routine, non-routine, and emergency maintenance work required to maintain the lighting systems. Suitable combinations of existing, temporary, or new lighting systems may be used to achieve the required performance, safety, and reliability of the lighting system. The Contractor shall provide routine, non-routine, and emergency maintenance service during seasonal shutdown. Routine, non-routine, and emergency maintenance work shall be according to the Electrical Engineering Manual, Volume 2.

106.07.05.02 Notification and Record Keeping - Highway Lighting Systems

The Contractor shall clearly identify in writing the designated contact person and alternate for liaison with the Contract Administrator. The Contract Administrator shall designate representatives and alternates as contact persons for the Owner.

A logbook shall be maintained and kept in the highway lighting system field cabinet or at a location agreed upon with the Owner. The logbook shall record any fieldwork performed on the highway lighting system, including the replacement of any hardware, changes to the software, or changes to the configuration or timing parameters. The time and date of each entry in the logbook shall be signed by the individual making the entry.

106.07.06 Temporary Electrical Work

All temporary electrical work specified in the Contract Documents shall be installed and made ready for operation prior to opening the associated traffic lanes or sidewalks that the work is intended to serve.

106.07.07 Layout of Electrical Equipment

All equipment shall be installed at locations detailed in the Contract Documents.

Layout for stations and offsets of concrete pads and footings, electrical chambers, and poles shall not exceed a tolerance of ± 100 mm.

The Contractor shall ensure there are no Utility conflicts, both overhead and underground, with any pole locations prior to starting any excavation or pole installation work. Underground ducts and cables shall not be located within 600 mm of guide rail.

106.07.08 Adjustment of Electrical Equipment

All luminaires, traffic signal heads, optical lens assemblies, photoelectric controllers, and other devices shall be adjusted according to the Contract Documents. Luminaires shall be adjusted under nighttime operational conditions and in the presence of the Contract Administrator.

106.07.09 Open Excavations

Excavations within 4.0 m of the edge of travelled roadway shall not be left open overnight.

106.07.10 Quality Control

106.07.10.01 General

Tests and inspections on electrical equipment shall be according to the appropriate specifications covering the work.

The Contractor is responsible for all pre-installation and proof of performance testing and inspections for electrical work. Each time the Contractor is to perform an inspection or test, the Contract Administrator shall be notified 48 hours prior to commencing the inspection or test.

106.07.10.01.01 Pre-Installation Testing and Inspection

Pre-installation testing and inspection of electrical work shall include all testing and inspection of system components, including testing of mock-ups, prototype testing, and normal factory production testing undertaken on behalf of the Contractor prior to the installation of such components.

106.07.10.01.02 Proof of Performance Testing and Inspection

Proof of performance testing and inspection of electrical work shall include all testing and inspection of system component installations into the work in order to verify the physical and operational features of each part of the system components and electrical subsystems.

A Request to Proceed shall be submitted to the Contract Administrator after the completion of testing and inspection work as specified in the Contract Documents. The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

106.07.10.02 High-Voltage System Testing

All high-voltage cable and electrical equipment shall be tested according to the Contract Documents.

One copy of test results and one copy of the cable and electrical equipment manufacturer's test report shall be submitted to the Contract Administrator.

106.07.11 Documentation

106.07.11.01 General

Documentation, including Working Drawings, catalogue sheets, calculations, drawings, diagrams, test print-outs, photographs, manufacturer's instructions, service manuals, and text shall be provided by the Contractor to a level of detail such that it assures the Contract Administrator that the system components that the Contractor is furnishing are according to the requirements of the Contract Documents. The documentation shall also be used to provide records for future operational and maintenance activities.

The Contractor shall submit, as part of the service manuals, a dated and signed form of inspection of each item of work.

106.07.11.02 Test Results and Inspection Reports

Test results and inspection reports shall be submitted to the Contract Administrator. Inspection reports shall include the completed checklist and any material observations made at the time of the inspection.

The documentation shall include the method of testing and inspecting of each item. The method of testing and inspecting shall ensure that the functional, physical, and environmental aspects of the contract specifications are demonstrated.

The documentation shall include all quantitative information generated as part of the testing and inspecting work, including meter readings, screen displays, charts, and any other numerical or graphical data.

The documentation shall present the results of all tests and inspections in a format that is logical and easily understood.

Test results and inspection reports shall be submitted to the Contract Administrator within 48 hours of completion of the inspection or test detailing:

- a) The installation and operation of the system components on an item-by-item basis.
- b) Clear detailed illustrations, including control layouts, displays, schematic diagrams, and all other information, required to correctly operate a fully functional unit as well as the maintenance and service aspects of the system components.
- c) The model number, suggested and actual settings, and options as installed and configured for each piece of electrical equipment.
- d) Sections that completely describe the theory of operation using block diagrams and schematic drawings.
- e) Diagnostic and repair procedures for corrective maintenance of the unit, assembly and disassembly instructions and drawings, layout drawings showing location of all components, and complete components listing showing component type, ratings, cost, and acceptable manufacturers. Complete schematic diagrams to the component level.
- f) Fully described adjustments and alignment procedures and provide descriptions of expected signals at all test points and outputs.
- g) The specifications of system components performance.

106.07.11.03 Service Manuals

Service manuals shall be provided for the items specified in Table 1.

Each service manual shall be assembled in three-ring binders of 75 mm maximum thickness and shall be indexed item by item. Several items may be covered in a single binder. The manual shall document in detail the installation and operation of the system components on an item-by-item basis. It shall contain clear detailed illustrations, including layout of controls, displays, schematic diagrams, and all other information required to correctly operate a fully functional unit as well as the maintenance and service aspects of the system components. The model numbers, with installed options and installed settings shall be clearly shown.

The manual shall provide sections that completely describe the theory of operation using block diagrams and schematic drawings. The manual shall include diagnostic and repair procedures for corrective maintenance of the unit; assembly and disassembly instructions and drawings; layout drawings showing location of all components; and complete components listing showing component type, ratings, cost, and acceptable manufacturers. Complete schematic diagrams to the component level shall be provided. The manual shall fully describe all adjustments and alignment procedures and provide descriptions of expected signals at all test points and outputs. Detailed specifications of the performance of system components shall be provided.

The Contractor is responsible for generating the required documentation in the event that it is not available from the manufacturer.

The manual shall detail, at the system engineering level, the procedures for installation of software on a given computer system. The manual shall also address the operation of the software at three different levels: beginner (trainee), intermediate (operator), and advanced (systems engineer).

106.07.11.04 Submission of Documentation

The Contractor shall submit to the Contract Administrator three hardcopies and three digital copies of the following documentation:

- a) All documentation required under the Documentation subsection.
- b) Record Drawings at the completion of the Contract. All deviations and design changes from the original design shall be marked accurately on the record drawings in red along with any required explanatory notes. The location of the underground facilities on the record drawings shall be drawn accurately and correctly with stations, offsets and tie down points.
- c) Any documents or drawings that are resubmitted.
- d) All ESA inspection certificates and any other third-party inspection certificates.

106.07.11.05 Quality of Documentation

The documentation shall be of professional quality, including machine- or hand-printed text, inked or CAD produced drawings, and photographic material, if applicable.

The digital files shall be provided in PDF format, unlocked, printable, and editable. Each digital copy shall be provided on a USB mass storage device (e.g. USB flash drive).

106.07.12 Restoration

The site of all electrical works shall be restored to original or better condition than existed prior to the works or as specified in the Contract Documents.

106.07.13 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

106.08**QUALITY ASSURANCE**

Electrical equipment requiring the submission of Working Drawings, as detailed in the Design and Submission Requirements section, is subject to inspection by the Owner's representative prior to shipping of the electrical equipment. The inspection shall take place at the manufacturer's factory or at the supplier's place of business. The Owner's representative shall be informed when the electrical equipment fabrication is approximately 80% and 100% complete and suitable arrangements shall be made for any required inspection.

All electrical work is subject to random inspection by the Owner's representative. The Owner's representative may witness any testing performed by the Contractor.

Upon notification, any Owner's representative (e.g., electrical coordinator, quality assurance representative) shall have access to the working area for the purpose of inspection and testing of electrical installations.

106.10**BASIS OF PAYMENT**

Payment at the Contract price for the tender items that require general electrical work shall be full compensation for all labour, Equipment, and Material to do the general electrical work.

When the Contract contains separate tender items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

106.10.01**Contractor's Workers**

When the Contract Administrator directs the removal of staff or the cessation of electrical work, no extra payment shall be made by the Owner for any costs incurred by the Contractor as a result of such direction.

106.10.02**Work to be Inspected by Electrical Safety Authority**

The work resulting from the inspection or re-inspection of electrical work by the ESA, except for correcting defects that are the direct result of compliance with the Owner's design of the work, shall be at no extra cost to the Owner.

106.10.03**Traffic Signal Systems**

The activation of traffic signals, including police supervision, shall be at no extra cost to the Owner.

106.10.04**Maintenance Costs**

When the Owner performs maintenance work resulting from inadequate workmanship on systems installed by the Contractor or defective materials supplied by the Contractor, the actual costs of the maintenance work shall be charged to the Contractor.

106.10.05**Temporary Work**

Payment for temporary items shall be made at the rate of 80% of the Contract price upon acceptance of the installation, and the remaining 20% of the Contract price shall be paid upon acceptance of the removal work.

TABLE 1
Submission Requirements for Working Drawings and Service Manuals

Item	Submission Requirements	
	Working Drawings	Service Manuals
Luminaires	Y	Y
High-voltage switches and fuses	Y	-
Transformers	Y	-
Distribution assemblies	Y	Y
Supply control cabinet assemblies	Y	Y
Traffic signal control cabinet assembly	Y	Y
Anchorage assemblies	Y	-
High mast lighting equipment (i.e., poles, raising and lowering equipment)	Y	Y
Advanced Traffic Management Systems equipment	Y	Y
Traffic data collection systems equipment	Y	Y
Traffic detection systems equipment (e.g. loop detectors, cameras, radar detectors, etc.)	-	Y
Accessible pedestrian signals	Y	Y
PXO systems equipment	Y	Y
Solar powered equipment	Y	Y
Electric vehicle charging systems equipment	-	Y
Maintenance camera systems equipment	-	Y
Uninterruptible Power Supply (UPS)	Y	Y
Animal detection systems equipment	Y	Y
Access gate systems equipment	Y	Y
Cathodic Protection systems equipment	Y	Y
Flasher Beacon systems equipment (e.g. school zones, animal detection, intersections)	Y	Y
Roadway weather information systems equipment	Y	Y
Traffic signal controllers	-	Y
Flasher mechanisms	-	Y
Conflict monitors	-	Y
Load switches	-	Y
DC isolators	-	Y
AC isolators	-	Y
Thermostat panel	-	Y



GENERAL SPECIFICATION FOR THE USE OF EXPLOSIVES

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120.01	SCOPE

This specification covers the requirements for the use of explosives.

120.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

120.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

120.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

Department of Fisheries and Oceans (DFO) Publication

Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters, 1998

International Society of Explosives Engineers (ISEE)

Performance Specifications for Blasting Seismographs, 2011 Edition

120.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Blaster means a competent person knowledgeable, experienced, and trained in the handling, use, and storage of explosives and their effect on adjacent property and persons.

Blast Monitoring Consultant means a consulting engineering firm with a minimum of 5 years experience related to blasting retained by the Contractor to provide blast monitoring services. The blast monitoring consultant shall be a third party that is not owned or corporately affiliated with the Contractor responsible for the Work.

Consulting Engineering Firm means a firm or an individual that has been issued a Certificate of Authorization and a Consulting Engineer designation by the Professional Engineers Ontario.

Designated Blast Area means the area where the Contractor has notified, in writing, and provided information to all Utilities, public and private property owners, and as the area where the Contractor has made arrangements to evacuate all persons whose safety might be threatened by the blasting operation.

Fish Habitat means as defined by the Fisheries Act.

Flyrock means rock that becomes airborne as a direct result of a blast.

Peak Particle Velocity (PPV) means the maximum component velocity in millimetres per second that ground particles move as a result of energy released from explosive detonations.

Pre-Blast Survey means a detailed record, accompanied by film or video, as necessary, of the condition of private or public property, prior to the commencement of blasting operations.

120.04 DESIGN AND SUBMISSION REQUIREMENTS

120.04.01 Design Requirements

A blast design shall be prepared by an individual or firm with a minimum 5 years experience and be certified by an Engineer. The blast design shall include, as a minimum, the following:

- a) Design PPV and design peak sound pressure level at 250 m radius from the area of the blast or nearest Utility, residence, structure, or facility.
- b) Number, pattern, orientation, spacing, size, and depth of drill holes.
- c) Collar and toe load, number and time of delays, and mass and type of charge per delay.
- d) Setback distances to affected fish habitat.
- e) The explosive products to be used.
- f) The designated blast area.

120.04.02 Submission Requirements

The following shall be submitted to the Contract Administrator:

- a) A minimum of 2 weeks prior to the use of explosives:
 - i. The name and statement of experience of the firm carrying out the blasting.
 - ii. The name of the blaster including a record of experience and safety training.
 - iii. The name of the individual or firm responsible for the blast design, including a record of experience and statement of qualifications.
 - iv. A letter from an Engineer certifying the design.
 - v. The name of the blast monitoring consultant, including a record of experience and a record of qualifications.
 - vi. A certificate of insurance indemnifying the Owner from all claims and damages arising from the use of explosives.

- b) A minimum of 48 hours prior to the use of explosives:
- i. A letter signed by the Engineer certifying the blast design indicating the areas for which the blast design has been completed.
 - ii. A letter signed by the blaster indicating receipt of the blast design and agreement that the blasting shall be according to the design.
 - iii. A letter signed by the Contractor certifying that a pre-blast survey has been carried out in accordance with the Pre-Blast Survey subsection and a copy of the pre-blast survey.
 - iv. A copy of the blast design, including all items shown in the Design Requirements subsection.
 - v. The designated blast area.
 - vi. A blasting schedule.
 - vii. A list of all locations to be monitored.
 - viii. Proof of calibration of all monitoring equipment.
- c) Upon request, any blasting permits, approvals, and agreements required for the use of explosives or to carry out blasting operations.

120.05 MATERIALS

120.05.01 Explosives

Only explosive products approved for use in Canada shall be used.

120.06 EQUIPMENT

120.06.01 Detonation Apparatus

Detonation apparatus shall be of the type approved by the detonation system manufacturer for the type of blasting operation to be undertaken. All apparatus shall be kept in working order and shall be thoroughly inspected before and after each blasting operation.

All wiring connected to electrical detonation apparatus shall be properly insulated.

120.06.02 Monitoring Equipment

All monitoring equipment shall be capable of measuring and recording ground vibration PPV up to 200 mm/s in the vertical, transverse, and radial directions. The equipment shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent. Proof of calibration shall be submitted to the Contract Administrator prior to commencement of any monitoring operations.

Monitoring equipment shall be according to ISEE Performance Specifications for Blasting Seismographs.

120.07 CONSTRUCTION

120.07.01 General

Blasting shall be carried out only during daylight hours and at a time when atmospheric conditions provide clear observation of the blast when practical from a minimum distance of 1,000 m. Blasting shall not be conducted on Sundays, statutory holidays, or during electrical storms.

Blasting shall not be carried out within 30 m of concrete placed less than 72 hours when the ambient temperature falls below 20 °C or for 36 hours when the ambient temperature is continuously greater than 20 °C, unless otherwise authorized by the Contract Administrator.

Protection of fish and fish habitat shall be according to the Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters.

120.07.02 Radio-Frequency Hazards

Prior to blasting, investigations shall be done to determine if radio-frequency hazards exist. When such hazards exist, necessary precautions shall be taken.

120.07.03 Pre-Blast Survey

A pre-blast survey shall be prepared for all buildings, Utilities, structures, water wells, and facilities likely to be affected by the blast and those within 150 m of the location where explosives are to be used. The standard inspection procedure shall include the provision of an explanatory letter to the owner or occupant and owner with a formal request for permission to carry out an inspection.

The pre-blast survey shall include, as a minimum, the following information:

- a) Type of structure, including type of construction and if possible, the date when built.
- b) Identification and description of existing differential settlements, including visible cracks in walls, floors, and ceilings, including a diagram, if applicable, room-by-room. All other apparent structural and cosmetic damage or defect shall also be noted. Defects shall be described, including dimensions, wherever possible.
- c) Digital photographs or digital video or both, as necessary, to record areas of significant concern.

Photographs and videos shall be clear and shall accurately represent the condition of the property. Each photograph or video shall be clearly labelled with the location and date taken.

A copy of the pre-blast survey limited to a single residence or property, including copies of any photographs or videos that may form part of the report shall be provided to the owner of that residence or property, upon request.

120.07.04 Notification

120.07.04.01 General

A minimum of 15 Business Days prior to blasting, the Contractor shall provide written notice to Utilities and all owners and tenants of improved property within 500 m of the right-of-way in the vicinity of the blast. The notice shall include a blasting schedule, information about the audible blast warning system, and contact name for questions or other concerns.

The Contractor shall ensure that a competent person is available to receive, document, and deal with public inquiries before and after blasting operations.

A minimum 48 hours prior to blasting, sufficient detail regarding the blasting operations shall be provided to NAV Canada.

120.07.04.02 Utilities

Authorities of all likely affected Utilities shall be notified a minimum of 72 hours prior to blasting.

120.07.04.03 Properties

Not more than 5 Business Days and not less than 4 hours prior to each blast, the Contractor shall provide notice of the blasting schedule to all owners and tenants of buildings or facilities within 150 m of the blast.

All blasts scheduled for the following 7 Days may be included in one notice. The notice shall include information about the audible blast warning system.

When blasting operations may incur property damage or require temporary evacuation, notification shall include evacuation information and instructions. The Contractor shall take all reasonable steps to ensure that the property owner acknowledges, by their signature, that they have received the information and shall comply with any evacuation requirements. When such signature is withheld, the Contractor shall maintain records showing the date and time that the information was delivered.

120.07.05 Monitoring

120.07.05.01 General

The Contractor shall employ a blast monitoring consultant to carry out monitoring for PPV, peak sound pressure levels, and water overpressures as required. During each blast, ground vibration PPV and the peak sound pressure level shall be monitored at 250 m from the area of the blast or at the closest portion of any Utility, residence, structure, or facility. Water overpressure in affected fish habitats shall be monitored adjacent to the shore closest to the blast. The monitoring equipment shall be repositioned as required.

120.07.05.02 Ground Vibration

Ground vibration as measured by PPV shall be limited to the maximum levels shown in Table 1. Should readings from any two consecutive blasts exceed these values or any single reading exceed these values by more than 30 mm/s, the blast operation shall cease until a revised blast design, certified by the Engineer, has been submitted to the Contract Administrator.

120.07.05.03 Water Overpressure

Instantaneous pressure change as measured by water overpressure in or near fish habitat shall not exceed 100 kPa.

120.07.05.04 Trial Blasts

The Contractor shall confirm the suitability of the blast design for the ground vibration PPV limits and sound pressure levels by carrying out a minimum of three limited test blasts at locations agreed upon by the Contract Administrator and the Contractor. The trial blasts shall be carried out with appropriate blast vibration and noise level monitoring equipment. Based on the results, the initial blast design shall be revised as necessary.

120.07.06 Protective Measures

Immediately prior to the blast, the designated blast area shall be cleared of all vehicular and pedestrian traffic.

All traffic shall be stopped and prevented from entering the area until the blaster gives permission. Traffic control shall be according to the Ontario Traffic Manual, Book 7. Signs shall be posted to inform the public of blasting operations and to turn off radio transmitters. Audible blast warning devices, capable of alerting workers and the public up to a radius of 1,000 m, shall be used before and after blasting.

Blasting mats or other suitable means of controlling flyrock shall be used to limit potential hazardous effects of the blast.

120.07.06.01**Protection of Utility Lines**

Where temporary rearranging and shielding of utility lines are detailed within the Contract Documents, such temporary rearranging and shielding is the minimum protection required. The Contractor shall remain responsible for any unauthorized disruptions of service and any damage to utilities arising out of the Contractor's work, notwithstanding such protection. The Utility authorities shall carry out the temporary rearranging and shielding of lines as detailed within the Contract Documents and more extensive rearranging and shielding if requested to do so by the Contractor. The cost of all such protective measures, together with the cost of restoring the lines to their original state and location, shall be at the expense of the Contractor, and shall be billed to the Contractor by the Utility authority.

Notwithstanding the preceding paragraph, the Utility authorities shall, subject to the Contractor's obligation under the Contract to assume responsibility for disruption of services and damage, consider alternative measures which the Contractor may suggest. Such alternative measures, if approved by the Utility authorities in writing, shall be provided at the Contractor's expense and billed to the Contractor by the Utility authority.

Whenever, in the opinion of the Utility authority, standby crews are necessary during blasting operations, the Contractor shall make the necessary arrangements with the Utility authority and the cost of such crews and equipment shall be billed to the Contractor by the Utility authority. These measures shall apply to those utilities located within all rock blasting areas.

120.07.07**Records**

A post-blast record shall be prepared and signed by the blaster for each blast completed. The post-blast record shall report the following conditions and be made available to the Contract Administrator for site review:

- a) The date, time, and location of the blast.
- b) The wind direction and approximate speed at the time of the blast.
- c) The general atmospheric conditions at the time of the blast.
- d) The actual blast details.
- e) PPV, peak sound pressure level, and water overpressure results of each blast.

A report summarizing the results of the ground vibration and peak sound pressure levels shall be submitted to the Contract Administrator at the end of each work day that blasting was carried out.

120.07.08**Damage**

Upon completion of blasting or immediately following the receipt of a complaint, a site condition survey shall be performed to determine if any damage has resulted. The Contractor shall record all incidents of any damage or injury, which shall be reported immediately in writing to the Contract Administrator. All other complaints shall be reported to the Contract Administrator in writing within 24 hours of receipt. Each complaint report shall include the name and address of the complainant, time received, and description of the circumstances that led to the complaint.

120.07.09**Management of Excess Material**

Management of excess material shall be according to the Contract Documents.

120.10**BASIS OF PAYMENT**

Payment at the Contract price for the appropriate tender items that requires the use of explosives shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

The cost of standby crews and equipment required by Utility authorities shall be the responsibility of the Contractor.

120.10.01**Claims**

The Contractor shall be responsible for the management of all claims and payment arising from the hauling, handling, use of, and storing of explosives and all effects, directly or indirectly related to the blasting operation.

TABLE 1
Maximum Peak Particle Velocity Values

Element	Frequency Hz	Peak Particle Velocity (PPV) mm/s
Structures and Pipelines	≤ 40	20
	> 40	50
Concrete and Grout < 72 hours from placement	N/A	10

Appendix 120-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



SCHEDULE OF RENTAL RATES FOR CONSTRUCTION EQUIPMENT, INCLUDING MODEL AND SPECIFICATION REFERENCE

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127.02.10	PILE DRIVING EQUIPMENT

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127.02.10.03	Leads, Including Hydraulics And Kicker
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127.02.11	DRILLING EQUIPMENT

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127.03.17	TRAFFIC CONTROL DEVICES - NOT USED
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127.01**SCOPE**

This specification covers equipment rental rate compensation for work on a Time and Material Basis. The calculated rate represents the cost of owning and operating the equipment and is made up of direct and indirect costs such as fuel, oil, lubrication, field repairs, overhaul, depreciation, financing, storage, insurance, overhead, and profit.

The rental rates in this schedule are hourly, unless otherwise stated, and do not include the cost of the operator.

The information was compiled from manufacturers, equipment dealers and distributors, and contractors and is based on equipment specifications for standard models, including all necessary attachments to perform the work. Adjustments shall not be made to the rental rate due to optional components that may increase the weight, capacity, or power of a piece of equipment.

Except for Subsection 127.02.09, Hoisting Equipment, the rates listed cover the range of all equipment up to the next highest increment. When a piece of equipment falls in between listed categories, with respect to weight or capacity, the lower rental rate shall apply. For Subsection 127.02.09, Hoisting Equipment, when the size of the equipment falls between the increments shown, the rental rate is to be determined by a straight- line interpolation and rounded to the nearest five cents.

The rental rates reflect the existing tax situations as they pertain to the purchase of equipment at the date of publication.

Section 127.03, Manufacturers' Model, Specification, and Capacity Reference Guide, covers a partial listing of manufacturers' equipment model or specification numbers, with appropriate capacity and power ratings. This guide is provided for reference purposes only to assist in determining the appropriate ratings listed in Section 127.02, Schedule of Rental Rates for Construction Equipment.

The rental rates are reviewed annually; therefore, any errors, omissions, or additional suggestions or amendments should be addressed in writing to:

Head, Contract Award
Contract Management Office
Ontario Ministry of Transportation
Garden City Tower, 2nd Floor
301 St. Paul Street
St. Catharines, ON L2R 7R4

127.02 SCHEDULE OF RENTAL RATES FOR CONSTRUCTION EQUIPMENT

127.02.01 AIR EQUIPMENT

127.02.01.01 Air Compressor, Silenced

Flow Rate, m³/min

3	11.90
5	18.55
7	26.50
10	44.20
17	79.85
25	111.40
45	187.30

127.02.01.02 Air Hammer, Including 15 M Hose, Excluding Points

Weight, kg

3	0.95
14	1.55
28	1.65

127.02.01.03 Sand Blaster, Including Nozzles And Hoses

Sand Pot Capacity, Weight, kg

135	12.00
270	17.70

127.02.02 ASPHALT EQUIPMENT

127.02.02.01 Asphalt Paver

Weight, kg

2,000	41.90
4,000	119.70
7,000	143.95
9,000	195.85
14,000	291.85
17,000	342.65
20,000	381.20

127.02.02.02 Asphalt Paver Attachment

Mechanical Floating Beam	6.05
Mechanical Grade and Slope Control	13.75
Screed Extension, Bolt On	4.60
Sonic Averaging Ski	8.60
Sonic Grade and Slope Control	11.30
Joint Match Heater	17.90

127.02.02.03 Asphalt Distributor With Truck

Tank Volume, litre

7,000	151.35
11,000	193.90

127.02.02.04	Asphalt Pavement Profiler	
Power, kW		
32		148.40
90		264.10
135		533.55
340*		794.85
700*		957.90
* Excluding teeth		

127.02.02.05 Asphalt Pavement Repair Equipment

Equipment Type		
4 kW Pavement Line Grinder		4.35
8 kW Pavement Line Grinder		11.75
Pavement Router		13.80
Hot Air Lance		9.50
Mastic Kettle		26.75

127.02.02.06 Asphalt Material Transfer Vehicle

Without Surge Bin	393.10
With Surge Bin	473.70

127.02.02.07 Profilograph

Equipment Type		
California Profilograph, including trailer		35.25
High Speed, including truck		65.20

127.02.02.08 Linestripper

Equipment Type		
Walk Behind		9.95
Walk Behind Ride-On Attachment		6.30
Skid Mounted		27.70
Ride-On		33.40
400 litre Truck Mounted		163.15
1,000 litre Truck Mounted		198.70
2,000 litre Truck Mounted		234.85
2,000 litre Truck Mounted, including attenuator		258.90

127.02.03 COMPACTION EQUIPMENT

127.02.03.01 Rammer

Minimum Weight, kg		
45		7.05
65		8.75

127.02.03.02 Manually Guided, Vibratory Plate

Minimum Weight, kg	
65	6.35
100	9.55
160	17.40
280	27.80
390	31.95
500	42.30

127.02.03.03 Hoe Mounted, Vibratory Plate, Hydraulic

Minimum Weight, kg	
100	6.90
300	8.65
600	12.85
900	21.70

127.02.03.04 Manually Guided, Self-Propelled, Vibratory, Tandem Drum

Minimum Weight, kg	
400	23.25
1,200	53.30

127.02.03.05 Self-Propelled, Vibratory, Single Pad Foot Drum

Minimum Weight, kg	
1,000	49.45
4,000	70.50
6,000	91.40
9,200	126.75
13,000	151.75
18,000	189.15
24,000	218.25

127.02.03.06 Self-Propelled, Vibratory, Single Smooth Drum

Minimum Weight, kg	
1,000	50.20
4,000	68.10
6,000	87.75
9,200	123.85
13,000	151.35
18,000	181.00
24,000	202.90

127.02.03.07 Self-Propelled, Vibratory, Tandem Drum

Minimum Weight, kg	
1,000	31.45
3,000	50.10
6,000	96.05
8,000	117.40
10,000	125.20
12,000	149.65

127.02.03.08	Self-Propelled, Static, Tandem Drum	
Minimum Weight, kg		
4,000		49.50
7,000		60.20
10,000		67.70
127.02.03.09	Self-Propelled, Static, Segmented, Four-Wheeled, Two Axles, Including Blade	
Minimum Weight, kg		
19,000		297.10
30,000		390.45
127.02.03.10	Self-Propelled, Static, Pneumatic Tires	
Maximum Ballasted Weight, kg		
8,000		76.05
18,000		121.80
127.02.04	CONCRETE EQUIPMENT	
127.02.04.01	Saw, Self-Propelled, Excluding Blades	
Power, kW		
5		13.20
10		16.30
15		29.65
40		60.40
Ride-On		88.35
127.02.04.02	Saw, Manually Guided, Excluding Blades	
Power, kW		
3		4.85
5		7.90
10		15.85
127.02.04.03	Slip Form Paver	
Power, kW		
10		56.50
30		205.15
70		217.20
120		303.75
200		566.15
127.02.04.04	Concrete Vibrator, Including Flexible Shaft And Electric Motor	
Vibrator Diameter, mm		
All models		2.80

127.02.04.05 Concrete Repair Equipment

Equipment Type	
50 mm Hammer Drill, excluding bits	1.30
Predampener	44.70
Shotcrete Pump, Dry Process	16.45
Shotcrete Pump, Wet Process	105.00
Batch Mixer Pump	67.50

127.02.04.06 Concrete Placing Equipment

Equipment Type	
15 m ³ /hr Concrete Pump, Trailer Mount	57.25
25 m ³ /hr Concrete Pump, Trailer Mount	58.60
35 m ³ /hr Concrete Pump, Trailer Mount	80.45
54 m ³ /hr Concrete Pump, Trailer Mount	131.00
98 m ³ /hr Concrete Pump, Trailer Mount	347.65
17 m Vertical Height, Concrete Pump-Truck Mount	232.65
24 m Vertical Height, Concrete Pump-Truck Mount	268.35
28 m Vertical Height, Concrete Pump-Truck Mount	336.30
33 m Vertical Height, Concrete Pump-Truck Mount	365.30
40 m Vertical Height, Concrete Pump-Truck Mount	474.85
47 m Vertical Height, Concrete Pump-Truck Mount	696.70
Concrete Deck Finisher, Self-Propelled	56.05
Concrete Placer	356.35
Concrete Placer Spreader	541.90
Concrete Texture Curing Machine	119.30
Concrete Conveyor	99.00

127.02.04.07 Hydraulic Breaker, Boom Mounted

Impact Energy, Joules	
200	6.30
400	9.85
900	10.45
1,500	20.05
2,200	27.30
3,300	38.85
4,500	62.10
6,000	68.45
12,000	94.75
20,000	209.10

127.02.05 CRUSHING EQUIPMENT**127.02.05.01 Jaw Crusher, Diesel**

Jaw Opening, m	
< 1.00	178.35
1.00	219.10
1.15	319.65

127.02.05.02	Cone Crusher, Diesel	
Jaw Opening, m		
0.90		292.20
1.00		377.85
1.30		416.40
127.02.05.03	Impact Crusher, Diesel	
Crusher Size, m		
1.0		271.40
1.2		292.15
1.3		389.85
127.02.05.04	Screening Plant, Double Deck, Diesel	
Screen Size, m		
3		135.85
5		147.45
6		183.55
127.02.05.05	Screening Plant, Triple Deck, Diesel	
Screen Size, m		
5		160.65
6		198.95
127.02.05.06	Surge Bins And Conveyor, Excluding Power Unit	
Bin Volume, m ³		
7		58.50
10		98.70
127.02.05.07	Stacker, Excluding Power Unit	
Conveyor Length, m		
Wheeled, Electric		
12		15.40
18		22.00
24		37.60
30		54.45
Tracked, Diesel		
18		79.30
24		89.85
30		119.75
127.02.05.08	Telescoping Stackers, Excluding Power Unit	
Conveyor Length, m		
36		133.90
46		198.50
61		281.95
76		311.85

127.02.05.09 Trommel Screening Plant, Diesel

Drum Diameter, m	
1.50	110.60
1.80	156.75

127.02.06 EARTH MOVING, GRADING EQUIPMENT

127.02.06.01 Scraper, Single Engine, Two-Wheel Drive

Minimum Struck Capacity, m ³	
10	274.20
16	364.25

127.02.06.02 Scraper, Twin Engine, Four-Wheel Drive

Minimum Struck Capacity, m ³	
10	358.30
16	478.55
22	629.55

127.02.06.03 Scraper, Single Engine, Self-Loading

Minimum Struck Capacity, m ³	
11	289.35

127.02.06.04 Scraper, Pull Type

Minimum Struck Capacity, m ³	
6	26.25
9	36.85
11	38.90
14	57.75

127.02.06.05 Tractor Bulldozer, Crawler Type

Minimum Net Flywheel Power, kW	
50	73.65
60	90.55
80	129.65
120	177.25
160	261.35
210	356.55
280	471.45

127.02.06.06 Tractor Bulldozer Ripper Attachment, Hydraulic, Rear Mounted

Power, kW	
50	7.25
120	11.15
160	14.75
210	23.40
280	39.00

127.02.06.07 Wheeled Tractor, Farm, Industrial, Two-Wheel Drive

Power, kW	
10	9.95
25	19.25
40	26.60
50	37.05
70	54.75
90	75.80
120	99.40
160	153.95

127.02.06.08 Wheeled Tractor, Farm, Industrial, Four-Wheel Drive

Power, kW	
10	12.20
25	20.15
40	26.45
50	38.40
70	54.65
90	70.15
110	94.10
135	109.20
150	142.15
180	178.85

127.02.06.09 Motor Grader, Articulated Frame

Minimum Operating Weight, kg	
14,000	153.10
20,000	178.10
30,000	358.10

127.02.06.10 Motor Grader Ripper Or Scarifier Attachment, Hydraulic Mounted

Grader Weight, kg	
14,000 - Grader Ripper	7.95
20,000 - Grader Ripper	9.55
30,000 - Grader Ripper	19.75
Scarifier - any size grader	6.35

127.02.06.11 Gravel Or Chip Spreader, Self-Propelled

Spreader Width, m	
3	192.55
4	248.45
5	307.60

127.02.06.12 Spreader Attachment

Equipment Type	
Grader/FEL - Shouldering	33.90

127.02.06.13 Shoulder Spreader/Road Widener

Spreader Width, m	
2	124.85
3	166.70

127.02.06.14 Reclaimer/Stabilizer, Excluding Teeth

Equipment Power, kW	
250	398.65
325	510.70
440	658.35

127.02.06.15 Grade Trimmer

Minimum Width, m	
3	466.30

127.02.07 EXCAVATION EQUIPMENT

127.02.07.01 Hydraulic Excavator, Crawler Mounted, Long Reach, 12 To 21 M Boom

Minimum Operating Weight, kg	
23,000	153.85
26,500	185.60
32,000	233.75
44,000	315.65

127.02.07.02 Hydraulic Excavator, Crawler Mounted

Minimum Operating Weight, kg	
1,000	27.65
4,000	46.60
6,000	65.90
12,000	114.55
19,500	135.40
23,000	150.70
26,500	185.85
32,000	209.05
44,000	316.65
55,000	429.50
70,000	500.75
100,000	593.05

127.02.07.03 Hydraulic Excavator, Rubber Tired

Minimum Operating Weight, kg	
11,000	145.90
18,000	175.45
21,000	187.05

127.02.07.04 Hydraulic Excavator, Bucket Attachment, Wrist Action

Minimum Carrier Weight, kg	
4,000	4.80
9,000	6.05
13,000	8.10
18,000	11.00

127.02.07.05 Telescopic Boom, Carrier Mounted Excavator

Weight, kg	
15,000	180.30
22,000	237.15

127.02.07.06 Telescopic Boom, Crawler Mounted Excavator

Weight, kg	
17,000	151.40
20,000	175.45
23,000	203.45

127.02.07.07 Tractor With Loader/Backhoe Combination, Two-Wheel Drive

Minimum Power, kW	
45	70.60
60	78.45
75	92.75
94	136.95

127.02.07.08 Tractor With Loader/Backhoe Combination, Four-Wheel Drive

Minimum Power, kW	
30	36.40
45	70.10
65	87.80
80	99.40
94	136.90

127.02.07.09 Tractor With Loader/Backhoe Combination, Attachments

Attachment Type	
Auger	5.55
Breaker	14.30
Bucket Thumb	5.00

127.02.07.10 Front End Loader, Crawler Mounted

Power, kW	
70	117.25
100	161.65
150	226.80

127.02.07.11 Front End Loader, Rubber Tire, Four-Wheel Drive

Power, kW	
40	53.65
75	86.95
100	100.35
125	111.90
140	142.10
175	164.75
200	176.50
225	215.00
250	234.90
300	271.80
370	470.35

127.02.07.12 Skid Steer Loader, Rubber Tire

Rated Operating Capacity (50% Tipping Load)	
300	24.30
700	37.25
850	39.85
1,000	44.30
1,200	48.55
1,500	60.85

127.02.07.13 Skid Steer Loader, Tracked

Rated Operating Capacity (35% Tipping Load)	
300	44.45
900	53.00
1,100	55.95
1,300	64.15
1,600	73.40
1,800	92.95

127.02.07.14 Skid Steer Loader, Attachments

Attachment Type	
Auger	4.20
Backhoe	12.35
Breaker	9.65
Cold Planer	20.35
Multi Bucket	3.90
Pick Up Broom	4.95
Power Rake	10.00
Scarifier	1.40
Steel Tracks	3.70
Sweeper, Angle Broom	5.40
Trencher	5.20

127.02.07.15	Chain Type Trenching Equipment	
Power, kW		
13		20.85
20		31.95
35		59.40
50		98.50
127.02.08	HAULAGE EQUIPMENT	
127.02.08.01	Tag Along Trailer	
Load Capacity, kg		
1,500		1.45
2,500		2.30
5,400		3.85
10,000		6.45
16,000		9.70
22,000		11.10
127.02.08.02	Rigid Gooseneck Float With Tractor	
Load Capacity, kg		
20,000		155.05
40,000		172.95
127.02.08.03	Detachable Gooseneck Float With Tractor	
Load Capacity, kg		
30,000		159.95
45,000		169.05
127.02.08.04	Pickup, Two-Wheel Drive	
Pickup Type		
Mini Type		21.25
2,600 kg GVW		32.75
3,800 kg GVW		39.50
4,500 kg GVW		40.05
127.02.08.05	Pickup, Four-Wheel Drive	
Pickup Type		
Mini Type		26.55
2,600 kg GVW		33.85
3,800 kg GVW		40.95
4,500 kg GVW		41.45
127.02.08.06	Rear Dump, Single Rear Axle, Diesel Or Gas	
AGW, kg		
5,000		68.45
12,000		85.10

127.02.08.07 Rear Dump, Tandem Rear Axle, Diesel Or Gas

AGW, kg	
24,000	119.05

127.02.08.08 Rear Dump, Tri- Axle, Diesel

AGW, kg	
32,000	138.45
32,000 kg Stone Spreader	159.10

127.02.08.09 Tractor, On Highway, Diesel

Tandem Axle	141.20

127.02.08.10 Trailers, Rear Dump

Axle Configuration	
Pony/Pup	19.70
Tri	23.75
Quad	31.20
Quint	37.10

127.02.08.11 Trailers, Live Bottom

Axle Configuration	
Tandem	26.05
Tri	32.50
Quad	36.30
Quint	41.00

127.02.08.12 Water Truck, Single Rear Axle

Spray Bar Type	
Gravity/Pressure	110.60

127.02.08.13 Water Truck, Tandem Rear Axle

Spray Bar Type	
Pressure	135.75

127.02.08.14 Dump Trucks, Off Highway, Rigid Frame

Payload, kg	
35,000	218.35
38,000	259.20
50,000	339.00
75,000	529.00

127.02.08.15 Dump Trucks, Off Highway, Articulated Frame

Payload, kg	
20,000	164.65
26,000	185.10
30,000	233.80
35,000	247.65
40,000	298.55

127.02.09 HOISTING EQUIPMENT

127.02.09.01 Boom Truck

Lift Capacity, kg	
7,000	120.75
11,000	166.60
19,000	181.95
25,000	230.95
40,000	339.05

127.02.09.02 Hydraulic Crane, Rough Terrain

Lift Capacity, kg	
13,000	131.40
20,000	167.75
40,000	213.00
65,000	291.65
100,000	451.50

127.02.09.03 Hydraulic Crane, Carrier Mounted

Lift Capacity, kg	
25,000	261.85
45,000	343.35
60,000	404.45
90,000	518.85
135,000	661.90
200,000	869.80
300,000	1213.70

127.02.09.04 Lattice Boom Crane, Crawler Mounted

Lift Capacity, kg	
50,000	253.75
70,000	258.15
90,000	333.80
130,000	472.75
200,000	587.05
250,000	805.35

127.02.09.05 Lattice Boom Crane, Carrier Mounted

Lift Capacity, kg	
110,000	573.75
270,000	799.60

127.02.09.06 Aerial Bucket Lift, Truck Mounted, Including Truck

Platform Height, m	
7.0	112.50
10.0	127.60
15.0	145.20
20.0	190.40

127.02.09.07 Aerial Bucket Lift, Self-Propelled, Telescopic/Articulating

Platform Height, m	
9.0	41.65
12.0	60.25
18.0	90.30
22.0	127.45
30.0	165.90
41.0	261.55

127.02.09.08 Scissor Lift, Self-Propelled

Platform Height, m	
4.0	11.45
7.0	21.90
9.0	38.10

127.02.09.09 Tool Carrier

Power Rating, kW	
40	60.55
75	86.95
100	103.40
125	131.65
200	248.00

127.02.09.10 Telescopic Handlers

Lifting Height, m	
5	66.00
10	91.65

127.02.10 PILE DRIVING EQUIPMENT

127.02.10.01 Hammer, Open End, Diesel

Rated Energy, joules	
50,000	47.75
80,000	79.30
120,000	92.35
220,000	178.70
300,000	209.40

127.02.10.02 Driver/Extractor, Vibratory Centrifugal, Including Power Pack, Excluding Crane

Driving Force, kN	
245	191.10
392	208.85
637	262.30
980	354.35
1,471	467.15

127.02.10.03 Leads, Including Hydraulics And Kicker

Length, m	
20, Fixed/Vertical	41.70
20, Hanging	15.90
24, Fixed/Vertical	41.95
24, Hanging	17.40
30, Fixed/Vertical	43.60
30, Hanging	21.25

127.02.10.04 Hydraulic Post Driver

Track Mounted	79.60
Truck Mounted	172.10

127.02.10.05 Universal Piling Machine, Including Attachment

Power Rating, kW	
< 450	759.10
450	1,019.95
570	1,277.00

127.02.11 DRILLING EQUIPMENT

Note: Use Manufacturer's Model, Specification, and Capacity tables to determine power rating for hydraulically driven rotary drilling equipment.

127.02.11.01 Mechanical Drilling Equipment, Truck Mounted, Including Auger And Crowd And Power Pack

Power, kW	
80	269.90
120	528.70

127.02.11.02 Mechanical Drilling Equipment, Crawler Mounted, Including Auger

Power, kW	
95	282.40
113	419.35
130	511.80

127.02.11.03 Hydraulic Drill Rig

Power, kW	
185	651.60
250	924.85
350	1,075.25
430	1,410.80
570	1,825.85

Note: Base rate includes initial casing up to 20 m, teeth, and auger. Replacement auger teeth not included.

127.02.11.04 Mechanical Drilling Equipment, Crane Mounted Attachment, Including Auger

Power, kW	
110	102.90
200	134.15

127.02.11.05 Horizontal Earth Boring Equipment

Power Rating, kW	
20	57.35
50	101.95
100	151.55
200	312.60

Note: Base rate includes 20 m auger and cutting head.

127.02.11.06 Trenchless Directional Drill, Track Mounted

Operating Weight, kg	
1,000	144.45
7,000	319.00
12,000	429.20
20,000	552.40

127.02.11.07 Hydraulic Rock Drill, Including Power Pack, Excluding Drill Steel And Bits

Diameter, mm	
75	252.15
125	328.75
150	616.70

127.02.11.08 Tieback Drill Rig, Hydraulic, Dual Head

Power, kW	
< 140	232.90
140	374.40

Note: Base rate includes initial casing, drilling, augering components up to 20 m.

127.02.12	BROOM AND SWEEPER EQUIPMENT	
127.02.12.01	Front Mounted Attachment, Hydraulic	
Broom Width, m		
1.2		5.75
1.8		7.05
2.4		11.35
127.02.12.02	Self-Propelled, Dual Control	
Sweeper Type		
Mechanical		148.75
Regenerative Air		164.45
Vacuum		171.25
127.02.13	FORESTRY EQUIPMENT	
127.02.13.01	Brush Chipper, Tow Type	
Minimum Net Flywheel Power, kW		
19		28.60
35		48.25
60		48.80
80		86.90
140		155.55
127.02.13.02	Lod Skidder, Cable/Grapple	
Minimum Net Flywheel Power, kW		
120		164.25
170		201.15
127.02.13.03	Chain Saw	
Power, kW		
1		4.00
3		7.75
5		11.55

127.02.14 PORTABLE GENERATING EQUIPMENT

127.02.14.01 Generator, Gas Or Diesel

Power, kW	
0.5, Air Cooled, Gasoline	2.35
3, Air Cooled, Gasoline	3.95
5, Air Cooled, Gasoline	5.75
10, Air Cooled, Diesel	18.35
40, Water Cooled, Diesel	44.55
80, Water Cooled, Diesel	72.75
150, Water Cooled, Diesel	122.30
250, Water Cooled, Diesel	165.90
300, Water Cooled, Diesel	206.45
400, Water Cooled, Diesel	275.10
600, Water Cooled, Diesel	373.30
900, Water Cooled, Diesel	535.20

127.02.15 PUMPING EQUIPMENT

127.02.15.01 Centrifugal, Dewatering, Including 6 M Suction And 7.5 M Discharge

Intake Size, mm	
25, Air Cooled, gasoline	1.30
50, Air Cooled, gasoline	2.85
100, Air Cooled, gasoline	5.30

127.02.15.02 Centrifugal, Trash, Including 6 M Suction And 7.5 M Discharge

Intake Size, mm	
50	4.70
75	6.75
100	16.00
150	41.80
200	97.90

127.02.15.03 Diaphragm, Including 6 M Suction And 7.5 M Discharge

Intake Size, mm	
50, Air Cooled, gasoline	3.95
75, Air Cooled, gasoline	4.15

127.02.15.04 Electric Submersible, Including 30 M Cable And 7.5 M Discharge, Excluding Generator

Intake Diameter, mm	
50	1.05
75	2.50
100	5.35
150	11.90
200	30.10

127.02.16	WELDING EQUIPMENT	
127.02.16.01	Dc Arc Welder, Engine Driven, Including Rods	
Current, A		
125		7.40
150		9.30
200		11.70
300		14.15
400		21.05
127.02.16.02	Oxygen/Acetylene Torch, Including Gas, Excluding Rods	
Equipment Type		
Hand Mobile, Heavy Duty		9.40
127.02.17	TRAFFIC CONTROL DEVICES	
127.02.17.01	Portable Variable Message Signs	
Equipment Type		
Trailer Mounted, Solar		16.75
Truck Mounted		6.35
127.02.17.02	Buffer Vehicles, Including Arrow Board And Attenuator	
Equipment Type		
Crash Truck		91.65
127.02.17.03	Traffic Barrels	
Each Per Day		0.95
127.02.17.04	Portable Light Towers, Trailer Mounted	
Extended Tower Height, m		
9		17.45
127.02.18	MISCELLANEOUS EQUIPMENT	
127.02.18.01	Hydro Excavation Equipment	
Hydro Excavating / Vacuum Truck		
Single Axle		194.75
Tandem Axle		208.90
Tri Axle		257.25

127.03

MANUFACTURERS' MODEL, SPECIFICATION AND CAPACITY REFERENCE GUIDE

Note: Each table has a number in parentheses as part of the table title that refers to the corresponding clause in Section 2 - Schedule of Rental Rates for Construction Equipment.

127.03.01

AIR EQUIPMENT

Air Compressor, Silenced (127.02.01.01)

Flow Rate m ³ /min	3	5	7	10	17	25	45
Atlas Copco	XAS 57 Dd XAS 67 Dd XAS 77 Dd XAS67KD-16	XAS 97 Dd XAS185-16 XATS 250 KD7 XAS 110 XAS188	XAS126 XAS146 XATS 300 KD7 XATS250	XAHS186 XAS186 XATS 400 XATS156	XAHS336 XAMS356 XATS750-16 XAVS650 XAVS900	XATS 1050 XPHS486 XRVS366 XAS950 XRVS1000 CD	XAS 1800
Chicago Pneumatics	CPS 90	CPS 185 CPS 185 DD CPS 185 DD1 CPS 185 PD1 CPS185KD CPS250KD		CPS 375 CPS375	CPS 750 CPS 750 CD3 CPS750-16		
Doosan		C185WDO C185WDZ P185 P185WDO XP185	P250/HP210WDO P260	HP375 HP400 HP450/VHP400WCU P425 P450 VHP400	HP600 HP750 XP825	HP1600WCU HP900 HP915WCU XHP1170WCU	P425/HP375WCU XHP750WCU XP825/HP750WCU HP1600WCU
Gradall		125G					
Grimmer Schmidt	125	185E 210D	250D	375D			
Ingersoll- Rand	P110WIR						
Kaeser		M50 M50PE M57 M58 M58-16 M55PE	M82	M100 M114 M125		M250 M350	
Multiquip		DIS185SS14F					
Sullair		185 185 DPQ	260	375 375H 375H DPQ 400HH DPQ 425 DPQ		185	260

Sand Blaster, Including Nozzles and Hoses (127.02.01.03)

Weight kg	135	270
Clemco	1648 2452 2024	3661 3680
Schmidt	AX6001-061-01 AX6001-062-02 AX6001-063-01 BMS65TERRA BMS65CMS BMS65TVA	

127.03.02 ASPHALT EQUIPMENT**Asphalt Paver (127.02.02.01)**

Weight kg	2,000	4,000	7,000	9,000	14,000	17,000	20,000
Astec			CP75 II CP85	CP100 II CP130			
Blaw-Knox							P7110 P7110B P7170 P7170B
Bomag		BF 200 C-2	BF 300 C-2 BF 300 P-2		CR 820 T CR 820 W CR352 CR362	CR 1030 W CR452 CR462 CR552	CR 1030 T CR562 CR652RX CR662RM
Caterpillar		AP255E	AP300F AP355F		AP 300F AP 555E AP500E AP500F	AP1000E AP1000F AP555F AP600D AP600F AP655D AP655F	AP1055E AP1055F
Gehl	1448 Plus	1648 Plus					
Lee Boy		1000G 5300 7000C	8500D 8510E 8515E 8520B	8530 8616D			
Mauldin	550-E	1550-C 690 F 690-F	1750-C				
Roadtec					RP-170e	RP-170 RP-175 RP-175e/ex RP-190E RP-250e	RP-190e RP-195e RP-2505 SP-200e

Asphalt Paver (127.02.02.01) - CONTINUED

Weight kg	2,000	4,000	7,000	9,000	14,000	17,000	20,000
Volgele/ Wirtgen		Super 700 -2017 SUPER 700i	Super 1300-3 Super 1303-3	SUPER 1300 3i	Vision 5100-2 Vision 5103-2	Super 1300 SUPER 1700-3i Vision 5200-2 Vision 5203-2	SUPER 2000 3i SUPER 2003 3i SUPER 2100 3i Super 2100-3 Vision 5100-2 -2017 Vision 5103-2 -2017 Vision 5200-2 -2017 Vision 5203-2 -2017
Volvo					PF-2181 PF4410A	PF-6160 PF-6170	P7110 P7170 PF-6110
Weiler			P385				

Asphalt Distributor With Truck (127.02.02.03)

Tank Volume Litre	7,000	11,000
Bearcat	BC-501/CRC 2	BC-501/CRC 3
E. D. Etnyre	A/C Dist 2000 Black Topper Centennial	A/C Dist 3500
LeeBoy		Maximizer 3 MAXIMIZER 4B
Note: 1. Equipment available in 7,000+ and 11,000+ tank capacities		

Asphalt Pavement Profiler (127.02.02.04)

Power kW	32	90	135	340	700
Bomag		BM 500/15 BM 500/15-2 BM 600/15 BM 600/15-2	BM 1000/35 BM 1000/35-2 BM 1200/30 BM 1200/35 BM 1200/35-2 BM 1300/30 BM 1300/35 BM 1300/35-2 BM1000/30	BM 2000/75 BM 2200/75	
Caterpillar			PM 310 PM 312 PM 313	PM 620 PM 622 PM 820 PM 822 PM 825	
Roadtec			RX-400e	RX-600e RX-600E/EX RX-700e	RX-900e
Volvo				MT2000	
Wirtgen	W 35 XRI	W 50 Ri W 60 Ri	W 100 RI W 100 XFI W 120 XFI W 130 XFI W 150 XFI	W 200 FI W 207 FI W 210 FI W 220 FI	W 250 FI

Asphalt Pavement Repair Equipment (127.02.02.05)

Equipment Type	4 kW Pavement Line Grinder	8 kW Pavement Line Grinder
Ase		Ferro
Bartell	SP8-G1 BF 200N-4A	BGG10
BW Manufacturing	SC-9	D-1800
Edco	CPM-4	CPM-10 CPU-10FC CPU-10FC (13HP) TLR-7 TRL-7
Infinity	CT-SML-A	

Asphalt Material Transfer Vehicle (127.02.02.06)

Equipment Type	No Surge Bin	Surge Bin
Roadtec	MTV-1000D MTV-1100e/ex MTV-1105	SB-1500D SB-1500e/ex SB-2500e SB-2500E/EX SB3000
Weiler	E1250 E1250B E1650A	E2850 E2850B

127.03.03 COMPACTION EQUIPMENT**Rammer (127.02.03.01)**

Minimum Weight kg	45	65
Bomag	BT50 BT60	BT 65
Crown		RAM-70H
Doosan	DRX60	DRX70
Husqvarna	LT 5005	LT 6005
Multiquip	MTR40HF MTX50HD MTX60HD	MTX70HD MTX70HDR MTX80HDR
Sakai	RS45	RS65 RS75
Tomahawk	eJX60H	JX60H TR68H
Wacker	BS 50-2 BS 50-2+ 11"	AS50E AS60E BS50-4AS BS60-2+ 11" BS60-4AS BS70-2+ 11" BS70-4AS

Manually Guided, Vibratory Plate (127.02.03.02)

Minimum Weight, Kg	65	100	160	280	390	500
Bomag	BVP 10/36 BVP 12/50A BVP 18/45	BPR 25/40	BPR 35/60	BPR 45/55	BPR 50/55 D BPR 60/65 BPR 60/65 D	BPR 70/70D
Crown	MVP95					
Doosan	DFP 1516 DFP 1520		DRP 2316 DRP 3220		DRP 4924	
Husqvarna	LF100L LF60 LAT LF75 LAT LF80 LAT LX90	LF100 LAT LG164	LG204 LG300	LG 300	LF500 LG400	LG 504
Multiquip	MVC64H MVC64VH MVC64VHW MVC82VH MVC82VHW MVC88VTH MVC90H	MVC88VTHW MVH128GH MVH158GH	MVH208GH	MVH308DZ MVH308GH MVH408GH	MVH408DZ MVH508GH	MVH508DZ
Sakai	PC600	PC800 PF120 PF150				
Tomahawk	TPC80H	TPC80 TPC90H	TPC170H			
Wacker Neuson	VP1340A VP1340AW VP1550A VP1550AW WP1540A WP1540AW WP1550A WP1550AW	AP1850E AP1850WE BPU2540A VP2050A VP2050AW	BPU3050A BPU3750A DPU3050H	BPU4045A BPU5545A DPU4545YEH	DPU5545HEH DPU6555HEH	DPU110 DPU90

Hoe Mounted, Vibratory Plate, Hydraulic (127.02.03.03)

Minimum Weight, Kg	100	300	600	900
Allied	400B 700B	1000B 1000C	1600	2300 4000
Blue Diamond	C310	C410		C610
Bobcat	PCF34	PCF64		
Case	SC-30T	SC-60 SC-60T SC-80	SC-110	SC-220
Caterpillar	CVP16	CVP40	CVP75	CVP110
Epiroc	HC 150	HC 350 HC 450	HC 850	HC 1050
Furikawa Rock Drill	HP 35 ME	HP 65 II - 18" HP 65 II - 24" HP 75	HP 135 II	HP 210 II
Gen-Pac	GE-870 GE-970 LT	GE-970	GE-980	
Indeco	IHC50	IHC 70 HC 75		IHC 250
John Deere	PC4 PC7	PC10		
Magnum	RHP15V	RHP20V	RHP30V	RHP40V RHP60V
Spartan	SE250	SE1000 SE2000		

Manually Guided, Self-Propelled, Vibratory, Tandem Drum (127.02.03.04)

Minimum Weight, Kg	400	1200
Ammann		ARR1575
Bomag	BW 65 BW 65 H	BMP 8500
Dynapac		D.One
Husqvarna	LP 6505	LP 9505
Multiquip	MRH601DS MRH800GS	RX1575
Sakai	HS67ST	
Wacker	RD7A	RTKX-SC3 RTLX-SC3

Self-Propelled, Vibratory, Single Pad Foot Drum (127.03.03.05)

Minimum Weight, Kg	1,000	4,000	6,000	9,200	13,000	18,000	24,000
Ammann			ARS70PD				
Bomag	BW124 PDH-40 BW124 PDH(B)	BW145 PDH-5	BW177PDH-5	BW 211 PD-5 BW 211 PDH-5 BW213PDH-4i	BW 213 PDH-5 BW 216 PDH-5	BW 219 PDH-5 BW 226 PDH-5	
Case			SV207E SV208PD SV210PD	SV211E SV212PD SV213E	SV216PD SV215E PD SV217E PD		
Caterpillar		CP34	CP44 CP44B	CP11 GC CP12 GC CP54B CP56B	CP68B CP74B		
Dynapac		CA1300PD	CA1400PD CA1500PD	CA2500PD CA3500PD	CA4600PD CA5000PD	CA5500PD CA6000PD CA6500PD	
Hamm		H5IP	H7IP	H10IP H12IP	H13ICP H14IP H16IP	H18IP H20ICP H20IP	H25ICP
Hyundai			HR70CPD		HR110C PD HR120C PD HR140C PD		
Sakai		SV204T	SV414T	SV544T			
Volvo		SD45B SD45F	SD75B SD75F	SD115 D4F SD115B	SD160F	SD200F	

Self-Propelled, Vibratory, Single Smooth Drum (127.03.03.06)

Minimum Weight, Kg	1,000	4,000	6,000	9,200	13,000	18,000	24,000
Ammann			ARS70				
Bomag	BW 124 DH-5 BW124 DH40	BW 145 D-5 BW 145DH-5 BW145 DH-3	BW 177 D-5 BW 177 DH-5 BW 177 BVC-5	BW 211 D-5 BW 211 DH-5 BW 213 DH-5 BW 213DH-4i BW213 DH-40	BW 213DH-5 BW213 BVC-5 BW216 D-5 BW216 DH-5	BW 219 BVC-5 BW 219 DH-5 BW 226 BVC-5 BW 226 DH-5	
Case			SV207E SV208 SV210	SV211E SV212 SV213E	SV216 SV216D SV215E SV217E	SV208D SV212D	
Caterpillar		CS 34 CS35	CS-433E CS44B	CS10 GC CS11 GC CS12 GC CS54B CS56B CS64B	CS68B CS74B	CS78B	
Dynapac		CA1300D	CA1400D CA1500D	CA2500D CA3500D	CA4600D CA5000D	CA5500D CA6000D CA6500D	
Hamm		H5i	H7I H7I VIO	H10I H12I H13I VIO	H13IC H14I H16I	H18I H20I H20IC	H25I
Hyundai			HR70C	HR120C HR110C	HR140C		
Sakai		SV204D	SV414D	SV544D			
Volvo		SD45 SD45B	SD75 SD75B	SD115 D4 SD115B	SD160	SD200	
Wacker Neuson		RC50					

Self-Propelled, Vibratory, Tandem Drum (127.02.03.07)

Minimum Weight, Kg	1,000	3,000	6,000	8,000	10,000	12,000
Drum Width, m	0.75	1.30	1.40	1.67	1.67	1.67
Ammann	ARX16-2 ARX20-2 ARX26.1-2 ARX26-2	ARX36-2 ARX45-2				
Bomag	BW 100 AD-5 BW 100 SL-5 BW100 ADM-5 BW 120 AD-5 BW 120 SL-5 BW 90 AD-5 BW 900-50	BW 138 AD-5 BW 135 AD-5	BW 141 AD-5 BW 151 AD-5 BW 154 AP-4V BW 154 APO-4V	BW 154 AD-5 BW 174 AP-4F BW154AD-5 BW161ADO-5 BW174AP-4	BW 161 AD-5 BW 161 ADO-5 BW 190 ADO-5	BW 190 AD-5 BW 191 AD-5 BW 191 ADO-5 BW 206 AD-5 BW 206 ADO-5
Case	DV23CE DV23D DV23E DV26 DV26CE DV26E	DV36D DV36E DV45 DV45E	DV207	DV209CD DV209D	DV209CD DV210 DV210C DV210D	DV213
Caterpillar	BW100 ADM-5 CB1.7 CB1.8 CB2.5 CB2.5 GC CB2.7 CB2.7GC CB2.9 CB22B CB24B CB32B CB34B	CB24 XT CB24B XT CB32 CB34 CB34B CB36B CB4.0 CB4.4 CP34	CB7 - SOLID DRUM CB8 - SOLID DRUM	CB10 CB44B-16 CB54B - SOLID DRUM CB7 CB8 CD10 - SOLID DRUM	CB54	CB13 CB15 CB16 CB63
Dynapac	CC1000 PLUS CC1100VI CC1200VI CC800 PLUS CC900 PLUS CC900G PLUS CC950	CC1300VI CC1400VI	CC2200	CC2300 CC3200 CC4200VI CC3300	CC5200VI	CC6200VI
Hamm	HD10 VV HD10C VV HD12 VV HD12I VV HD8 VV	HD13I VV HD14I VV	DV+70I VV-S HD+70I VV HD+70I VV-HF HD+80I VV HD+80I VV-HF	DV+90I VV-S HD+80I VV-S HD+90I VV HD+90I VV-HF	HD+110I VV HD+110I VV-HF HD+90I VV-S	HD+120I VV HD+120I VV-HF HD+140I VV HD+140I VV-HF
Hyundai	HR25T-9 HR26T-9	HR30T-9				
Multiquip	AR14H					
Sakai	CR271 SW354	SW504 SW504W	SW654 SW654ND		SW774 SW774ND	SW884 SW884ND SW994 SW994ND
Volvo	DD15 DD15B DD25B	DD30B DD35B			DD105 DD110C	DD120C DD128C DD140C

Self-Propelled, Vibratory, Tandem Drum (127.02.03.07) - CONTINUED

Minimum Weight, Kg	1,000	3,000	6,000	8,000	10,000	12,000
Drum Width, m	0.75	1.30	1.40	1.67	1.67	1.67
Wacker	RD12-90A RD12A RD18-100 RD18-80					
Weiler	C303					

Self-Propelled, Static, Tandem Drum (127.02.03.08)

Minimum Weight, kg	4,000	7,000	10,000
Bomag	BW5 AS (3-5) BW9 AS (8-10)	BW11 RH-5	
Weiler	C307A	C307 C310A	C310

Self-Propelled, Static, Segmented, Four-Wheeled, Two Axles, Including Blade (127.02.03.09)

Minimum Weight, kg	19,000	30,000
Bomag	BC 462 EB BC 473 EB-4 BC 473 EB-5 BC572RB-2	BC 772 EB-4 BC 772 EB-4 BC 773 EB-5 BC672RB-2 BC772RB-2
Caterpillar	815 815F Series 2	815K 825H 825K
Dynapac	CT3000	

Self-Propelled, Static, Pneumatic Tires (127.02.03.10)

Maximum Ballasted Weight, kg	8,000	18,000
Bomag	BW11 RH-5	BW24 RH BW27 RH BW28 RH
Case		PT240R PT240D
Caterpillar	CW14 CW16 11-WHEEL CW16 9-WHEEL	CW34
Dynapac	CP1200 CP1200W	CP2700
Hamm		HP280I HP180I GRW 180I-15 GRW 180I-20 GRW 180I-10
Sakai	GW754	
Volvo	PT125C	ABG PTR240

127.03.04**CONCRETE EQUIPMENT****Slip Form Paver (127.02.04.03)**

Power, kW	10	30	70	120	200
Cmi				SF 2204	SF 6004
Curb Fox	CF 2000M CF2000A CF3000 CF5000 CF5000-T				
Gomaco Corporation	Curb Cadet	Commander II GT 3200 GT3200 GT3200 SW GT-6000	4400 GT3400 GT3400 GT3600 GT6300	Commander III CommanderIII S/B 16 GP2400	GHP2800 GP2600 GP4000
Power Curbers	150 Extruder		5700C-2016	SF1700-2016 SP2700-2016	

Concrete Placing Equipment (127.02.04.06)

Equipment Type	Concrete Deck Finisher	Concrete Placer Spreader	Concrete Texture Curing Machin	Concrete Conveyor
CMI			TC-3	
Gomaco Corporation	C450 C750	PS2600 PS4000	TC-400 TC-600	RC Conveyor
Power Curbers		PS2700 PS3000	TC2700	
Terex Bidwell	2450 3600 4800			

127.03.06**EARTH MOVING, GRADING EQUIPMENT****Scraper, Single Engine, Two-Wheel Drive (127.02.06.01)**

Minimum Struck Capacity, m3	10	16
Caterpillar	621H 621K	631G 631K

Scraper, Twin Engine, Four-Wheel Drive (127.02.06.02)

Minimum Struck Capacity, m3	10	16	22
Caterpillar	627H 627K	637G 637K	657 657G

Scraper, Single Engine, Self-Loading (127.02.06.03)

Minimum Struck Capacity, m3	11
Caterpillar	623K

Scraper, Pull Type (127.02.06.04)

Minimum Struck Capacity, m3	6	9	11	14
Ashland Industries	140TS2 140TS2-LGP	155TS2 155XL2 175XL2	215TS2 220TS4	
John Deere	1510 D	1612 D 1812 D 1814 D 2010 D (2 tire) 2010 D (4 tire) 2112 D	1510 D 1612E 1810 C 2010E 2014 D 2014E 2112 D 2412 D (4 tire)	1812 D 1814 D 2112 D 2412 D (2 tire) 2412E
K-Tec Earthmovers				1228 1228 ADT 1233 1236 1237 ADT 1243 ADT 1263 ADT
Landoll	Icon 414	Icon 17C	Icon 19C Icon 418 Icon 819	Icon 8221
Reynolds	12C10 14E10.5 15CFB14	16CS10 17C12 17C12LGP 17CS12 17E10.5 18CMX12.5 18CS14 20E12.5		

Tractor Bulldozer, Crawler Type (127.02.06.05)

Minimum Net Flywheel Power, kW	50	60	80	120	160	210	280
Case	650 L LT 650M LGP 650M LT 650M WT	750M LGP 750M LT 750M WT 750M WT/LGP	1150M LGP 1150M PAT LT 1150M PAT WT/LGP 1150M WT 1150M XLT 1650 L 1650M XLT 750M LT 850M LGP 850M LT 850M WT 850M WT/LGP	1650M LGP 1650M PAT WT/LGP 1650M PAT XLT 1650M SEMI-U XLT 1650M WT 1650M XLT 1850 K	2050M LT 2050M PAT WT/LGP 2050M PAT XLT 2050M SEMI-U XLT 2050M STR PT WT/LGP 2050M WT 2050M XLT		
Caterpillar	D1 D3K2 D3K2 XL	D2 D3 D4K2 XL D5K2 XL	D4 D6K D6K2 XL D6N XL (2018)	D5 D6N XL D6T XL SU	D6 D6T XL SU D7 D7E STD SU	D8T D8T	D10T2 D9 D9T
John Deere	450 K	450 K 550 K 650 K 650 K XLT	700 K XLT 700 L 700 L XLT 750 J 750 K XLT	750 L 750 L XLT 850 K	750 L 850 L 950 K	1050 K 950 K	
Komatsu		D37 D37EX D37PX D39 D39 EX D39 PX	D51 D51 EX D51 PX D51EX-22	D61 D61 EX D61 PX D61EX-15EO D61PX-15EO D65 D65EX-17 D65PX-17	D155AX-7 D65 EX D65 PX D65 WX D85 D85 EX D85 PX D85EX-15EO D85PX-15EO	D155AX-8	D375A-8
Liebherr			PR 716 G8 Litronic PR 716 Litronic PR 736 G8 Litronic PR 746 G8 Litronic	PR 726 G8 Litronic PR 726 Litronic PR 736 Litronic	PR 746 Litronic	PR 756 G8 Litronic PR 756 Litronic	

Note:

1.The power rating should be obtained from equipment in use, as the models in the table above may span a number of years and categories/ratings.

Tractor Bulldozer Ripper Attachment, Hydraulic, Rear Mounted (127.02.06.06)

Power, kW	50	120	160	210	280
Case	1150M series Ripper 1150M XLT Ripper 650L LT Ripper 750m series Ripper 750M WT Ripper 850 series Ripper 850M LT Ripper	1650m series Ripper 1650M XLT Ripper	2050m series Ripper 2050M XLT Ripper		
Caterpillar	D1 Ripper D2 Ripper D3 Ripper D3K2 Ripper D3K2 XL Ripper D4 Ripper D4K2 XL Ripper D5K2 XL Ripper D6K2 XL Ripper D6N XL Ripper	D5 Ripper D6N XL Ripper D6T XL SU Ripper	D6 Ripper D6T XL SU Ripper D7 Ripper D7E STD SU Ripper	D8T Ripper	D10T2 Ripper D9 Ripper D9T Ripper
John Deere	450 K Ripper 550 K Ripper 650 K XLT Ripper 700 K XLT Ripper 700 I XLTRIPPER 750 K XLT Ripper	750 I XLT Ripper 850 K Ripper	850 I Ripper 950 K Ripper	1050 K Ripper	
Komatsu	D51- Multi Shank	D61- Multi shank D65-Multi Shank	D85-Multi Shank		
Liebherr	PR 716 G8 Ripper PR 716 Litronic Ripper	PR 726 G8 Ripper PR 726 Litronic Ripper PR 736 Litronic Ripper	PR 736 G8 Ripper PR 746 Litronic Ripper	PR 746 G8 Ripper PR 756 G8 Ripper PR 756 Litronic Ripper	

Wheeled Tractor, Farm, Industrial, Two-Wheel Drive (127.02.06.07)

Power, kW	10	25	40	50	70	90	120	160
Case							Maxxum 115 Maxxum125 Maxxum135 Maxxum145 Maxxum150	
John Deere		5045E	5055E 5065E	5065E 5075E 5075E 5075M 5090M	5100M 6105E 6105E 6110M 6110R 6120E 6120M 6120R	6130M 6130R 6130R 6135E 6145M 6145R 6155R	6155M 7210R	7230R
Massey Ferguson	1726E GC1705 GC1715	1739E 1749 1754 2604H 2605 2615	1758 1759	2635 4608 4609 5609	5610 5611 5612	5613		
New Holland		Workmaster 50	Powerstar 60 Workmaster 60	Powerstar 75 Powerstar 75 Powerstar 90 Powerstar 90 Powerstar 90 MS t4.89v t4a t4.90v t4a Workmaster 70	Powerstar100 Powerstar100 Powerstar110 Powerstar110 Powerstar110 MS Powerstar120 Powerstar 120 MS Powerstar 120 TwoWD t4 100v t4a ts6.110 ii t4b ts6.120 ii t4b	TS6.130 II T4B TS6.140 II		

Wheeled Tractor, Farm, Industrial, Four-Wheel Drive (127.02.06.08)

Power, kW	10	25	40	50	70	90
Case					vestrum 100	vestrum 130
John Deere	1023E 1025R 2025R 2032R 3025E 3032E 3033R	2038R 3038E 3039R 3046R 4044M 4WD 4044R 4WD 5045E	4052M 4WD 4052R 4066M 4066R 5055E	5065E 5075E 5085E 5090E 5090R	5090EL 5100E 5100M 5100ML 5100R 5115M 5115ML 5115R 6105E 6110M 6110R 6120E 2018 6120M 6120R	5125M 5125R 6130M 6130R 6135E
Massey Ferguson	1526 4WD 1529 4WD 1532 4WD 1533 4WD	1540 4WD 2605 4WD 2615 4WD 2850e	2604H 2750e 2860e	4608 4WD 4609 4WD 4707 4708 4709 W2630 4WD	4710 5610 4WD 5611 4WD 5612 4WD 5710 5711 5711s 6712	4610 4WD 5609 4WD 5613 4WD 5712s 5713s 6714s 6715s 7715S MF6614 4WD
New Holland	Boomer 24	Boomer 35 Boomer 35 Boomer 40 Boomer 45 Boomer 50 Boomer45 Boomer45D Boomer46D Boomer50 T4B Boomer50D Workmaster 40 Workmaster 35 Workmaster 50	Boomer 55 Boomer54D Boomer55 T4B Powerstar 60 t3.60f t3.70f Workmaster 55 Workmaster 60 Workmaster 65	Powerstar 75 Powerstar 90 t3.80f t4.80v t4a t4.90v t4a T5.90 DC Workmaster 70 Workmaster 75	Powerstar 100 Powerstar 100 MS Powerstar 110 Powerstar 110 MS Powerstar 120 Powerstar 120MS t4 110v t4a t4.100v t4a T5.100 DC T5.105 Electro Comm T5.110 Electro Comm T5.115 Electro Comm T5.120 DC T5.120 T4B T6.145 EC TS6.110 4WD TS6.120 4WD Workmaster 105 Workmaster 120 Workmaster 95	T6.155 EC T6.160 EC T6.175 EC T6.180 EC T7.175 4WD TS6.125 4WD TS6.140 4WD

Wheeled Tractor, Farm, Industrial, Four-Wheel Drive (127.02.06.08) - CONTINUED

Power, kW	110	135	150	180	250
Case	PUMA 165HP CVXDRIVE ST5 PUMA CVXDRIVE ST5	MAGNUM 180 PS AFS C PUMA 185HP CVXDRIVE ST5	MAGNUM 200 PS AFS C MAGNUM 220 PS AFS C PUMA 200HP CVXDRIVE ST5 PUMA 220HP CVXDRIVE ST5	MAGNUM 250 PS AFS C MAGNUM 280 PS AFS C PUMA 240HP CVXDRIVE ST5	MAGNUM 310 PS AFS C MAGNUM 340 PS AFS C STEIGER 370 WL AFS C STEIGER 420 WL AFS C STEIGER 470 WL AFS C STEIGER 500 WL AFS C STEIGER 540 WL AFS C STEIGER 580 WL AFS C STEIGER 620 WL AFS C
John Deere	6175R	6175M 6195R	6195M 6215R 6230R 7210R 7230R 7R 210 7R 230 8R 230	6250R 7250R 7270R 7290R 7310R 7R 250 7R 270 7R 290 7R 310 7R 330 8R 250 8R 280	7R 350 8R 310 8R 340 8R 370 8R 410 9R 390 9R 440 9R 490 9R 540
Massey Ferguson	6716S 6718S 7716S 7718S MF6616 4WD MF7614 4WD MF7615 4WD MF7616 4WD MF7618 4WD MF7619 4WD	7720S MF6615 4WD MF7620 4WD MF7622 4WD	MF7624 4WD MF7626 4WD	8727S 8730S 8732S	8735S
New Holland	T7.210 4WD	T7.190 4WD T7.230 T7.245 4WD		T8.320 AC T8.350 AC T8.380 AC	T8.410 AC T8.435 AC T9.435 AC PLMI T4B T9.480 AC PLMI T4B T9.530 AC PLMI T4B T9.565 AC PLMI T4B T9.600 AC PLMI T4B T9.645 UC PLMI T4B T9.700 UC PLMI T4B

Motor Grader, Articulated Frame (127.02.06.09)

Minimum Operating Weight, kg	14,000	20,000	30,000
Case	845B 856C 4WD 856C AWD 865B 865B AWD 885B 885B AWD		
Caterpillar	120 12M3 140 140M3 150	12M3 AWD 14 140M3 AWD 14M3 160M3 160M3 AWD	16 16M3 18 18M3
John Deere	620G/GP 622G/GP 670G/GP 672G 770G/GP 772G 870G 872G	672G 772G 772G/GP 870G 870G/GP 872G 872G/GP	
Komatsu	GD655-6		
Lee Boy		685 D	
Volvo	G930B G940B G946B G960B G970 G976	G990	

Spreader Attachment (127.02.06.12)

Equipment Type	Grader/FEL - Shouldering
Midland	SA 2012 WA 2012
Road Widener	Roadwidener attachment

Shoulder Spreader/Road Widener (127.02.06.13)

Spreader Width, m	2	3
Lee Boy	4130	RW-100B RW-195E
Midland	SPD-8 SPF-8	SPD-10 SPD-12
Weiler	W430A	W530A W530B W730A W730B

Reclaimer/Stabilizer (127.02.06.14)

Equipment Power, kW	250	325	440
Bomag	RS360	RS460 RS500	RS600 RS650
Caterpillar	RM300 RM400	RM500B	
Roadtec	SX-2E	SX-4E SX-5E	SX-6E SX-8E
Weiler	S200		
Wirtgen	WR 200 XLI		W 240 CRI W 380 CRI WR 240I WR 250I

Grade Trimmer (127.02.06.15)

Minimum Width, m	3
Gomaco Corporation	9000 9500

127.03.07 EXCAVATION EQUIPMENT**Hydraulic Excavator, Crawler Mounted (127.02.07.02)**

Minimum Operating Weight, kg	1,000	4,000	6,000	12,000	19,500	23,000
Nominal Bucket Size, m ³				0.3	0.7	1.0
Bobcat Equipment	E10 E20 E26 E26 E32 E35	E42 E42 E45 E50 E55 E60	E63 E85 E88	E145 E165		
Case	CX17C CX26C CX30C CX33C CX37C	CX57C CX60C	CX60C CX75C CX80C	CX130D CX145D CX145D SR CX160D	CX210D	CX245D CX245D SR CX250D
Caterpillar	300.9 D 301.4 C 301.5 301.7 301.7 D 301.8 302 CR 302.4 D 302.7 CR 302.7D CR 303.5 CR 303E CR 303E CR 304	304 E2 CR 304.5E2 30450 304E2 CR 305 E2 CR 305.5 E2 CR 305.5E2 305E2	306 306 CR 307.5 307E2 308 308E2 309 310	311FL RR 313 313F 315 315F 316F 317 318F	320 320F 325 325F CR	320 EL 320E LRR 321D LCR 323 323F 326

Minimum Operating Weight, kg	1,000	4,000	6,000	12,000	19,500	23,000
Nominal Bucket Size, m3				0.3	0.7	1.0
Doosan	DX35-5	DX42-5 DX50-5	DX62R-3 DX63-3 DX85R-3	DX140LC-5 DX170LC-5	DX180LC-5	DX225LC-5 DX235LCR-5 DX255LC-5
Hitachi	ZX17U-5 ZX26U-5 ZX35U-5	ZX50U-5	ZX60USB-5 ZX75US-5 ZX85USB-5	ZX130-6 ZX160LC-6 ZX180LC-6	ZX210-6	ZX250LC-6
Hyundai	R17Z-9A R25Z-9AK R35Z-9A R930Z-9AK	R55-9A R60CR-9A	R60CR-9A R80CR-9A	HX130LCR HX140L HX145LCR HX160L HX180L		HX220L HX235LCR
JCB				JS131 JS145	JS190 JS220	
John Deere	17G 26G 30G 35G	50G	60G 75G 85G	130G 135G 160G	180G 200G 210G	245G LC 250G LC
Kobelco	SK17SR-5E SK25SR-6E SK30SR-6E SK35R-6E	SK45SRX-6E SK55SRX-6E	SK75SR-3E SK75SR-7 SK85CS-3E SK85CS-7	ED160-3 Blade Runner ED160BR-5 SK140SRLC-5 SK170LC-10	SK210LC-10	SK 260 SRLC SK230SRLC-5 SK260LC-10
Komatsu	PC30MR-5 PC35MR-5	PC45MR-5 PC55MR-5	PC78US10 PC88MR-10			
Kubota	KX 91 KX018-4 KX033-4 KX71-3S4 KX71-3S4 U17 U17VR1 U25R1T4 U25S U27-4 U35-4	KX040-4 KX057-4 KX057-5 U48-5 U55-4 U55-5	KX080-4s KX080-4S2			
Liebherr				R914 R920	R918 R922	R926
Link Belt			75 X3 SPIN ACE 80 X3 SPIN ACE	130 X4 145 X4 145X3 Spin Ace 160X4	210 X4 210X4	245 X4 250X4
New Holland	E17C E26C E30C E37C	E57C E60C				

Minimum Operating Weight, kg	1,000	4,000	6,000	12,000	19,500	23,000
Nominal Bucket Size, m3				0.3	0.7	1.0
Takeuchi	TB210R TB216 TB216H HYBRID TB225 TB230 TB235-2 TB240	TB250-2 TB257FR TB260	TB280FR TB290 TB370	TB2150		
Volvo	EC20 D EC20C EC20E EC27D EC35D ECR 25 D ECR18E ECR40D	EC60E ECR 58 D ECR50F ECR58F	EC27D ECR 88 D	EC 160E EC140E ECR145E	EC 220E EC220E	EC 240C EC250E ECR235 E

Hydraulic Excavator, Crawler Mounted (127.02.07.02) - CONTINUED

Minimum Operating Weight, kg	26,500	32,000	44,000	55,000	70,000	100,000
Nominal Bucket Size, m3	1.2	1.5	1.7		2.0	5.0
Case	CX250D CX300D	CX350D	CX 470C CX490D CX500D ME	CX 700B	CX 800B CX750D CX750D RTC	
Caterpillar	326 FL 326F 329 FL 330 330F	328 D LCR 335 335F 336 336 EH 336 F 336F 336FXE	349 349 F 349F 349F XE 352 352F		374 374F 390F 395	
Doosan	DX300LC-5	DC350LC-5 DX300LC-5 DX420LC-5	DX490LC-5 DX530LC-5		DX800LC-7	
Hitachi	ZX300LC-6	ZX350LC-6 ZX380LC-6	ZX470LC-6			
Hyundai	HX260L HX300L	HX330L HX380L	HX480L HX510L HX520L		HX900L	
JCB		JS300 JS330 JS370				
John Deere	290G LC 300G LC	345G LC 350G LC 350P 380G LC 380P	470G LC 470P	670G LC 670P	870G LC	

Minimum Operating Weight, kg	26,500	32,000	44,000	55,000	70,000	100,000
Nominal Bucket Size, m ³	1.2	1.5	1.7		2.0	5.0
Kobelco	SK270SRLC-5 SK300LC-10	SK350LC-10	SK500LC-10		SK850LC-9	
Komatsu				PC650LC-11	PC800LC-8	PC1250-8 PC1250LC-8
Liebherr	R930	R934		R956 R960 SME	R966 R976	R980 SME
Link Belt	300 X4	350 X4 350X4	490 X4		750 X4	
Volvo	EC 290C EC300E	EC330 C EC340 D EC350E EC360 C EC380E ECR355E	EC480 D EC480E		EC700 C EC750E	

Hydraulic Excavator, Rubber Tired (127.02.07.03)

Minimum Operating Weight, kg	11,000	18,000	21,000
Caterpillar	M314 M314F M315 M315F M316 M316F M317F M318 M318F	M319 M320 M320F M322	M322F
Doosan	DX140W-5	DX190W-5	DX210W-5
Gradall	XL3300 V	XL4300 V	XL5300 V
Hitachi		ZX190W-5	
Hyundai	HW140 HW180		HW210
John Deere		190G W	230G W
Liebherr	A910 COMPACT Litronic A914 COMPACT Litronic	A918 COMPACT Litronic A918 Litronic	A920 Litronic
Volvo	EW160E EWR130E EWR150E EWR160E EWR170E	EW180E EW210D	EW220E

Telescopic Boom, Carrier Mounted Excavator (127.02.07.05)

Weight, kg	15,000	22,000
Badger Equipment Ltd.	470 TM 4x2 470 TM 4x4	
Gradall	D154 4X4 D174 4X4 D254 4X4 XL 3100V XL 3100V 4X2 XL 3100V 4X4	XL 4100V 6X4 XL 4100V 6X6 XL 5100V 6X4 XL 5100V 6X6

Telescopic Boom, Crawler Mounted Excavator (127.02.07.06)

Weight, kg	15,000	20,000	23,000
Gradall	XL 3200V	XL 4200V	XL 5200V

Tractor with Loader/Backhoe Combination, Two-Wheel Drive (127.02.07.07)

Minimum Power, kW	45	60	75	94
Nominal Bucket Size, m3	0.7	1.3	1.3	1.3
Case	580N 580N EP	580 SUPER N 580N 580N EP	590 SUPER N	
Caterpillar		416F2 420F2		
John Deere	310L EP	310L 310SL	310SL 310SL HL 410L	710L
New Holland		B95C	B110C	

Tractor with Loader/Backhoe Combination, Four-Wheel Drive (127.02.07.08)

Minimum Power, kW	30	45	65	80	94
Nominal Bucket Size, m3	0.5	0.7	1.3	1.3	1.3
Case		580N 580N EP	580 SUPER N 580N	580 SUPER N WT 590 SUPER N	
Caterpillar		415 416 416F2 416F2	416F2 420 420F2 420XE 430 430F 440	430F2	450 450F
JCB		3CX		3CX-14 3CX14 Super 4CX Super 4CX-14 4CX-15	
John Deere		310L EP	310L 310SL 315SL	310SL HL 410L	710L
Kubota	L47	M62			
New Holland		B75D	B95C B95TC	B110C	

Front End Loader, Crawler Mounted (127.02.07.10)

Power, kW	70	100	150
Caterpillar		953 953D 953K 963D 963K	963 973D 973K
John Deere	605K	655K 755K	
Liebherr		LR636 LR636 G8	

Front End Loader, Rubber Tire, Four-Wheel Drive (127.02.07.11)

Power, kW	40	75	100	125	140	175	200	225	250	300	370
Bobcat Equipment	L65 L85										
Case	121F 21F 221F 321F	121F 521F 521G	621F 621G	721F 721G	821F 821G 921F	921G	1021F 1121F	1021F 1021G 1121F 1121G			
Caterpillar	906M 907M 908M 910M 914M	910 910M 914 914M 918M 920	926M 930M	926M 930M	938M 950K 950GC 962K	950M 962M	966K 966M 966MXE 972K 972M	966 972MXE	972 980 980K 980M 982M 986K	3982	988K 990K 992
Doosan			DL200-5 DL200TC- 5 DL220-5	DL250-5 DL250TC- 5 DL280-5			DL300-5 DL350-5 DL350-7		DL420-5 DL420-7 DL450-5 DL550-5 DL580-5 DL580-7		
Hyundai			HL940		HL955 HL960		HL965	HL970 HL975	HL980		
JCB	407 409	411HT 417HT		427HT 427ZX 437ZX 437HT		457HT	457HT 457ZX				
John Deere	204L 244II 244L 304K 304L 324L 344K	344L 444K 444L 444P 524KII	524L 524P 544L 544P	624KII	624L 624P 644K 644X	324K 644L 644P 724K 724K 724P	724L	744KII 744L 824KII	824L 844KII 844K-III	844L	944K
Kubota	R630 R640										
Liebherr			L526 L538	L546	L538 L550	L556	L566	L580	L586		
New Holland	W50C W80C										
Volvo	L20F L30G L35G L40B L20HS L25HS L30GS L35GS L45G L45H L45HS	L45G L50G L50H L50HS	L60G L60H	L70G L70H L90G L90H		L110G L110H	L120G L120H L150H	L180H	L220H	L260H	L350F L350H

Skid Steer Loader, Rubber Tire (127.02.07.12)

Rated Operating Capacity (Note 1) Kg	300	700	850	1,000	1,200	1,500
Bobcat Equipment	S450 S70	S510	S550 S570 S590 S595 S590 S62	S630 S64 S66	S650 S740 S740 S76	S770 S850
Case	SR130	SR175 SR160 SR160B SR175 SR175B SR185 SV185 SV185B	SR210 SR210B	SR240 SR240B	SR270 SR270B SV280 SV280B	SV340 SV340B
Caterpillar		226D 226D3 232D 236D 236D3	232D3 239D 242D 246D	242D3 246D3 249D	262D 262D3 272D	272D2 XHP 272D2 XP 272D3 272D3 XE
JCB	135	155 175	190 205	225 260	215 270 280 300 330 TELESKID 3TS-8W	
John Deere		312GR 314G 316GR	318G 320 E 320G		324G 330G	332G
Kubota			SSV65		SSV75	
New Holland		L216 L218 L316 L318	L220 L221 L320 L321		L228 L328	L334

Note:

1. SAE - Rated Operating Capacity @ 50% Tipping Load

Skid Steer Loader, Tracked (127.02.07.13)

Rated Operating Capacity (Note 1) Kg	300	900	1,100	1,300	1,600	1,800
Bobcat Equipment	T450	T550 T595 T62 T64	T66	T740 T76 T770	T870	
Case	TR270 TR270B	TR310 TR310B TR340 TR340B	TV370 TV370B TV380	TV450 TV450B		TV620B
Caterpillar	239D 239D3 249D 249D3 249D3 CANOPY 257D	259D 259D3 277D 279D 279D3	287D 289D	289D3 297D2 297D2 XHP 299D2 299D2 XHP 299D3	299D3XE	
JCB	150T 190T	205T 215T 225T TELESKID 2TS-7T	260T 270T	300T 320T 325T	TELESKID 3TS-8T	
John Deere		317G	323E 325 G 325G	331G	333E 333G	
Kubota		SVL75				
New Holland	C227 C327	C232 C332 C334	C238 C337	C345		C362
Terex	R070T R160T R190T	R265T				
Note: 1. SAE - Rated Operating Capacity @ 35% Tipping Load						

Skid Steer Loader, Attachments (127.02.07.14)

Attachment Type	Angle Broom	Auger	Backhoe	Breaker	Cold Planer	Multi-Bucket
Bobcat Equipment	52" 64" 68" 84"	10 15C 30C 35PH 50PH	8811 7BH 9BH M06	HB1180 HB1380 HB2380 HB680 HB880 HB980	40" M7017-24" M7018-18" M7019-14"	62" 68" 74" 80"
Caterpillar	BA118C	A23 A41 A68	BH130	B4 B6 B8	PC104 PC106 PC305 PC306 PC310 PC406 PC408 PC412	MP 62" MP 68" MP 74" MP 80" MP 86"
Construction Attachments				225B-SS 500B-SS 650B-SS 850B-SS CAL-100-SS		CAL60 CAL67 CAL73
Digga		1DSS DDD DGA-2DSS-3-MF DGA-3DSS-3-MF DGA-4DDS-3-MF				
JCB					CP12 CP16HF CP18HF CP24HF CP30HF	
Spartan Equipment	48" 60" 72" 84"	SE1475 SE1975 - 36" BIT SE2475 - 36" BIT SE875 SE975	SE-BH06	SE500 SE750	12" 16" 18" HE 20" HF 24" HF 30" HF 36" HF 40" HF	
Sweepster	S26-4 S26-5 S26-6					
TMG Industrial	TMG-AB72	TMG-SAG12	TMG-SBH50	TMG-HB90S		
York	SSAB24-3 SSAB24-4 SSAB24-5 SSAB24-6 SSAB32-5 SSAB32-6 SSAB32-7 SSAB32-8					

Skid Steer Loader, Attachments (127.02.07.14) - CONTINUED

Attachment Type	Pick Up Broom	Power Rake	Scarifier	Steel Tracks	Trencher
Bobcat Equipment	44" 54" 60" 72" 84"		6563526	10.00-16.5 12.00-16.5 14.00-17.5 31-12-16.5	LT112 LT113 LT213 LT313 LT414 TR36
Caterpillar	BP115C BP118C	PR172 PR184			T109-6" T109-8" T112-6" T112-8" T315-6" HF T315-8" HF
Digga					BF-4 BF-6 BF-8
Eterra				ET-CP-T-10SS ET-CP-T-12SSN	
Harley		HR-M5F-0022			
JCB					TR30 TR48
Spartan Equipment	72" 84"		60" RIPPER 72" RIPPER 84" RIPPER 96" RIPPER	SEST10X16.5 SEST12X16.5 T1000 T1200	SE625 SE640
TMG Industrial	TMG-PS72				TMG-SDT36
Virnig		VG-PWR72 VG-PWR90			
York	SSPU-5 SSPU-6	YPRSS6 YPRSS7 YPRSS8			

Chain Type Trenching Equipment (127.02.07.15)

Power, Kw	13	20	35	50
Ditch Witch	C24X	C30X		RT100 RT120 RT120 QUAD RT80 RT80 QUAD
Toro	TRX20 TRX26		RT600	RT1200
Vermeer	RTX150 RTX250	LM42 PTX44	PTX40	RTX1250 RTX550 RTX750

127.03.08
HAULAGE EQUIPMENT
Dump Trucks, Off Highway, Rigid Frame (127.02.08.14)

Payload, kg	35,000	38,000	50,000	75,000
Caterpillar	770 770G	770G 772 772G	773 773G 775 775G	777G
Hitachi			EH1100-3	EH1700-3
Komatsu	HD325-7	HD325-7 HD405-7	HD465-7 HD605-7	
Terex		TR45	TR60	TR100

Dump Trucks, Off Highway, Articulated Frame (127.02.08.15)

Payload, kg	20,000	26,000	30,000	35,000	40,000
Bell			B35D	B40D	B45D B50D
Case	327B	330B	335B	340B	
Caterpillar	725 725C 725C2	730 730 730C 730C Ejector 730C2 730C2EJ 730EJ	735 735B 735C	740 740B 740B Ejector 740CEJ 740EJ 740GC	745 745C
John Deere	250D 260E ADT	300D 310E ADT	370E	410E 410E-II ADT	460E 460E-II ADT
Komatsu		HM300-2		HM400-2	
Terex		TA300		TA400	
Volvo	A25G A325F	A30F A30G	A35F A35FFS A35G A35GFS	A40F A40FFS A40G A40GFS	A45G A45G FS A60H

127.03.09

HOISTING EQUIPMENT

Boom Truck (127.02.09.01)

Lift Capacity, kg	7,000	11,000	19,000	25,000	40,000
Altec		AC 18-70B AC 18-70B HL AC 18-70R HL	AC 23-95B AC 23-95R AC 26-103B AC 26-103R	AC 28-130B AC 30-101B AC 30-103S AC 30-53T AC 38-103S AC 38-127S AC 40-152S	AC 45-127S
Elliot Equipment				40142R	40142
Load King	STINGER 10-47	STINGER 19-51TM STINGER 19-70	STINGER 25-92	STINGER 28-106 STINGER 35-100	STINGER 80-126 STINGER 80-160
Manitex		1770C 1970C 2085T	26101C 2892C	2892C 30100C 40124 40124SHL	50128SHL 50155 SHL TC65131 TC700
National Crane	300 C 400B	500E2 600E2	800D 800H 900A	1400A 1400H [NC1427H] NBT30H-2 NBT40-127 NBT40-142	NBT45-127 NBT55-128 NBT60L-151
Terex	BT 2047	BT 3870 S	BT 4792	BT 28106 BT 70100 RS 70100	CROSSOVER 8000

Hydraulic Crane, Rough Terrain (127.02.09.02)

Lift Capacity, kg	13,000	20,000	40,000	65,000	100,000
Badger Equipment Ltd.	CD 4415	CD 4430			
Broderson Manufacturing	IC-2003-G IC-250-3C IC-250-3D RT-300-2E RT-300-2G				
Grove		RT530E2 RT540E	GRT655 RT600 E RT700E RT765E-2	GRT880 RT 770 E RT- 890 E RT770E RT880E RT890E	GRT8100 GRT8120 GRT9165 RT9130E RT9130E-2 RT9150E
Liebherr				LRT 1090 - 2.1	LRT 1100 - 2.1
Link Belt		RTC-8030 SII	RTC-8050 SII RTC-8065 SII	100 RT 75 RT RTC-8090 SII RTC-8080 SII RTC-80110 SII RTC-8065 SII	100 RT 120 RT RTC 80150 SII RTC-80110 SII RTC-80130 SII RTC-80160 SII
Tadano		GR-350XL-2	GR-550XL-2	GR-1000-XL GR-750XL-2 GR-800-XL	GR-1600-XL
Terex		RT 230 RT 230-XL T340-1	RT 345-XL RT 670-1 RT 555 -1 T560-1	RT 100 RT 780-1	Quadstar 1100 RT 130
Zoomlion		RT-35	RT-55 RT-55-XL	RT-75	RT-100

Hydraulic Crane, Carrier Mounted (127.02.09.03)

Lift Capacity, kg	25,000	45,000	60,000	90,000	135,000	200,000	300,000
Demag		AC 55-3			AC 160-5	AC 220-5	AC 300-6
Grove	TMS500-2 [95 FT]	GMK 3050-1 GMK 3050-2 TMS 700E TMS 750E	GMK 3060 GMK 3060-1 GMK 4100 B TMS 800E	GMK 4090 GMK 4100L-1 GMK 5165-2 TMS 9000 E TMS 9000-2	GMK 5150 GMK 5180-1	GMK 5200-1 GMK 5250-1	GMK 6300L GMK 6300L-1
Liebherr	LTM 1030-2.1	LTM 1045-3.1 LTM 1050-3.1 LTM 1055-3.2	LTM 1070-4.1 LTM 1070-4.2	LTM 1090-4.1 LTM 1095-5.1 LTM 1100-4.2 LTM 1100-5.2 LTM 1130-5.1	LTM 1160-5.1 LTM 1160-5.2	LTM 1200-5.1 LTM 1220-5.2 LTM 1250-5.1 LTM 1250-6.1	LTM 1300-6.1 LTM 1300-6.2 LTM 1350 6.1
Link Belt	HTC-8640 SL	HTC-8660 SERIES II	HTC-8675 SERIES II HTC-8690	HTC 3140 LB HTC-86100 HTC-86110			
Loadstar Trailers Inc.						ATC-3275	
Tadano			ATF 70G-4	ATF 100G-4	ATF-130G-5		
Terex	T 340-1-XL T-340 -1		T 780-1 T-560 -1	Roadmaster 9000			

Lattice Boom Crane, Crawler Mounted (127.02.09.04)

Lift Capacity, kg	50,000	70,000	90,000	130,000	200,000	250,000
Kobelco		CK800G CK850G-2	CK1100G-2	CK1600G2	CK2750G-2	CK3300G-2
Kobelco Cranes North America		CK 850G	CK 1100G	CK 1600G		
Liebherr	HS 8050 HD HS 835 HD Litronic	HS 8070 HD	HS 8100 HD HS 8100 HD Litronic HS 855 HD Litronic HS 885 HD Litronic LR -1100	HS 8130 HD LR -1130 LR -1160	HS 895 HD HS 895 HD Litronic LR -1200	HS 8300 HD LR-1250 LR-1200SX LR-1280 LR-1300 LR-1300SX
Link Belt	108 HYLAB 5	138 HSL 138 HYLAB 5	218 HSL 228 HSL	238 HSL 248 HSL	248 HSL 298 HSL 298 SERIES II	298 HSL 348 HYLAB 5 348 SERIES II 548
Manitowoc Cranes Inc.		8000-1 8500-01 8500-1 MLC80A-1 MLC90A-1	10000A-1 10000B-1 11000-01 12000-01 MLC100-1	777 MLC150-1 MLC-165 MLC165-1	14000 777	999 MLC300 - FIXED CTR
Terex		HC 80	HC 110 HC 110-1	HC 165	HC 230	HC 275

Lattice Boom Crane, Carrier Mounted (127.02.09.05)

Lift Capacity, kg	110,000	270,000
Link Belt	HC-238 II HC-238H II	HC-278H II

Aerial Bucket Lift, Truck Mounted, Including Truck (127.02.09.06)

Platform Height, m	7	10	15	20
Altec	AT200A AT200A VAN AT30G	AT35G AT37G AT40G AT41M AT41P AT48M AT48P AT48S TA45M AT248F	AA50 AA55 AA55E AA60 AM50 AM55 AM55E AM60 AN50E-OC LR7-56 LR7-58 LR7-60 LR7-60RM LS60 LS63 TA50 TA50S TA55 TA60	AN67-E100 LR7-60E70 LR7-60E70RM LS87 A77TE93 Class A77T (77)
Elliot Equipment		M43R	G50F H60F H70R L60R	G85F G85R H70F I70F I85F
Terex		HR37 HR46 LT40 LTM40 TL45	HRX60 LT40 SCM55 TC55 TC65 TCX55 TL50 TL55 TL60 XT PRO 56 XT PRO 60	TCX65/100 TM100 TM125 XT PRO 60/70
Versalift	TEL-29-N VANTEL-29-NE	SST-36-NE SST-37-EIH SST-40-EIH VST-36-I VST-40-I VST-40-MHI VST-40-SI VST-43-TN VST-47-I VST-47-MHI	SST-40-EIH VN-55-MHI VO-255 VO-255-I VO-260-I VO-260-REV VO-270E VO-355X-MHI VST-47-MHI VST-5000-I VST-50-TN VST-52-I VST-52-MHI VST-5500-I VST-6000-I VST-6000-MHI VST-6300-I	VO-270E VO-270-I VST-6600-I VST-7100-MHI

Aerial Bucket Lift, Self-Propelled, Telescopic/Articulating (127.02.09.07)

Platform Height, m	9	12	18	22	30	41
Genie Industries	Z30/20N Z-30/20N Z-30/20N RJ Z33/18 Z34/22 DC Z-34/22 DC Z-34/22 IC 2WD Z-34/22 IC 4WD Z34/22N Z-34/22N Z34/24 IC - 2WD Z34/24 IC - 4WD Z45/25 DC	S40 S-40 XC S45 S-45 XC S60X - 4WD Z34/22N Z40/23N Z-40/23N Z40/23N RJ Z-40/23N RJ Z-45 XC Z45/25 DC Z45/25J DC Z-45/25J DC Z45/25J RT - 2WD Z45/25J RT - 4WD	S-60 XC S60X - 4WD S65 - 4WD S-65 XC Z60/34 Z60/37 DC Z-60/37 DC Z62/40	S-80 XC S80X - 4WD S85 - 4WD S-85 XC Z80/60 Z-80/60 2WS	S100 S105 S120 S125 SX-105 XC SX-125 XC Z-60/37 FE	Z30/20N Z-30/20N Z-30/20N RJ Z33/18 Z34/22 DC Z-34/22 DC Z-34/22 IC 2WD Z-34/22 IC 4WD Z34/22N Z-34/22N Z34/24 IC - 2WD Z34/24 IC - 4WD Z45/25 DC
JLG	340AJ E300AJ H340AJ	400S 400S - 2WD 400S - 4WD 400S HC3 - 2WD 400S HC3 - 4WD 400SC 450 AJ 450A - 2WD 450A - 4WD 460SJ 460SJ - 2WD 460SJ - 4WD 460SJ HC3 - 2WD 460SJ HC3 - 4WD 460SJC E400A NARROW E400AJP E400AJP-N E400A-N E450A E450AJ M450AJ X430AJ (CRAWLER) X500AJ (CRAWLER)	600A 600AJ 600AJ - 2WD 600AJ - 4WD 600AJ NARROW - 2WD 600AJ NARROW - 4WD 600AJ-N 600A-N 600S 600S HC3 600SC 600SJ 660SJ 660SJ HC3 660SJC E600J E600JP EC600SJ EC600SJP H600SJ H600SJP M600J M600JP X600AJ (CRAWLER)	740AJ 800A 800AJ 800AJ - 2WD 800AJ - 4WD 800S 800S - 2WD 800S - 4WD 800S HC3 - 2WD 860SJ 860SJ - 2WD 860SJ - 4WD 860SJ HC3 - 2WD 860SJ HC3 - 4WD H800AJ SJ85 AJ X770AJ	1200SJP 1250AJP X1000AJ	340AJ E300AJ H340AJ
Skyjack	SJ30 AJE SJ30 ARJE	SJ40 T SJ40 T+ SJ45 T SJ45 T+ SJ46 AJ SJ46 AJ+ SJ61 T	SJ61 T+ SJ63 AJ SJ63 AJ+ SJ66 T SJ66 T+	SJ82 T SJ85 SJ85 AJ SJ86 T		SJ30 AJE SJ30 ARJE
Snorkel International	A38E	400S 460SJ 660SJ A46JE A46JRT	600S AB60J	AB80J AB85J TB80 TB86J	TB120 TB126J	A38E

Scissor Lift, Self-Propelled (127.02.09.08)

Platform Height, m	4	7	9
Genie Industries	GS 1530 GS 2032 GS 2046 GS-1530 GS-1930 GS-1932 GS-2032 GS-2046	GS 2646 GS-2632 GS-2646 GS-2669 BE GS-2669 DC GS-2669 RT	GS 3246 GS-3390 RT GS-3232 GS-4047 GS-3246 GS-4069 BE GS-3369 BE GS-4069 DC GS-3369 DC GS-4069 RT GS-3369 RT GS-4390 RT GS-3384 RT GS-5390 RT GS-3385 RT
Jlg	1930ES 1932R 2032ES AE1932 ES1530L ES1932 R1932	260 MRT 2632ES 2646ES ERT2669 R2632	3246ES ERT3369 330LRT ERT4069 3369ES ERT4769 3369LE R3246 3394RT R4045 4069LE RT2669 430LRT RT3369 4394RT RT4069 530LRT RT4769
Skyjack	SJ3215 SJ3219 SJ3220 SJIII 3215 SJIII 3219 SJIII 3220	SJ3226 SJ4726 SJ6826 RT SJIII 3226 SJIII 4626	SJ 6832RT SJ9233 RT SJ4732 SJ9243 RT SJ4740 SJ9250 RT SJ6832 RT SJ9253 RT SJ6832 RTE SJ9644 RT SJ7135 SJIII 4632 SJ8831 RT SJIII 4740 SJ8841 RT
Snorkel International	S2255RT S3010E S3215L S3219E	S2770RT S3226E S4726E	S3370RT S3970RT S4732E

Tool Carrier (127.02.09.09)

Power Rating, kW	40	75	100	125	200
Case	570N EP 570N EP 2WD 570N EP 4WD		521G XT 521G XT T4	621G XT 621G XT T4F 721G XT 721G XT T4F	
Caterpillar	906M 907M 908M 910K 910M 914K 914M	914M 918M 920	924K 926M 930K 930M	926M 930M 938K 938M	
Doosan			DL200-5	DC250-5	
Hyundai			HL940TM	HL955TM	
JCB	407 409 411HT	411HT 417HT		427HT 436HT 437HT 457HT	
John Deere		444K 524L	544K 544K-II	624K 624K-II 624L 644K	
Volvo	L20H L25H L45H L50H		L60H	L110H L70H L90H	L120H L150H L180H L220H

Telescopic Handlers (127.02.09.10)

Lifting Height, m	5	10
Bobcat Equipment	V519 V723 V923	
Caterpillar	TH 255C TH255C	TH 514D TL 642D TL 1055C TL 943C TL 1255 TL 943D TL 1255C TL1055D TL 1255D TL642D TL 642C TL943D
Genie Industries	GTH-5519	GTH-1056 GTH-1256 GTH-1544 GTH-636 GTH-844
JCB	506-23 TC 509-23 TC 512-26 INDUSTRIAL 531-70 531-70T 541-70T	505-20 TC 510-55 TC 506-36 510-56 507-42 512-56 508-66 TC 514-56 509-42 535-140 509-45 TC 550-140 510-42 550-170
Jlg	1732 HIGH CAPACITY G5-18A	1043 1055 1075 1255 1644 HIGH CAPACITY 642 742 943
Skyjack	SJ519 TH	SJ1044 TH SJ1056 TH SJ1256 TH SJ643 TH SJ843 TH SJ883 TH ZB2044
Skytrak		10042 10054 12054 6036 6042 8042

Hammer, Open End, Diesel (127.02.10.01)

Rated Energy, joules	50,000	80,000	120,000	220,000	300,000
APE	D19-52	30-52 D25-21 D25-52	D36/26-52 D36-52 D46-52 D50-52 D62-22	D62-52 D70-52 D80-22 D80-42	D100-22 D100-42 D128-42 D138-42 D160-42
Bauer Pileco	D 19-42 D25-32	D 36-32	D 62-22	D 80-23	D 100-13
Berminghammer	B-21 EML30	B-32 EML45	B-5505	B-64 B-650S	
Delmag	D19-42	D25-32 D30-32/33	D36-32/33 D46-32/33	D62-22	
Pileco	D19-42 D25-32	D36-32	D62-22	D80-23	D100-13

Driver Extractor, Vibratory Centrifugal, Including Power Pack, Excluding Crane (127.02.10.02)

Driving Force, kN	245	392	637	980	1,471
APE	20	50	100 150		200 200-6 300-4 300-6 400 600
HPSI		150	250		500
ICE			14	28 33	110 44 66
J&M Foundation Equipment	216	11-23	22-30 28-35 416B	44-50 815	66-80

Universal Piling Machine, Including Attachment (127.02.10.05)

Power Rating, kW	<450	450	570
A.B.I	TM 13 TM 11/14	TM 13/16 SL TM 14/17V	
Bauer	KDK 275 Rotary Head MR 105 Vibro MR 125 V MR 150	RG 16T RG 19T RG 18S RG 21T	RG 20S RG 21T RG 25S
Casagrande	CFA	PR 16/19 CX85 PR 16/19 V16/19 20RHFV PTC PR16/19 PTC PR16/19 V16-19 V16-19 – CFA	
Junttan	PM25H	MPX90 PMX28	
Liebherr	1100H Vibro 23 VML Vibro 40 VML Vibro BA 220 Rotary Head BA 250 Rotary Head LRB 18 LRB 16 LRH 100 LRH 200	LRB 125XL LRB 155	LRB 255 LRB 355.1 LRB 23

127.03.11 DRILLING EQUIPMENT**Mechanical Drilling Equipment, Truck Mounted, Including Auger and Crowd and Power Pack (127.02.11.01)**

Power, kW	80	120
Central Mine Equipment	55/300 Track CME-55 CME-75	850X Track
Terex	330 650	
Watson Inc	1100 2100	2500 3110

Mechanical Drilling Equipment, Crawler Mounted, Including Auger (127.02.11.02)

Power, kW	95	113	130
Caterpillar			325C EX-12 325C EX-25
Watson Inc	1100	2500	3110 4400CM

Hydraulic Drill Rig (127.02.11.03)

Power, kW	<185	185	250	350	430	570
Bauer	BG 15 H BT 40	BG 15 H BT 50 BG 18 H BT 50 BG 20 H BT 60 BG 23 H BT 65	BG 24 H BS 75 BG 28 H BT 75 BG 33 H BT 75	BG30V BS 95	BG 34 H BS 95 BG 36 BS 95 BG 36 H BS 95 BG 39 BS 95 BG 45 BS 95	BG 42 BS 115 BG 46 BS 115 BG 55 BS 115 BG 50 BT 180
Casagrande	B125XP C20 C30	B125 XP-2 B160 XP-2 B175 XP-2 B175XP B200 XP-2 B200XP C30 C16XP2 C8XP2 C9XP	B240 XP-2 B250 XP-2 B275 XP-2 B250XP	B300 XP-2 B300XP2 B300XP B360 XP-2 B360XP	B400 XP-2 B420 XP-2 B470 XP-2	
Liebherr		LB 20.1	LB 25 LB 30	LB 35 LB45		
Delmag			RH-12			
Soil Mec		R312/200				
Watson Inc	2500 3110		4400CM 4500			

Mechanical Drilling Equipment, Crane Mounted Attachment, Including Auger (127.02.11.04)

Power, Kw	110	200
Berminghammer	BHD-40	BHD-80
Watson Inc	5000	

Horizontal Earth Boring Equipment (127.02.11.05)

Power Rating, Kw	20	50	100	200
American Augers	24/30-150	36-600 NG 42-600 NG	48-54-900 NG 60-1200 NG 72-1200 NG	84/96-1800 NG
Bor-it	Model 24 Model 30 Model 36	Model 42 Model 48	Model 54 Model 60	
Mclaughlin Underground	MCL-24B MCL-30/36B	MCL-36/42C	MCL-54/60	

Trenchless Directional Drill, Track Mounted (127.02.11.06)

Operating Weight, kg	1,000	7,000	12,000	20,000
American Augers				DD110 DD-155T
Ditch Witch	JT5 JT10 JT20 JT24	JT25 JT28 JT3020 JT32 JT40	JT60 JT4020 Mach 1	JT100
TT Technologies	5X			
Vermeer	D20X22 S3 D23X30 S3 D9X13 S3	D24X40 D40X55DR S3	D36X50DR SII D60x90 SIII	

Hydraulic Rock Drill, Including Power Pack, Excluding Drill Steel and Bits (127.02.11.07)

Diameter, mm	75	125	150
Atlas Copco		ROC F9C	ROC L8(25)
Bayshore			TR40
Caterpillar		MD5075 MD5090	MD5150C MD6250 DTH MD6200 MD6200 DTH MD6250 MD6250
Furikawa Rock Drill	HCR1100 HCR1100-ED HCR1100-ER HCR1450 EDII HCR900-ESV	DCR20 DTH HCR L110-E5 HCR1800-EDII 828 HCR1800-EDII 836 HCRL90-E5	
Sandvik		DP 1100i DP 800i DX 800	D1500i DI 1550

Tieback Drill Rig, Hydraulic, Dual Head (127.02.11.08)

Power, Kw	< 140	140
Casagrande	C3 XP-2 C3V XP-2 C4 XP-2 C5 XP-2 C5R XP-2 C5XP C6 XP C6 XP-2	C7 XP-2 C7XP C8 XP-2 C8XP C9 XP-2 C10 XP-2 C12 XP-2 C12V XP-2 C16 XP-2 M9 XP-2 M9-1
Hutte Bohrtechnik	HBR 502-2	
Klemm	KR 600-1 KR 801-3GS KR 800-3G	806-3D KR 806-3F KR807-7

127.03.12
BROOM AND SWEEPER EQUIPMENT
Front Mounted Attachment, Hydraulic (127.02.12.01)

Broom Width, m	1.2	1.8	2.4
Caterpillar	PC115C BU115	BP118C BU118	BA25 BA30
Spartan Equipment	SE48ABHP SE60ABHP SE22060MH-0022	SE72ABHP SE84ABHP SE22071M-0022 SE22084MH-0022	SE22096MH-0022
York	SSAB24-4 SSAB24-5 SSAB32-5	FLB32-6 FLB32-7 SSAB24-6 SSAB32-6 SSAB32-7 TFB32-7	FLB32-8 SSAB32-8 TFB32-8 TFB32-9 TFB32-10

Self-Propelled, Dual Control (127.02.12.02)

Sweeper Type	Mechanical	Regenerative Air	Vacuum
Elgin Sweeper Co.	BROOM BADGER BROOM BEAR EAGLE PELICAN ROAD WIZARD	CROSSWIND CROSSWIND1 REGENX	MEGAWIND WHIRLWIND WHIRLWIND1
Global Environmental	M3 M4	R3AIR R4AIR	V4 AIR V6 AIR
Johnston North America	ES 351	RS 655 RT 655	VT 651 VT 801 VT 652 VT 652 HYDRO
Schwarze Industries	M4 CASCADE M6 AVALANCHE	A4 STORM A7 TORNADO A8 TWISTER A9 MONSOON A9 MONSOON TE	HYPERVAC
TYMCO		435 600 500X DST-4 DST-6	

Brush Chipper, Tow Type (127.02.13.01)

Minimum Net Flywheel Power, kW	19	35	60	80	140
Bandit	65XP 90XP	150 XP 200UC 75XP TRACK 90XP 90XP TRACK INTIMIDATOR 12XPC	12XP 200UC 200XP 90XP INTIMIDATOR 12XPC	150 XP 15XP 18XP 19XPC 200HD 200XP 21XP 250XP 250XP TRACK 255XP 255XP TRACK 280XP INTIMIDATOR 15XPC INTIMIDATOR 18XP INTIMIDATOR 19XPC	INTIMIDATOR 19XPC INTIMIDATOR 21XP
Morbark	M8D	1215 M12R M12R TRACK M12RX		1415 1621 1621X 1821 1922 2131-SA M15R M15R TRACK M18R M18RX	2131-TA 2230 M18R TRACK M20R
Vermeer	BC900XL	BC1000XL	BC1000XL	BC1200XL BC1500 BC1800XL	BC2100XL

Log Skidder, Cable/Grapple (127.02.13.02)

Minimum Net Flywheel Power, kW	120	170
Caterpillar	525D 535D	545D 555D
John Deere	648L-II 848H	640L 640L-II 648L 748L 748L-II 768-II 848L 848L-II 948L 948L-II
Tigercat	610E	620H 625H 630H 632H 635H
Weiler	S250 S350	S450 S550

127.03.14

PORTABLE GENERATING EQUIPMENT

Generator, Gas or Diesel (127.02.14.01)

Power, kW	0.5	3	5	10	40	80
Atlas Copco				DPX-19403 QAS 25 QAS 45	QAS 70 QAS 90	QAS 120 QAS 150 QIS 175
Broadcrown						
Caterpillar		RP3600	RP5500 RP6500E RP7500E	XQ35	XQ60	XQ125
Champion			100165			
Cummins			5.5HGJAE-6757	10.0HDKCC	80KW	
Defender		4000W	TP-10000E TP12000E			
Doosan				G25 G40	G70 G70WCU-3A G85 G85WCU-3A	G125 G125WCU-3A G145 G150WCU-3A G185 G190WCU-3A
Firman	WO1782	HO3652 PO3501 PO3612	PO8004			
Gardner Connell						
Generac				6028 6783 MDG25IF4 MLG15M MLG20IF4 MMG45IF4	MDG75D4F MMG55DF4	MDG100DF4 MDG150DF4 MDG175DF4
Honda	EU1000ITC3 EB2200ITC EU2200ITC EU2200ITC1 EP2500 EG2800IC1 EM3000 EM3000C3 EU3000IKC1 EU3000ISC4 EU3200IC	EB4000 EB5000 EB5000X3CT2 EG5000 EM5000S EM5000S3CT2	EB6500 EB6500XCT2 EG6500 EM6500S EM6500S2CT 2 EU7000ISCT1 EB10000 EB10000C1			
Kubota				GL11000 GL14000		
Magnum				MLG15 MLG20 MLG20IF4 MLG25 MMG25 MMG25IF4 MMG35 MMG35D4F MMG45i MMG45IF4	MMG100 MMG100D MMG55 MMG55DF4 MMG75 MMG75D	MGD150DF4 MMG130 MMG130D MMG175

Power, kW	0.5	3	5	10	40	80
Mtu						MTU100
Multiquip				DCA36SPXU4F DCA45SSIU4F	DCA70	DCA125SSIU4F DCA150SSJU4F DCA180SSJU4F
Swp				GS25		
Toromont						100KW
Triton				TP-C25-T1-60 TP-C30-T1-60 TP-P14-T4-60 TP-P17-T1-50 TP-P20-T1-50 TP-P29-T4iF-60 TP-Y20-T4i-60 TP-Y25-T4i-60 TP-YR40-T4i-60	TP-JDR80-T3F-60	TP-JDR100-T3F-60
Wacker Neuson	GP2500A	GP3800A	GP5600A	G14 G25 G50	G70	G100 G120 G150 G180
Wilson						P110-3
Winco				RP25	RP80	DX100 DX130 DX90
Yamaha	2600 EF1000IS EF2000IS EF2000IST EF2200IST EF2400ISHC EF2600C EF2800I EF3000ISE EF3000ISEB	EF4500ISE EF5500DE EF5500P	EDL7000SDE EF6300iSDE EF7200P EF7200DE	EDL11000SDE		

Generator, Gas or Diesel (127.02.14.01) - CONTINUED

Power, kW	150	250	300	400	600	900
Atlas Copco	QIS 250	QAS 330				
Broadcrow n					BCC 725P-60 T2	
Caterpillar	XQ200		XQ375 XQ425	C15 XQ570	C18 XQ800	XQ1000
Cummins				500DFEK		
Doosan	G240	G325	G450 G450WCU-2B-T2	G570 G570WCU-2B-T2		
Generac	MDG175D4F MDG250D4F	MDE330P		MDE570		
Magnum	MMG205	MMG330	MMG480	MMG625VT2		MCG1000M2
Mtu	MTU200		MTU400	MTU500		
Multiquip	DCA220SSJU4F DCA300SSJU4F2		DCA400	DCA600SSVC	DCA800SSK2C	
Swp			QP500			
Triton	TP-C330-T1-50 TPI250-T#-60-UL TP-P250-T1-60	TP-C330-T1-60 TP-P350-T3-60	TP-P400-T1-60 TP-V350-T1-60	TP-550-T1-60 TP-600-T2-60	TP-CD900-T1-60 TP-P800-T1-50 TP-P880-T1-60	TP-U1000-T2-60-UL TP-U1275-T2F-60
Wacker Neuson	G240	G320				
Winco	DX175 DX250	DX300	DX350			

127.03.15 PUMPING EQUIPMENT

Centrifugal, Dewatering, Including 6 m Suction and 7.5 m Discharge (127.02.15.01)

Intake Size, mm	25	50	100
Amt	1G4XAR	2AG5LPE 382A-99 4222-95 4226-95	4226-V5 GCW2 GCW3
Generac	6821 6917	6918	
Honda	WX10TC1 WX15TCX1	WB20XT4C WB30XT3C1	
Multiquip		QP2H QP303H	QP402H
Tsurumi	TE2-25HA	TE3-50HA TE3-80HA	TE2-100HA
Wacker Neuson		PG2A PG3A	

Centrifugal, Trash, Including 6 m Suction and 7.5 m Discharge (127.02.15.02)

Intake Size, mm	50	75	100	150	200
AMT	3163-95 3930-95 3932-95 3937-D5	3941-96 3943-96 3944-96	3993-96 3993-Z6 3994-96 3995-96	55588-D6 5585-H6 5587-D6	
Generac	6822 6919 6920	7725	MTP4DZD MTP4DZV	MTP6DZD MTP6DZV	MTP8DZD MTP8DZV
Gorman-Rupp	12D1-GX160	13D1-GX270	14D1-GX270 14D1-GX390		
Honda	WT20XK4C	WT30XK4C	2S5XHR WT40XK3C		
IPT	255XLR 2S5XAR 2S5XHR 2S5XLR 2S7XZR	3S5XAR 3S5XHR 3S5XLR 3S7XZR 3S9XAR 3S9XHR 3S9XLR 3S9XZR	4S13XAR 4S13XHR 4S13XZR 4S14KLR		
Multiquip	QP2TH QP2TK QPT2K	QP3TH QP3THX QP3TI QP3TK QP3TS	QP4TH QP4TK QP4TKT16 QP4TKT28 QP4TZ	MQ600H MQ600HTB MQ600HT MQ62TKS MQ62TKT	
Tsurumi	EPT3-50HA	EPT3-80HA	EPT3-100HA	EPT5-150HA	
Wacker Neuson	PT2A	PT3A	APT4S APT4T PT4A PTS4V	APT6S APT6T PT6LS PT6LT	APT8S APT8T

Diaphragm, Including 6 m Suction and 7.5 m Discharge (127.02.15.03)

Intake Size, mm	50	75
AMT	336G-96 338G-96 338L-96	335A-96 335G-96 335H-96 337G-96 337H-96 337L-96
Honda		WDP30
Multiquip	MQD2H MQD2HA	MQD3H MQD3HA
Tsurumi	TD6-200	TD6-300
Wacker Neuson	PDT2A	PDI 3A PDT 3A

**Electric Submersible, Including 30 m Cable and 7.5 m Discharge, Excluding Generator
(127.02.15.04)**

Intake Diameter, mm	50	75	100	150	200
AMT	02X11 02XH5 5770-95 5771-95 5773-95 5980-95 5981-95 598A-95	5777-95 577A-95 577B-95 5983-95	577E-93 577D-95		
Honda	WSP100 WSP50				
IPT	5711-95 5770-95 5771-95 5773-95 5780-98 5792-95	5777-95 577A-95 577B-95	577D-95 577E-95		
Multiquip	SS233 ST2037 ST2037F ST2038P ST2047	ST3020BCUL ST3050D	ST41230 ST41460	ST61230 ST61460	
Tsurumi	50TM2.4S 50TM2.75S 50TMA2.4S 50TMA2.75S LB-480 LB-480A LB-800 LB-800A LSR2.4S	LB-1500 NK2-15 NK3-22L NK4-22			
Wacker Neuson	PS2 1503 PS2 500 PS2 800 PS2-500 PSA2-500 PSA2-800 PSG2-500 PST2 400 PSTF2 400	PS3-1500 PS3-2200 PS3-2203 PS3-3703 PST3 750 PSTF3 750 PSW3 1500	PS4-11003HH PS4-5503		
WEDA	D04BN D04N D08N D10N	D30L D30N D30N	D40N D50H D50N D60N	D70L D80N D90L	D100N

DC Arc Welder, Engine Driven, Including Rods (127.02.16.01)

Current, A	125	150	200	300	400
Hobart	Champion 145 Champion Elite		Champion Elite Champion Elite All-in-One		
Lincoln Electric	Bulldog 5500 Outback 145	Outback 185	Dual Marerick 200/200X Eagle 10,000 Plus Ranger 260 MPX Ranger 225 Ranger 250 GXT Ranger 225GXT	CC300 CC300MP Classic 300 HE Classic 300 HE 1 pak R.305GEFI Ranger 305 G RANGER 305 D Ranger 305 D -1 Ranger 305 G EFI Ranger 330 MPX Ranger305LPG Ranger-D RangerD-One SAE 300 MP SAE-300 HE SAE300 SAE-300HE w WireFeed SAE300RP	Air Vantage 500 Air Vantage 650 DUAL MARERICK 200/200X Ready-Pak SAE 400 SAE 500 SAE500 SAE500 Severe Duty SAE500 Vantage 300 Vantage 400 Vantage 600
Miller Electric	Bluestar145	Bluestar185 Bobcat250GFCI Fusion160	Bobcat 225 Bobcat 250 Bobcat 260 Bobcat 3 Phase Trailblazer 275	Trailblazer 302 Trailblazer 302AP Trailblazer 325 Trailblazer 325 (D) TRAILBLAZER 325 AIR PAK Trailblazer325EF	Big Blue 300Pro Big Blue 400 Pro Big Blue 450 D CST Big Blue 500 Pro Big Blue 800 Airpak Big Blue 800 Pro Big Blue 350PipePro
Tomahawk			TWG210A		

Oxygen/Acetylene Torch, Including Gas, Excluding Rods (127.02.16.02)

Equipment Type	Hand Mobile, Heavy Duty	
Miller-smith	23-1003P HBAS-30300 MB54-510L	MB55A-510 NE835A
Stoody	0384-2112 384-2088	384-2111 384-2120
Uniweld	KAR780-1 KLT550-4P OPHI-730	OPHI-780A WURKS-A WURK-V
Victor	0384-2041 0384-2045 0384-2068 0384-2540	0384-2544 0384-2690 384-2101



GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS

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APPENDICES

180-A Commentary

180.01 SCOPE

This specification covers requirements for the management of excess materials.

Where the management of excess material requirements of other Ontario Provincial Standard Specifications differs from this specification, the requirements of this specification will take precedence.

180.01.01 Specification Significance and Use

This specification has been developed for use in provincial-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

180.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

180.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 209 Swamp Excavation

Ontario Provincial Standard Specification, Material

OPSS 1004 Aggregates - Miscellaneous

Canadian and Provincial Statutes

Environmental Protection Act, R.S.O. 1990, c.E.19 & R.R.O. 1990, Regulation 347
Transportation of Dangerous Goods Act, 1992, S.C. 1992, c. 34
Fire Protection and Prevention Act, 1997, S.O. 1997, CHAPTER 4

180.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bituminous Pavement means any combination of asphaltic material and aggregate, excluding asbestos modified asphaltic material.

Commercial Waste means waste described as commercial waste in Regulation 347, under the Environmental Protection Act, Ontario.

Concrete means concrete mixtures produced with Portland cement and may include blended hydraulic cement, supplementary cement materials, spent debris and silica sand abrasive blasting media from abrasive cleaning of concrete and reinforcing steel, and concrete brick and block and associated mortar. It may include embedded steel and excludes asbestos modified Portland cement concrete mixtures.

Disposable Fill means excess material other than that disposed of at a certified disposal site and that is managed in berms and mounds and as fill other than in road embankments.

Earth means earth as defined in OPSS 206.

Excess Material means material removed under the Work specified in the Contract Documents for which management is not specified and includes surplus and unsuitable materials.

Fabricated Metal and Plastic Products means metal and plastic products such as culverts, fence materials, and guide rails. It does not include containers, other packaging materials, storage tanks, septic tanks and ancillary equipment associated with sanitary sewage systems, septic systems, and fuel or lubricant dispensing and storage systems.

Groundwater means subsurface water and water that occurs beneath the water table in soils and rock formations that are fully saturated.

Manufactured Wood means wood that is not entirely natural wood.

Masonry means clay brick and associated mortar.

Natural Wood means stumps, trunks, branches, debris from tree and shrub removal, and wood products that are not treated, coated, or glued.

Non-Hazardous Solid Industrial Waste means waste described as non-hazardous solid waste in Regulation 347, under the Environmental Protection Act, Ontario.

Re-Use means using, processing, re-processing, or recycling of excess material into a construction material or other useful product and managed by these means for the Contract and other work.

Rock means rock as defined in OPSS 206.

Subject Waste means waste defined as subject waste in Regulation 347, under the Environmental Protection Act, Ontario.

Swamp Material means swamp material as defined in OPSS 209.

Waste means excess material that is not managed by re-use, open burning, or as disposable fill and includes any excess material.

Waterbody means waterbody as defined in OPSS 182.

180.04 DESIGN AND SUBMISSION REQUIREMENTS

180.04.01 Submission Requirements

180.04.01.01 Notification of Site Selection, and Property Owner Release

A copy of the completed MTO form PH-CC-181, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or MTO form PH-CC-182, Site Selection Notification for Material Managed as

Disposable Fill or both shall be submitted to the Contract Administrator and the property owner at least two weeks prior to the use of the property. These forms are not required for property owned by the Owner or designated for use in the Contract Documents.

At the completion of such work, a completed copy of the MTO form PH-CC-183, Property Owner's Release, shall be provided to the Contract Administrator.

180.04.01.02 Verification of Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste

When excess material is managed by disposal as non-hazardous solid industrial or commercial waste, a copy of the weigh ticket or receipt provided by the disposal site operator shall be submitted to the Contract Administrator on a weekly basis. When such documentation is not available, written confirmation that the waste has been received shall be obtained from the operator of the disposal site and submitted to the Contract Administrator within two weeks after disposal activities are complete.

Within three weeks of the completion of all disposal activities associated with the work, a completed copy of the MTO form PH-CC-184, Waste Quantity Report, shall be submitted to the Contract Administrator and shall account for all excess material managed by disposal as solid non-hazardous industrial or commercial waste.

180.04.01.03 Notification of Forest Resource Licensees

Forest resource licensees identified in the Contract Documents shall be notified at least two weeks prior to commencement of open burning.

180.04.01.04 Environmental Compliance Approval

When Environmental Compliance Approval(s)/Certificates of Approval for a Waste Management System or a Waste Disposal Site are required, a copy of such approval shall be submitted to the Contract Administrator prior to transporting excess material or waste from the Working Area.

180.04.01.05 Subject Waste Documentation

For each subject waste specified in the Contract Documents that is being shipped from the Working Area to a waste disposal site, the following shall be completed:

- a) The Contract Administrator shall be notified at least two weeks prior to the first shipment of subject waste, and at least 24 hours prior to each subsequent shipment of subject waste.
- b) A Regulation 347 manifest with Part B completed by the carrier for each truckload of subject waste, shall be submitted to the Contract Administrator for Part A completion. Copies #1 and #2 of the manifest with Part A and B completed shall be retained by the Contract Administrator and the remaining copies #3 to #6 returned to the carrier.
- c) Copy #6 of the Regulation 347 manifest shall be submitted to the Contract Administrator at the mailing address indicated on Part A of the manifest, within four weeks of the shipment of subject waste from the Working Area.

For each subject waste that is generated by the Contractor's operations and that is not specified in the Contract Documents that is being shipped from the Working Area to a waste disposal site, the following documentation shall be submitted to the Contract Administrator.

- a) Prior to shipment of the subject waste:

- i. Test results from testing to determine the Regulation 347 waste class and characteristics of the subject waste from the Canadian Association for Laboratory Accreditation (CALA) accredited laboratory selected by the Contractor;
- ii. Notification from the Ministry of the Environment and Climate Change (MOECC) Hazardous Waste Information Network (HWIN) of the registration of the subject waste to obtain a Regulation 347 Generator Registration Number (GRN); and
- iii. A duplicate of Copy #2 of the Regulation 347 manifest with Parts A and B completed and signed by the generator and carrier respectively.

b) After shipment of the subject waste:

- i. Notification of payment of all registration, manifest, and tonnage fees associated with the shipment from the MOECC HWIN;
- ii. A duplicate of Copy #6 of the Regulation 347 manifest with Part C completed and signed by the receiver; and
- iii. Notification of de-activation of the Regulation 347 GRN in the MOECC HWIN.

A record of all test sample numbers and sample dates shall be kept and submitted to the Contract Administrator upon request.

180.04.01.06 Excess Material Audit or Inventory Document

When an excess material audit or inventory is imposed by statute or is a condition specified in the Contract Documents, a copy of the audit or inventory documents shall be provided to the Contract Administrator.

180.04.01.07 Alternative Management Condition Approvals

When certain excess material is to be managed according to the conditions approved in writing by the local District office of the MOECC and such conditions differ from those specified in Table 1, a copy of such approval shall be submitted to the Contract Administrator at least two weeks prior to commencement of the work governed by the condition.

180.07 CONSTRUCTION

180.07.01 Conditions on Management of Excess Material - General

Management of excess material shall be as described in Tables 1 and 2 and the appropriate subsections of this specification, unless prior alternative management conditions are approved in writing by the MOECC.

When an excess material is a mixture of materials, it shall be managed in compliance with the most stringent conditions associated with any of the constituent excess material.

When excess material includes asbestos waste, the asbestos waste shall be managed as specified in the Contract Documents.

Excess materials shall not be permitted in waterbodies, and environmentally sensitive areas as identified in the Contract Documents, except when re-used according to the appropriate Ontario Provincial Standard.

180.07.02 Conditions on Management by Re-Use

Management of excess material by re-use for incorporation into the Work or for other designated re-use shall be as specified in the Contract Documents.

Management by re-use shall otherwise be outside the Owner's property.

Distance separations described in Table 2 do not apply for the following:

- a) Re-use of excess materials for the same purpose.
- b) Re-use of bituminous pavement, concrete, and masonry within a road right-of-way.
- c) Re-use of concrete as aggregate in bituminous pavement.
- d) Re-use of concrete as rip-rap, gabion stone, or rock protection according to the requirements of OPSS 1004.

Except cutting for construction purposes, excess material consisting of manufactured wood shall not be reprocessed.

180.07.03 Conditions on Management as Disposable Fill

Management of excess material as disposable fill, including sidecasting of swamp material, within the Owner's property and on other property designated in the Contract Documents shall be as specified in the Contract Documents.

Natural wood and debris from open fires may be managed as disposable fill only within a road right-of-way or on property with a boundary common to a road right-of-way, both within the Contract limits.

Such material shall be top covered by at least 300 mm of earth or topsoil.

180.07.04 Conditions on Management by Open Burning

Management of excess material by open burning is permitted only when specified in the Contract Documents. Where management by open burning is permitted, it shall be subject to the following conditions and conducted according to the Fire Protection and Prevention Act, 1997 where it applies, and with any applicable, local, municipal by-law(s):

- a) A permit from the Ministry of Natural Resources and Forestry (MNRF) under the Fire Protection and Prevention Act, and/or applicable local or municipal by-law shall be obtained by the Contractor for open burning, as required.
- b) Open burning is prohibited in areas subject to a restricted fire zone order as issued by MNRF or to a smog alert advisory as issued by MOECC.

180.07.05 Conditions on Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste

Management of excess material by disposal as non-hazardous solid industrial or commercial waste at receiving sites designated in the Contract Documents shall be as specified in the Contract Documents.

When receiving sites are not specified in the Contract Documents for management by disposal as non-hazardous solid industrial or commercial waste, such material shall be disposed of at sites identified by the Contractor.

Non-hazardous solid industrial or commercial waste shall be transported from the Working Area directly to a site that has an Environmental Compliance Approval/ Certificate of Approval for a Waste Disposal Site that is valid for non-hazardous solid industrial or commercial waste.

180.07.06 Conditions on Management by Stockpiling

Management of excess material by stockpiling within the Owner's property and on other property designated in the Contract Documents shall be as specified in the Contract Documents.

Stockpiling shall otherwise be outside the Owner's property.

Stockpiles of bituminous pavement, concrete, and masonry shall be separated according to Table 2 unless either of the following occurs:

- a) Stockpiles are located within a road right-of-way or on property with a boundary common to a right-of-way, both within the Contract limits for a period not exceeding 120 Days.
- b) Stockpiles are located within a provincial or municipal works yard or in a commercially licensed pit or quarry.

For all other excess materials, where Table 1 indicates that stockpiling is subject to management conditions in Table 2, such management conditions shall only apply to stockpiles that are to be in place for a period exceeding 120 Days.

180.07.07 Conditions on Management by Disposal as Subject Waste

When an excess material is identified as a dangerous goods waste, or a subject waste specified in the Contract Documents, management shall be as follows:

- a) Subject waste shipments shall be manifested and transported directly to a certified waste disposal site.
- b) When the subject waste is also a dangerous good as defined in the Transportation of Dangerous Goods Act (TDGA), the carrier shall provide all necessary TDGA labels and placards.

When an excess material generated by the Contractor's operations may be subject waste and it is not specified in the Contract Documents, the Contractor shall be responsible to manage it according to the following:

- a) Conduct sampling and testing using a laboratory certified by the CALA selected by the Contractor to determine whether it is subject waste and to determine the Regulation 347 waste class and characteristics.
- b) Register all subject waste in the MOECC HWIN and obtain a Regulation 347 GRN for disposal.
- c) Package and label all subject waste for transportation and disposal.
- d) Arrange for shipment of all subject waste to a certified waste disposal site using a certified carrier.
- e) Complete Part A of a Regulation 347 manifest including the GRN obtained from the MOECC HWIN and provide the manifest to the certified carrier for completion of Part B.
- f) Provide a duplicate of Copy #2 of the Regulation 347 manifest to the Contract Administrator with Parts A and B completed and signed.
- g) Pay all registration, manifest and tonnage fees associated with subject waste disposal in the MOECC HWIN.

- h) De-activate the GRN in the MOECC HWIN after shipment of all subject waste to a certified waste disposal site is complete and acceptance of the subject waste is acknowledged by the receiver completing and signing Part C of the Regulation 347 manifest.
- i) Provide a duplicate of Copy #6 of the Regulation 347 manifest to the Contract Administrator upon receipt from the receiver.

When an excess material is tested and found not to be a dangerous good waste or a subject waste, it shall be managed by disposal as Non-Hazardous Solid Industrial or Commercial Waste according to this specification.

180.10 BASIS OF PAYMENT

Payment for the management of excess material shall be included in the tender items requiring such management and shall include all costs associated with acquiring approvals, releases, and agreements.

Payment for the management of excess material that is subject waste generated by the Contractor's operations and not specified in the Contract Documents by the Owner, and is in addition to the cost of disposal as non-hazardous, solid industrial, or commercial waste, shall be administered as a Change in the Work, with provisions subject to testing to verify that the excess material is subject waste.

Table 1
Excess Material Management Conditions

EXCESS MATERIAL DESCRIPTION	Subsection in This Specification				
	Conditions on Management by Re-Use	Conditions on Management as Disposable Fill	Conditions on Management by Open Burning	Conditions on Management by Disposal as Non-hazardous Solid Industrial or Commercial Waste	Conditions on Management by Stockpiling
EARTH	Yes	Yes	n/a	Yes	Yes
SWAMP MATERIAL	Yes	Yes TABLE 2	n/a	Yes	Yes TABLE 2
AGGREGATE	Yes	Yes	n/a	Yes	Yes
ROCK	Yes	Yes	n/a	Yes	Yes
BITUMINOUS PAVEMENT	Yes TABLE 2	Not Permitted	n/a	Yes	Yes
CONCRETE	Yes TABLE 2	Not Permitted	n/a	Yes	Yes
MASONRY	Yes TABLE 2	Not Permitted	n/a	Yes	Yes
MANUFACTURED WOOD	Yes	Not Permitted	Not Permitted	Yes	Yes TABLE 2
NATURAL WOOD	Yes	Yes TABLE 2	Yes	Yes	Yes TABLE 2
DEBRIS FROM OPEN FIRES	n/a	Yes TABLE 2	n/a	Yes	Yes TABLE 2
METAL/PLASTIC POLYSTYRENE PRODUCTS	Yes	Not Permitted	Not Permitted	Yes	Yes
SUBJECT WASTE	Subject waste shall be managed as specified in the subsection for Conditions on Management by Disposal as Subject Waste.				
MATERIALS SUSPECTED OF BEING CONTAMINATED	When excess materials that were not generated by the Contractor's operations and are not specified in the Contract Documents, are suspected of being contaminated, direction on their management shall be obtained from the Contract Administrator.				
OTHER MATERIALS	Excess materials that are not listed above shall be managed as specified in the subsection for Conditions on Management by Disposal as Non-Hazardous Solid Industrial or Commercial Waste, unless prior alternative management conditions are approved in writing by the MOECC.				

Table 2
Excess Material Management Distance Separation Requirements

Adjacent Feature	Minimum Distance Separation
Groundwater	2 m (Above)
Waterbodies	30 m
Water Wells	100 m
Residences	100 m

Appendix 180-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**GENERAL SPECIFICATION FOR ENVIRONMENTAL
PROTECTION FOR CONSTRUCTION IN AND AROUND
WATERBODIES AND ON WATERBODY BANKS**

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182.01	SCOPE

This specification covers the environmental protection requirements and mitigation measures that apply to construction involving work in and around waterbodies and on waterbody banks.

182.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517	Dewatering
OPSS 803	Vegetative Cover
OPSS 804	Temporary Erosion Control
OPSS 805	Temporary Sediment Control

Canadian and Provincial Statutes

Endangered Species Act, S.O. 2007, c.6

Fisheries Act, R.S.C., 1985, c. F-14
Fish and Wildlife Conservation Act, S.O. 1997, c. 41 - Ontario Regulation 664/98 - Fish Licensing
Species at Risk Act, S.C. 2002, c. 29

Canadian and Provincial Policy

Fisheries and Oceans Canada Code of Practice: End-of-Pipe Fish Protection Screens for Small Water Intakes in Freshwater

Fisheries and Oceans Canada Protocol for the Detection of Fish Species at Risk in Ontario Great Lakes Area (OGLA)

Fisheries and Oceans Canada Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area (OGLA)

182.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Aquatic Species at Risk means a fish and/or a freshwater mussel species provincially or federally listed as extirpated, endangered, threatened species or species of special concern.

Cofferdam means a temporary enclosure constructed within a waterbody to allow the enclosed area to be pumped out, creating a dry work environment.

Deleterious Substance means as defined by the Fisheries Act.

Entrainment means when a fish is drawn into a water intake and cannot escape.

Endangered Species Act Permit means as defined by the Endangered Species Act.

Fish means as defined by the Fisheries Act.

Fish Habitat means as defined by the Fisheries Act.

Fish Salvage means the physical relocation of fish from the work area.

Fish Screen means a device designed to prevent fish from swimming or being drawn into a water intake pipe.

Fisheries Act Authorization means as defined by the Fisheries Act.

Fisheries Assessment Specialist means an individual who meets the requirements of the Fisheries Assessment specialty and is registered on MTO's Consultant Registry.

Fisheries Contracts Specialist means an individual who meets the requirements of the Fisheries Contracts specialty and is registered on MTO's Consultant Registry.

Freshwater Mussel means as defined by the Fisheries Act.

High-Water Level means the elevation of the top of the bank of the channel. In watercourses this refers to the "bank-full channel" which is often the 1:2 year flood flow return level. In inland lakes and wetlands, it refers to those parts of the waterbody bed and banks that are frequently flooded by water that leaves a mark on the adjacent land and where the natural vegetation changes from predominately aquatic vegetation to terrestrial vegetation.

Impingement means when an entrapped fish is held in contact with the intake screen and is unable to free itself.

In-Water Work means any work, activity or undertaking occurring at or below the high-water level that may impact the waterbody bed or flow in the waterbody.

In-Water Work Timing Windows means a restriction to in-water work related to an activity during certain periods to protect fish and freshwater mussels from impacts of works or undertakings in and around waterbodies during critical life stages.

Licence to Collect Fish for Scientific Purposes means as defined in Part IV of Ontario Regulation 664/98, under the Fish and Wildlife Conservation Act.

Mitigation Measures means measures to reduce the spatial scale, duration, or intensity of harmful impacts to fish and fish habitat when such impacts cannot be avoided.

Riparian Vegetation Areas means trees, shrubs and other vegetation on waterbody bank from the high-water level upland for 30 metres.

Sediment means soils or other surface material transported by wind or water as a result of erosion.

Species at Risk Act Permit means as defined in the Species at Risk Act.

Waterbody means any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses.

Waterbody Bank means the land adjacent to a waterbody from the high-water level to the top of slope.

Waterbody Bed means the bottom and sides of the waterbody over which the water flows, up to the high-water level.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or ephemeral.

182.04 DESIGN AND SUBMISSION REQUIREMENTS

182.04.01 Submission Requirements

182.04.01.01 Licences and Permits

A Licence to Collect Fish for Scientific Purposes shall be obtained from the Ontario Ministry of Natural Resources and Forestry (MNRF) to conduct a fish salvage prior to any in-water works.

Copies of all permits and licences obtained from regulatory agencies shall be submitted to the Contract Administrator upon receipt.

182.04.01.02 Fisheries Specialists

When a fisheries specialist(s) is required, the name(s) of the fisheries contracts specialist(s) and, if applicable, fisheries assessment specialist(s), shall be provided to the Contract Administrator a minimum of 10 Business Days prior to the commencement of work at each location where specialist oversight is specified.

182.05 MATERIALS

All Materials used to provide environmental protection shall not contain any deleterious substances.

182.06 EQUIPMENT

All Equipment used for the work in and around waterbodies or on waterbody banks shall at all times be free of excess or leaking fuel, lubricants, coolant and any other deleterious substances that could enter the waterbody.

182.07 CONSTRUCTION

182.07.01 General Requirements

In addition to the environmental protection requirements specified elsewhere in the Contract Documents, all Work shall be controlled to provide effective waterbody and fish habitat protection. If fish are observed in the work area during construction the work shall cease, and the fish salvaged.

The Work shall be according to all mitigation measures specified in the Contract Documents.

Unless specified in the Contract Documents, waterbodies shall not be permanently diverted, relocated, blocked, or filled.

Unless specified in the Contract Documents, the removal of woody debris, rocks, sand or other materials from the waterbody bed and banks shall not be permitted.

When practicable, work shall be scheduled to avoid wet or windy periods that may increase erosion and sedimentation.

182.07.02 Operation of Equipment in and around Waterbodies or on Waterbody Banks

Equipment shall arrive on site in clean condition and is to be maintained free of fluid leaks.

Unless specified in the Contract Documents, Equipment shall not enter a waterbody and shall be operated on dry land above the high-water level, on ice, or from a floating barge in a manner that minimizes disturbance to the waterbody banks.

Equipment refueling and maintenance shall take place at locations as far away as practicable from a waterbody and in a manner that prevents any sediment and other deleterious substances from entering a waterbody. An emergency spill kit shall be kept on site to address any fluid leaks or spills from Equipment.

182.07.03 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

182.07.04 Preservation of Riparian Vegetation

Riparian vegetation removal shall be no more than one third (1/3) of the total woody riparian vegetation within 30 metres of the high-water level of a waterbody. Vegetative root masses found within the waterbody banks shall remain undisturbed unless specified in the Contract Documents.

Existing trails, roads or cut lines shall be used wherever possible as access routes to avoid disturbance to waterbody banks and riparian vegetation areas. Equipment travel paths, stockpile areas and staging areas, within the vicinity of the crossing, shall be established to minimize impacts to riparian vegetation.

When practicable, riparian vegetation in the right-of-way shall be altered by hand.

182.07.05 Erosion and Sediment Control

The installation, monitoring, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS 804 and OPSS 805.

Erosion and sediment control measures shall be in place prior to any soil disturbance and shall remain effective at all times, including seasonal and other shut down periods.

Site isolation measures (i.e. cofferdams, turbidity curtains) shall be installed prior to any in-water work activities taking place and shall remain effective at all times to allow the Contractor to work in a manner that prevents sediment from entering into a waterbody.

Measures for managing water being pumped and/or diverted from the site shall be according to OPSS 517.

182.07.01 Restoration of Disturbed Areas

All disturbed areas shall be immediately restored after a disturbance or upon completion of the work in or around waterbodies, waterbody banks, and riparian vegetation areas. The disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

All disturbed areas on waterbody banks and riparian vegetation areas shall be stabilized with effective temporary erosion and sediment control measures as specified in the Contract Documents and maintained until vegetation is established.

All vegetative cover shall be applied as specified in the Contract Documents and according to OPSS 803.

Materials for the restoration of waterbody beds shall not be obtained from below the high-water level of any waterbody unless specified in the Contract Documents.

182.07.07 Contaminant and Spills Management

All stockpiled materials, including but not limited to excavated overburden and topsoil, excess materials, construction debris and containers shall be stored and stabilized in a manner that prevents them from entering any waterbody.

All materials such as paint, primers, blasting abrasives, concrete, rust, solvents, degreasers, grout, or other chemicals shall not enter a waterbody.

All building materials used in and around a waterbody or on waterbody banks shall be handled and treated in a manner to prevent the release or leaching of substances into a waterbody that may be deleterious to fish.

All waste materials (e.g., dredging spoils, construction waste and materials, commercial logging waste, uprooted or cut aquatic plants, accumulated debris) shall be contained and stabilized above the high-water level of nearby waterbodies to prevent re-entry.

182.07.08 Fish Protection

182.07.08.01 Timing of In-Water Works

All in-water work construction activities shall comply with the in-water works timing windows specified in the Contract Documents.

182.07.08.02 Fish Salvage

Fish stranded by the Work or found in the work area during construction shall be salvaged and relocated according to the Licence to Collect Fish for Scientific Purposes, unless specified in the Contract Documents. If fish cannot be safely relocated, the local MNRF office shall be consulted prior to fish salvage commencing to determine a suitable relocation site.

Fish exclusion measures (i.e. block nets) shall be used to prevent fish from re-entering work areas. If the fish exclusion measures fail, additional fish salvage activities shall be performed to relocate the fish from the work areas prior to recommencing construction. All fish exclusion measures shall be removed once the works in the area has been completed.

All fish shall be handled as little as possible and in a manner that minimizes stress and shall prevent the death of fish.

All persons conducting electrofishing shall possess a valid Ontario Electrofishing Certification.

182.07.08.03 Reporting Species at Risk

When an aquatic species at risk (protected under the federal Species at Risk Act (SARA) or the Ontario Endangered Species Act (ESA) is incidentally captured during fish salvage activities, the individual that incidentally captured the aquatic species at risk shall take a digital photograph according to Fisheries and Oceans Canada's Protocol for the Detection of Fish Species at Risk in Ontario Great Lakes Area (OGLA). Once the digital photograph has been taken, the species shall be released immediately. The digital photograph shall be reported and emailed to the Contract Administrator and the appropriate regulatory agency, (i.e. MECP for ESA, and Fisheries and Oceans Canada (DFO) for SARA).

All mortalities of species protected under SARA or ESA associated with the fish salvage activities shall be reported to the Contract Administrator, and the appropriate regulatory agency, immediately upon being discovered. Mortalities shall be vouchered according to Fisheries and Oceans Canada Protocol for the Detection of Fish Species at Risk in Ontario Great Lakes Area (OGLA) and/or Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area (OGLA).

182.07.08.04 Fish Screens

Any water intakes or outlet pipes in fish bearing waters shall have screens to prevent entrainment or impingement of fish and shall follow the measures as outlined in Fisheries and Oceans Freshwater Code of Practice: End-of-Pipe Fish Protection Screens for Small Water Intakes in Freshwater.

182.07.05 Fisheries Specialist Services

When oversight by a fisheries specialist is required for a location as specified in the Contract Documents, a fisheries contracts specialist shall be retained to provide the following services.

- a) Work with construction personnel to protect fish and fish habitat;
- b) Work with construction personnel in the development of waterbody and fisheries protection strategies and plans, when specified in the Contract Documents;
- c) Liaise with the Owner, the Contract Administrator, and, as necessary, Regulatory Agency representatives regarding Fisheries Act authorization requirements;
- d) Be on-site to inspect the installation, function and decommissioning (as appropriate) of all temporary and permanent mitigation measures as specified in the Contract Documents and including providing field fit advice and necessary corrective actions for issues of non-compliance;

- e) Inspect erosion and sediment control measures within 24 hours after a rain event;
- f) Provide immediate notification to the Contractor and Contract Administrator of any release of a deleterious substance or any unauthorized harmful impacts to fish or where there is imminent danger to fish or any of these potentially occurring;
- g) Complete and submit all monitoring documentation as specified in Table 1;
- h) Fish salvage, as necessary, under a Licence to Collect Fish for Scientific Purposes; and
- i) Review Change Proposals for compliance with the Fisheries Act. If a fisheries assessment is required, it shall be conducted by a fisheries assessment specialist.

182.07.09 Contingency Measures

When an environmental protection measure is found to be ineffective, corrective actions shall be taken immediately including repair or replacement of the measure to ensure waterbody and fish habitat protection.

182.07.10 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

182.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items that require fisheries protection and mitigation measures shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Fisheries Contracts Specialist - Monitoring Documentation

MTO Documentation Name	Warrant for Completion	Distribution
Construction Inspection Checklist	Every day that a fisheries contracts specialist is on site.	Within 1 Business Day of inspection, submit one (1) electronic copy of the inspection checklist to Contract Administrator.
Non - Compliance Summary Form	Friday of each week when the Contractor is not in compliance with waterbody and fish habitat protection measures, conditions of a Fisheries Act authorization, Endangered Species Act permit, or Species at Risk Act permit, as specified in the Contract Documents.	By the following Monday, submit one (1) electronic copy of the non-compliance summary to Contract Administrator.
Construction Monitoring Report	Annually on multi-year construction projects and prior to the completion of construction as specified in the Fisheries Act authorization or unless otherwise specified in the Contract Documents.	Unless specified otherwise in the Contract Documents, by November 15 of the monitoring year, submit one (1) electronic copy of the draft report to Contract Administrator. Unless specified otherwise in the Contract Documents, by December 15 of the monitoring year, submit one (1) electronic copy and one (1) hard copy of the final report incorporating MTO comments on the draft to Contract Administrator.



Note: The PROV published in April 2019 replaces OPSS 201 COMMON, November 2011 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
CLEARING, CLOSE CUT CLEARING, GRUBBING,
AND REMOVAL OF SURFACE AND PILED BOULDERS**

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201.01 SCOPE

This specification covers the requirements for the removal of trees, brush, bushes, stumps, windfalls, surface boulders, and piled boulders.

201.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading

Ontario Government Publications

Crown Forest Sustainability Act, 1994, S.O. 1994, c. 25

201.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Clearing means the cutting of all standing trees, brush, bushes, and other vegetation to a maximum height of 300 mm above original ground level and the removal of felled materials and windfalls.

Close Cut Clearing means the cutting of all standing trees, stumps, brush, bushes, and other vegetation at original ground level and the removal of felled materials and windfalls.

Grubbing means the removal of all stumps, roots, embedded logs, debris, and secondary growth.

Piled Boulders means any cobbles, boulders, or rock fragments that have been placed in fencerows or piles.

Rock means rock as defined in OPSS 206.

Surface Boulder means any boulder or rock fragment that measures 200 mm or greater in any one dimension, extends a minimum of 200 mm above original ground, and can be removed without excavation.

201.04 DESIGN AND SUBMISSION REQUIREMENTS

201.04.01 Submission Requirements

201.04.01.01 Crown Forest

Crown forest, as defined by the Crown Forest Sustainability Act, shall not be cut until a permit has been obtained from the Ministry of Natural Resources and Forestry (MNRF).

201.07 CONSTRUCTION

201.07.01 General

Trees measuring 150 mm or more in diameter, measured 1.0 m above ground, shall be cut, limbed, and stacked for collection by others. Cut trees shall not be stacked in or transported through areas identified as being environmentally sensitive in the Contract Documents or elsewhere by an Authority.

When specified in the Contract Documents, cut trees shall be stacked outside and adjacent to the right-of-way for the property owner, adjacent to and between the stations listed.

Within Crown Land areas specified in the Contract Documents for clearing and close cut clearing, marketable timber shall be made available for purchase from the Contractor to the holder of the sustainable forest licence. All cut and stacked trees shall be cut into lengths agreed to by the Contractor and the sustainable forest licence holder, but in no case exceeding 5.0 m.

All timber not purchased by others or stacked for adjacent landowners is excess material.

The work shall not damage or disturb the area outside the areas specified in the Contract Documents.

When work is done in or near waterbodies or waterbody banks, the work shall be according to the Contract Documents.

201.07.02 Clearing

The work shall consist of clearing all areas of earth excavation, earth surfaces to be covered by embankments up to and including 1.2 m in height, and any other areas specified in the Contract Documents.

201.07.03 Close Cut Clearing

The work shall consist of close cut clearing all earth surfaces to be covered by embankments greater than 1.2 m in height, and any other areas specified in the Contract Documents.

201.07.04 Grubbing

The work shall consist of grubbing all areas of earth excavation, earth surfaces to be covered by embankments up to and including 1.2 m in height, and any other areas specified in the Contract Documents.

Grubbing is not required in swamps.

Mechanical stump cutters are permitted, provided the entire root structure is removed.

Depressions remaining after grubbing shall be backfilled with suitable earth material and compacted to avoid settlement.

When clearing has been previously completed by others, all secondary growth, brush, and debris shall be removed.

Piled boulders and surface boulders that are not specified in the Contract Documents for removal and lie within areas to be grubbed shall be removed.

201.07.05 Removal of Surface Boulders and Removal of Piled Boulders

The work shall consist of the removal of surface boulders and removal of piled boulders within the areas specified in the Contract Documents.

Depressions remaining after removal shall be backfilled with suitable earth material and compacted to avoid settlement.

201.07.06 Mechanical Stump Cutting

The work shall consist of mechanical cutting of stumps to a depth of 150 mm below original grade, as specified in the Contract Documents.

201.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

201.09 MEASUREMENT FOR PAYMENT

201.09.01 Actual Measurement

Measurement shall be by area or by each, as specified in the Contract Documents.

201.09.01.01 Clearing, Close Cut Clearing, and Grubbing

Measurement of clearing, close cut clearing, and grubbing shall be by area or by each, as specified in the Contract Documents.

201.09.01.01.01 By Area

Removal shall be measured by area in a horizontal plane in hectares or square metres.

201.09.01.01.02 By Each

For measurement purposes, a count shall be made of the trees or stumps removed.

201.09.01.02 Removal of Surface Boulders and Removal of Piled Boulders

Removal shall be measured by area in a horizontal plane in hectares or square metres.

201.09.01.03 Mechanical Stump Cutting

For measurement purposes, a count shall be made of the stumps removed by mechanical cutting.

201.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

201.10 BASIS OF PAYMENT

**201.10.01 Clearing - Item
Close Cut Clearing - Item
Grubbing - Item
Removal of Surface Boulders - Item
Removal of Piled Boulders - Item
Mechanical Stump Cutting - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Areas designated for removal of piled boulders that lie within areas specified in the Contract Documents for either grubbing or removal of surface boulders shall be paid separately with no deduction from the grubbing or surface boulder removal item.

Removal of individual boulders that are 1 m³ and greater in volume, shall be paid as rock excavation according to OPSS 206.



**CONSTRUCTION SPECIFICATION FOR ROCK REMOVAL
BY MANUAL SCALING, MACHINE SCALING, TRIM BLASTING,
OR CONTROLLED BLASTING**

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APPENDICES

202-A	Commentary

202.01 SCOPE

This specification covers the requirements for removing rock by manual scaling, machine scaling, trim blasting, or controlled blasting.

202.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

202.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

202.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading

202.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Controlled Blasting means cushion blasting, line drilling, and pre-shearing as defined in OPSS 206.

Grubbing means as defined in OPSS 206.

Mucking means as defined in OPSS 206.

Rock Cut Sounding means any non-destructive method using mechanical or electronic devices to acoustically determine areas where rock is partially or completely detached from the main rock mass.

Rock Face means as defined in OPSS 206.

Scaling means as defined in OPSS 206.

Trim Blasting means a blasting technique involving the drilling of a single row of closely-spaced holes along the excavation limits, loading them with light, well-distributed charges, completely stemmed, and simultaneously firing the charges.

Wall Control Blasting means as defined in OPSS 206.

202.04 DESIGN AND SUBMISSION REQUIREMENTS

202.04.02 Submission Requirements

A minimum of 5 Business Days prior to beginning the Work, the name and contact number of the on-site person that is responsible for the Work being carried out (i.e., foreman) and a written statement showing that the person has had at least 5 years of related work experience, including dates, and has taken all appropriate safety training shall be submitted to the Contract Administrator.

202.06 EQUIPMENT

202.06.01 Lifting Equipment

Lifting equipment shall consist of a two-person aerial lift, crane, or other equipment suitable to access the Work.

202.06.02 Drilling Equipment

Drilling equipment shall consist of a hydraulic track drill or other suitable drilling equipment acceptable to the Contract Administrator and capable of producing holes accurately and uniformly across the top of a rock cut to the depth specified in the Contract Documents.

202.06.03 Backhoe Excavator

Backhoe excavators shall have a minimum operating weight of 30,000 kg and shall be capable of operating to a minimum height of 10 m.

202.06.04 Hoe-Ram Excavator

A backhoe excavator shall be equipped with a minimum 5,200 Joule hydraulic impact hammer.

202.07 CONSTRUCTION

202.07.01 General

The work of the removal of rock by scaling or blasting or both shall include the following:

1. All equipment, including any lifting equipment, materials, and labour that is:
 - a) necessary to gain access to the rock removal locations specified in the Contract Documents.
 - b) required by the Owner to obtain access to any areas where:
 - i. the Work is being inspected;
 - ii. quantities are to be measured; or
 - iii. quality assurance and acceptance procedures are being conducted.

2. All associated mucking, hauling, and management of rock material.

Removal of rock shall always be carried out in such a manner as to minimize fracturing and all other disturbance to the surrounding rock beyond the removal limits specified in the Contract Documents.

All blasting, including the use of explosives, shall be as specified in the Contract Documents.

202.07.02 Scaling

202.07.02.01 General

Scaling shall consist of the complete removal of all loose and partially-detached rock at the locations and heights specified in the Contract Documents.

Scaling shall begin at the top of the rock cut and progress to lower elevations as the work proceeds. As the scaling progresses, care shall be taken to avoid undercutting the upper sections of the scaled rock cut.

The scaling crew shall be in continuous full-time radio contact with the foreman to permit direct and immediate control.

Each day, the scaling crew shall inspect the rock cut:

- a) prior to the start of work and remove any identified loose or visually unstable rock that may endanger workers.
- b) prior to shutdown and remove any identified loose or visually unstable rock that may endanger the traveling public.

202.07.02.02 Manual Scaling

The work of manual scaling shall consist of the complete removal of all loose and partially-detached rock at the locations and heights specified in the Contract Documents by the manual scaling work unit and in addition to all of the other items specified in the Contract Documents, shall also include the following:

- a) Rock cut sounding.
- b) Scaling of the rock cut with hand tools and hand-held machine tools.

Manual scaling may include blasting with small quantities of explosives, but only when specified as an option in the Contract Documents.

As a minimum, the manual scaling work unit shall consist of the following:

- a) Two labourers that are experienced in doing scaling work at the heights required in the Contract and have taken the appropriate safety training.
- b) All tools and materials required for the performance of the work.

202.07.02.03 Machine Scaling

The work of machine scaling shall consist of the complete removal of all loose rock and partially-detached rock at the locations and heights specified in the Contract Documents by the machine scaling work unit and in addition to all of the other items specified in the Contract Documents, shall also include the following:

- a) Grubbing.
- b) Rock cut sounding.
- c) Scaling of the rock cut.

As a minimum, the machine scaling work unit shall consist of the following:

- a) Either a:
 - i) Backhoe excavator equipped with a narrow scaling/ditching bucket and hydraulic thumbs; or
 - ii) Hoe-ram excavator.
- b) Backhoe and hoe-ram excavator operators with experience in machine scaling work.
- c) All tools and materials required for the performance of the work.

202.07.03 Trim Blasting or Controlled Blasting

202.07.03.01 General

The work of trim blasting or controlled blasting shall consist of drilling and blasting to remove the rock specified for removal in the Contract Documents, while minimizing damage to the surrounding rock.

Any loosened or partially-detached rock shall be properly scaled, as specified in the Scaling subsection.

202.07.03.02 Trim Blasting

In addition to all of the other items specified in the Contract Documents, the work of trim blasting shall also include locating and drilling 50 mm diameter vertical holes along the perimeter of the specified trim at a maximum spacing of 750 mm or at a spacing approved by the Contract Administrator.

202.07.03.03 Controlled Blasting

In addition to all of the other items specified in the Contract Documents, the work of controlled blasting shall also include the appropriate wall control blasting techniques, as specified for rock face in OPSS 206.

202.07.04 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

When possible, excess rock material shall be managed within the right-of-way by slope flattening at locations approved by the Contract Administrator or as specified in the Contract Documents.

202.09 MEASUREMENT FOR PAYMENT

202.09.01 Actual Measurement

202.09.01.01 Rock Excavation, Manual Scaling

Measurement of rock excavation by manual scaling shall be by time in hours that the scaling crew is in effective operation.

Effective operation shall not include the time taken for the management and disposal of the materials generated by the scaling operation.

202.09.01.02 Rock Excavation, Machine Scaling

Measurement of rock excavation by machine scaling shall be the cumulative sum of the time in hours that each individual scaling unit is working on the site in effective operation.

Effective operation shall not include the time taken for the management and disposal of all materials generated by the scaling operation or for the construction of any associated ramps.

202.09.01.03 Rock Excavation, Trim Blasting

Measurement of rock excavation by trim blasting shall be by vertical length in metres of drilling required.

202.09.01.04 Rock Excavation, Controlled Blasting

Measurement of rock excavation by controlled blasting shall be by volume in cubic metres of rock measured in-place.

202.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

202.10 BASIS OF PAYMENT

**202.10.01 Rock Excavation, Manual Scaling - Item
Rock Excavation, Machine Scaling - Item
Rock Excavation, Trim Blasting - Item
Rock Excavation, Controlled Blasting - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Appendix 202-A, November 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR ROCK STABILIZATION

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203.10	BASIS OF PAYMENT

203.01	SCOPE

This specification covers the requirements for the stabilization of a rock face using rock bolts, shotcrete, concrete buttresses, or a combination of the aforementioned.

203.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 931	Structure Rehabilitation - Shotcrete
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specifications, Material

OPSS 919	Formwork and Falsework
OPSS 1002	Aggregates, Concrete
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1303	Admixtures for Concrete
OPSS 1306	Burlap

OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-410 Method of Test for Compressive Strength of Concrete Cores

MTO Forms:
PH-CC-322 Concrete Construction Report
PH-CC-340 Field Sample Data Sheet - Concrete
PH-CC-433-A Concrete Mix Design Submission Form A
PH-CC-701 Request to Proceed
PH-CC-702 Notice to Proceed

CSA Standards

A23.2-1B Testing for properties of flowable grout*
A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing*
A3001 Cementitious Materials for Use in Concrete**
*[Part of A23.1:19/A23.2:19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
**[Part of A3000-18 - Cementitious Materials Compendium]
G40.21-13(R2018) General requirements for rolled or welded structural quality steel / Structural quality steel

ASTM International

A123/A123M-17 Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A820/A820M-22 Specification for Steel Fibers for Fiber-Reinforced Concrete
A563/A563M-21ae1 Specification for Carbon and Alloy Steel Nuts
A1022/A1022M-22a Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
A1064/A1064M-22 Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C1550-20 Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)
D1784-20 Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D4285-83(2018) Test Method of Indicating Oil or Water in Compressed Air
F436/F436M-19 Specification for Hardened Steel Washers Inch and Metric Dimensions
F593-22 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F1554-20 Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
F2329/F2329M-15 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

Others

International Society for Rock Mechanics (ISRM) Suggested Method for Rock Anchorage Testing

203.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Basal Plane means a planar discontinuity within a rock mass along which one portion of the mass could slide over another.

Cold Weather means those conditions when the air temperature is less than or equal to 10 °C. It is also considered to exist when the air temperature is at or is likely to be less than 10 °C within 96 hours after concrete placement. Temperature refers to shade temperature.

Concrete Buttress means a structurally reinforced concrete structure designed to support rocks.

Centralizer means a device to support and position the tendon and sleeves in the drill hole throughout the bond length of the tendon so that a minimum grout cover is achieved.

Dry Mix Shotcrete means shotcrete which is the prebagged dry material is mixed and placed into a stream of compressed air. The material is carried by the compressed air through a delivery hose to the nozzle where water is added. Water is added to the mixture as it is jetted from the nozzle.

Hot Weather means those conditions when the air temperature is greater than or equal to 28 °C. It is also considered to exist when the air temperature is at or is likely to be greater than 28 °C within 24 hours after the shotcrete operation. Temperature refers to shade temperature.

Nozzleperson means the qualified worker on the shotcrete crew who has obtained ministry approval for shotcrete nozzleperson certification who manipulates the nozzle, controls consistency, and controls final disposition of the material.

Rock Bolting means the pinning of a rock block or rock mass in-situ using anchoring agent or cement grouted steel bars.

Saturated Surface Dry means concrete or rock face that is fully saturated without free standing water.

Wet Mix Shotcrete means shotcrete in which all of the materials, including water, are mixed before introduction into the delivery hose. Compressed air is introduced to the material flow at the nozzle.

203.04 DESIGN AND SUBMISSION REQUIREMENTS

203.04.01 Submission Requirements

203.04.01.01 Mix Design for Shotcrete

The submission of the shotcrete mix design including all supporting documentation shall be according to OPSS 931, with additional documentation showing the steel fibre manufacturer's name, type, product name and fibre content, if applicable.

203.04.01.02 Mix Design for Concrete Buttress

Concrete mix design submissions shall be according to OPSS 1350.

203.04.01.03 Shotcrete Equipment

The submission of the shotcrete equipment shall be according to OPSS 931.

203.04.01.04 Nozzleperson

The submission of the nozzlepersons shall be according to OPSS 931.

203.04.01.05 Cold Weather Protection

The submission of the cold weather protection shall be according to OPSS 931.

203.04.01.06 Hot Weather Shotcreting

The submission of the hot weather shotcreting shall be according to OPSS 931.

203.04.01.07 Curing

The submission of the curing for shotcrete shall be according to OPSS 931.

203.04.01.08 Rock Bolting

The following rock bolting information shall be submitted to the Contract Administrator, for information purposes, a minimum of 2 weeks prior to starting the work:

- a) The name and statement of experience of the persons or firm(s) responsible for installing and testing the rock bolts.
- b) The name of the firm supplying the rock bolts.
- c) The mill certificates for the rock bolts to be used.
- d) The name of the firm supplying the anchoring agent, if applicable.
- e) The type, date of manufacture, set time and dimensions of the anchoring agent, the drill hole diameter, and the installation methodology to be used.
- f) The type of grout and installation methodology for grouted rock bolts, if applicable.

203.04.01.09 Steel Fibres

Test reports from the steel fibre manufacturer, for the physical properties of the steel fibres, including tensile strength, according to ASTM A820 shall be submitted to the Contract Administrator at least 2 weeks prior to the use of the product. The steel fibre diameter and length shall be included in the report.

203.04.01.10 Flexural Toughness of Steel Fibre-reinforced Shotcrete

For steel fibre-reinforced shotcrete, test report for flexural toughness according to ASTM C1550 shall be submitted to the Contract Administrator at least 2 weeks prior to the placement of the shotcrete. Test specimens shall be prepared using the same materials and mix design as the shotcrete to be used in the work. Test results shall not be more than 6 months old at the time of submission. Testing shall be carried out by an independent laboratory, acceptable to the Owner, and certified by the Canadian Council of Independent Laboratories (CCIL) - Concrete Certification or equivalent qualification programme acceptable to the Owner.

The test report shall indicate that the flexural toughness meets the minimum requirement specified in the Contract Documents.

203.05 MATERIALS

203.05.01 Admixtures

Admixtures shall be according to OPSS 1303.

203.05.02 Aggregates

Aggregates shall be according to OPSS 1002, except the nominal maximum aggregate size shall be 13.2 mm.

203.05.03 Anchors

Anchors for the attachment of the welded steel wire reinforcement to the rock face shall be of adequate length, diameter, and grade to resist a pull-out force of 1.0 kN. The anchors shall be according to ASTM F1554 and the galvanizing according to ASTM F2329.

When stainless welded steel wire reinforcement is used, anchors and tie wires shall be made of the same type of stainless steel according to ASTM F593.

203.05.04 Burlap

Burlap shall be according to OPSS 1306.

203.05.05 Concrete Buttress

Cast-in-place concrete buttress shall be according to OPSS 1350 with a minimum 28-Day compressive strength of 30 MPa.

Steel reinforcement, mechanical connectors, and associated hardware shall be according to OPSS 905.

203.05.06 Cementing Material

Cementing materials shall be according to OPSS 1301 and CSA A3001.

203.05.07 Formwork

Formwork shall be according to OPSS 919.

203.05.08 Grout Tubes

Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. The grout tubes shall be able to withstand a pressure of 1 MPa.

203.05.09 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's prequalified product list. The list of proprietary patching materials shall be obtained from the Contract Administrator.

203.05.10 Rock Bolts

203.05.10.01 General

Rock bolts shall be a minimum 25M reinforcing steel bars according to OPSS 1440 with a minimum yield strength of 400 MPa and a minimum length of 3.0 m, unless otherwise specified elsewhere in the Contract Documents. Rock bolts shall be fully threaded bars or bars threaded at one end and provided with a face plate of at least 100 x 100 mm in area with a nut and beveled or spherical washers as recommended by the manufacturer.

The steel for nuts shall be according to ASTM A563. Washers shall be according to ASTM F436. Face plates shall be according to CSA G40.21.

Rock bolt shall be hot-dip galvanized according to ASTM A123 and all other rock bolt components shall be hot-dip galvanized according to ASTM F2329.

The minimum yield strength of the rock bolt components shall be as specified in the Contract Documents.

203.05.10.02 Anchoring Agent for Rock Bolts

The anchoring agent for rock bolts shall be supplied in cartridges containing a polyester resin with a catalyst that has a maximum gel time of 15 minutes. Fully cured anchoring agent shall have a minimum compressive strength of 50 MPa and a minimum tensile strength of 15 MPa. Resin with an expired shelf life shall not be used.

203.05.10.03 Grout for Rock Bolts

Portland cement-based grout shall be a proprietary pre-bagged, non-metallic, shrinkage compensating grout placed according to the manufacturer's specifications. The grout shall be mixed, handled, and cured according to the manufacturer's specifications.

The grout shall have a minimum compressive strength of 20 MPa at 7 Days and a minimum compressive strength of 30 MPa at 28 Days when tested according to CSA A23.2-1B.

The grout shall bleed less than 2% after allowing the grout to stand for 1 hour when tested according to CSA A23.2-1B.

203.05.11 Rock Drains

Rock drains shall consist of slotted polyvinyl chloride (PVC) pipe according to ASTM D1784 and have a minimum internal diameter of 19 to 25 mm, inclusive.

203.05.12 Rock Shotcrete

203.05.12.01 General

Shotcrete shall have a minimum 28-Day compressive strength of 35 MPa. The shotcrete mix shall contain 8% silica fume by mass of total cementing materials.

Steel fibres or welded steel wire reinforcement shall be used in the shotcrete, as specified in the Contract Documents. When steel fibre-reinforced shotcrete is specified in the Contract Documents, the minimum flexural toughness when tested at 28-Days according to ASTM C1550 shall be a minimum of 400 joules at 40 mm deflection.

Dry mix shotcrete shall be used, unless otherwise specified in the Contract Documents.

203.05.12.02 Additional Requirements for Dry Mix Shotcrete

The dry shotcrete mix shall be supplied pre-bagged and unopened. Each bag shall be stamped with the following:

- a) Name of the manufacturer;
- b) Mix identification;
- c) Manufacturer's batch number; and
- d) Date of packaging.

The pre-bagged mix shall contain cementing materials and aggregates. When specified in the Contract Documents, the pre-bagged mix shall contain the steel fibres. The bags shall be maintained in a dry condition up to the time of use and shall be stored within a temperature range of 10 °C to 30 °C.

Material from bags that contain lumps of hydrated shotcrete or appear to be frozen or otherwise damaged shall not be used in the work. The pre-bagged mix shall be used within 6 months of the date of packaging.

203.05.12.03 Additional Requirements for Wet Mix Shotcrete

Silica fume shall be added to the concrete mix in the form of a blended cement containing silica fume.

When steel fibre for wet mix shotcrete is specified in the Contract Documents:

- a) The steel fibres shall be added to the ready-mix concrete truck at the plant when the shotcrete is delivered using trucks; or
- b) The pre-bagged mix shall contain the steel fibres when the shotcrete is produced using pre-bagged material.

203.05.13 Steel Fibres

Fibre reinforcement shall be steel fibres with a minimum tensile strength of 1,100 MPa when tested according to ASTM A820. The steel fibre shall be bent or deformed low-carbon, cold-drawn steel wire, Type I according to ASTM A820.

203.05.14 Tie Wire

Tie wire shall be according to OPSS 905.

203.05.15 Water

Water used for production, fog-misting, curing, and pre-soaking of burlap shall be according to OPSS 1302.

203.05.16 Welded Steel Wire Reinforcement

The welded steel wire reinforcement shall be welded galvanized or stainless steel according to OPSS 1440 and shall have 100 mm x 100 mm openings fabricated from 4 mm diameter galvanized wires or stainless steel. Galvanized steel wire shall be according to ASTM A1064. Stainless steel wire reinforcement shall be in according to ASTM A1022.

203.06 EQUIPMENT

203.06.01 Shotcreting

203.06.01.01 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 14.2 m³/min. The compressed air shall be free from oil and other contaminants according to ASTM D4285.

203.06.01.02 Fog Misting Equipment

Fog misting equipment for the curing of shotcrete shall be according to OPSS 904.

203.06.01.03 Hand Finishing Equipment

Where hand finishing is required, only magnesium, wood, or sponge rubber floats shall be used.

203.06.01.04 Mixers

Mixers for dry mix process or wet mix process shall be according to OPSS 931.

The dry mix process shall be used, unless otherwise specified in the Contract Documents.

203.07 CONSTRUCTION

203.07.01 Rock Bolting

203.07.01.01 Drilling of Rock Bolt Holes

Holes for rock bolts shall be drilled with the diameter recommended by the anchoring agent manufacturer for the sizes of the rock bolts at the locations specified in the Contract Documents. For cement grouted rock bolts, holes shall be drilled as specified in the Contract Documents.

Holes shall be drilled in a direction angled downward in order to connect the basal planes and to a depth such that when the rock bolt is fully inserted it protrudes 70 mm + 20 mm from the rock or shotcrete surface.

The drill holes shall be thoroughly cleaned with compressed air prior to the installation of the anchoring agent or grout.

203.07.01.02 Installation of Rock Bolts

The holes shall be filled with the anchoring agent or grout to ensure complete encapsulation of the rock bolt and an adequate bond along the full length of the drill hole while allowing some overflow.

Centralizers shall be maintained in position during installation.

Rock bolts shall be installed according to the anchoring agent manufacturer's installation instructions or as specified in the Contract Drawings. For the resin anchor, during the insertion of the rock bolt in the hole, the bolt shall be steadily rotated by means of a pneumatic tool and suitable coupling attached to the threaded end of the bolt according to the anchoring agent manufacturer recommendations. The rotation shall be continued after the bolt has been inserted for a further 15 seconds or according to the recommendations of the anchoring agent manufacturer and the bolt shall then be maintained in position until the anchoring agent has hardened.

After the rock bolts are fully inserted into the drill holes in a vertical or inclined rock face, the rock bolts shall be maintained in position to prevent any further loss of resin while the anchoring agent is setting.

Grout shall be pumped or poured through the grout tube until the hole is filled.

The face plate, washer and nut shall be pneumatically fastened to the rock bolts at angles of less than 30 degrees from the perpendicular, in order to provide full contact of the face plate with the rock or shotcrete bearing surface and nominal tensioning of the bolt.

Rock bolts in holes that are not completely filled with anchoring agent or which protrude from the hole by an amount greater or less than the length specified shall not be accepted and shall be replaced at a location as close to the original bolt as possible.

203.07.01.03 Quality Control Testing of Plastic Grout

203.07.01.03.01 General

Field testing of grout shall be performed by a person holding either of the following certifications:

- a) CCIL Certified Concrete Testing Technician;
- b) ACI Concrete Field Testing Technician, Grade 1; or
- c) CSA Standard Concrete Field Testing Technician.

This person shall have a valid original card issued by the certifying agency in their possession at all times.

Bleeding shall be measured according to CSA A23.2-1B after allowing to stand for 1 hour.

203.07.01.03.02 Acceptance of Plastic Grout

The Contractor shall be responsible for all quality control inspection and testing required to ensure that plastic grout meets the specified requirements for bleed water and is mixed, handled, and cured according to manufacture's specifications.

Grout which does not meet the specified requirements for bleed water or manufacturer's specifications for mixing, handling, and curing shall be rejected.

After each Day's work, a daily summary shall be submitted to the Contract Administrator. The daily summary shall include volume of grout used, bleed water test results and shall identify rejected material.

203.07.01.04 Material Sampling and Testing

203.07.01.04.01 Compressive Strength of Grout

The Contractor shall cast, cure, and transport grout cubes for compressive strength testing at 7 Days and 28 Days by the Owner.

Every time a set of acceptance grout cubes is cast, a second set of grout cubes shall be cast for referee testing purposes.

Grout cubes for compressive strength testing for acceptance and for referee testing purposes shall be cast, cured, and transported according to CSA A23.2-1B. Referee grout cubes shall be cured and transported to the Regional Quality Assurance Laboratory, along with the acceptance grout cubes. A set of grout cubes shall consist of three 50 mm in dimension cubes, at each specified age.

Test information shall be recorded on MTO form PH-CC 322, Concrete Construction Report, and submitted with each set of the grout cubes.

The Contractor shall continuously record and monitor air temperature immediately adjacent to the grout cubes during the field-curing period. The maximum time interval for recording the temperature shall be every 15 minutes. Curing temperature records shall be submitted to the Contract Administrator at the completion of the field-curing period.

203.07.01.04.02 Testing of Rock Bolts

Rock bolt tests shall be conducted as specified in the Contract Documents to demonstrate the performance of the rock bolts by axial pull tests using a calibrated hollow hydraulic jack.

The rock bolt pull testing shall be carried out according to ISRM Suggested Method for Rock Anchorage Testing in the presence of the Contract Administrator. The axial tensioning equipment shall consist of a hollow plunger type hydraulic jack with a minimum capacity of 200 kN, a hydraulic pump, pressure gauges, displacement gauges capable of measuring displacements of 0.0025 cm, and all necessary accessory items for carrying out the rock bolt performance tests.

Rock bolts that fail to meet the acceptance requirement shall be reinstalled and tested at no additional cost to the Owner.

203.07.02 Rock Shotcreting

203.07.02.01 Operational Constraints

The Contract Administrator shall be notified of the intent to apply shotcrete a minimum of 3 Business Days prior to the commencement of the shotcreting operation.

A MTO form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator at the completion of the surface preparation operation and prior to the commencement of the application of shotcrete.

The application of shotcrete shall not proceed until a MTO form PH-CC-702, Notice to Proceed, has been received from the Contract Administrator.

No shotcrete shall be placed until all curing materials, and, in cold weather, all cold weather protection materials have been delivered to the site.

Shotcreting shall not be carried out when the air temperature or existing rock face temperature is less than 10 °C or is likely to be less than 10 °C, or is greater than 30 °C or likely to be greater than 30 °C throughout the duration of the shotcreting operation unless cold weather protection is provided according to the Contractor's submitted plan.

Prior to shotcreting, the Contractor shall demonstrate to the Contract Administrator that the substrate temperatures meet the Contract requirements by measuring the substrate temperatures using a contact thermometer, and recording them.

Shotcrete shall not be placed against frozen surfaces. All surfaces against which shotcrete is to be placed shall be free of standing water. Shotcrete shall be protected from contact with rain or snow.

The air in contact with the shotcreted surfaces shall be maintained at temperatures greater than 10 °C for a minimum of 96 hours after the application of shotcrete. Unvented heaters shall not be used.

Shotcreting operations shall be suspended during weather conditions that may adversely affect the quality of the work. This includes but is not limited to wind causing segregation of ingredients, rain or snow.

Prior to seasonal shutdown, operations shall be scheduled in such a manner as to ensure that the shotcreting operations are completed in all areas where surface preparation has commenced.

203.07.02.02 Surface Preparation

All rock surfaces against which shotcrete is to be placed shall be clean, solid and free from loose or unsound rock, vegetation or other organic materials, and any foreign substances or other debris. All dust and loose material shall be removed using compressed air. Additional methods for surface preparation may be required and shall be approved by the Contract Administrator.

Prior to the application of shotcrete:

- a) The area to be shotcreted shall be maintained in a wet condition for a minimum period of 2 hours; prior to the application of the shotcrete.
- b) Excess water shall be removed from the rock surface using compressed air to reach a saturated surface dry condition.

203.07.02.03 MTO Nozzleperson Certification Program

Shotcreting shall be carried out by a nozzleperson who has successfully participated in the MTO Shotcrete Nozzleperson Certification Program that is valid for the current construction season. Notwithstanding this prequalification, the nozzleperson shall be replaced when in the opinion of the Contract Administrator, acceptable quality of work is not achieved or maintained.

203.07.02.04 Placing

All necessary measures shall be taken during shotcrete application to guard against damage, including damage to passing vehicles which may be caused by excessive rebounding of shotcrete material.

The specified thickness of the shotcrete shall be a minimum of 100 mm, unless otherwise specified in the Contract Documents.

During the application of the shotcrete, a steady continuous flow of shotcrete shall be maintained.

For dry mix shotcrete, any pre-dampened mixture which is not utilized within 30 minutes, shall be rejected and shall not be incorporated into the work. When wet mix shotcrete is transported to the site by means of agitating or mixing equipment, discharge of the shotcrete shall be completed within 1.5 hours after introduction of the mixing water to the cement and aggregates, except when the air temperature is greater than 28 °C and the concrete temperature is greater than 25 °C, the concrete shall be discharged within 1 hour after the introduction of the mixing water. Use of retarders does not change the specified concrete discharge time.

The total required depth of shotcrete shall be placed within the same Day once the shotcrete placement has commenced for an area.

Shotcrete shall be applied so that there is no sagging or separation of the material in place.

All rebound and overspray material shall be removed as the work proceeds. Rebound, overspray or waste material shall not be worked back into the shotcrete or salvaged and re-used.

203.07.02.05 Curing

Shotcrete shall be moist cured for a minimum period of 4 Days. Curing for at least the first 24 hours of the curing period shall be by fog mist.

Application of fog mist shall begin immediately after application of the final layer of shotcrete or, where hand finishing is specified, immediately after finishing of the shotcrete.

For the remainder of the moist curing period, moist curing shall be by means of fog mist or wet burlap.

When wet burlap is used, the burlap shall be placed in a manner that will ensure that it is in full contact with the surface of the shotcrete for the full duration of the curing period. Curing with burlap and water shall be according to OPSS 904.

203.07.02.06 Cold Weather Protection

Cold weather protection shall be according to OPSS 931.

203.07.03 Material Sampling and Testing

203.07.03.01 Sampling for Acceptance Testing of Compressive Strength and Thickness of Shotcrete

Core samples for acceptance testing of 28-Day compressive strength and thickness shall be removed from the shotcrete at locations randomly selected by the Contract Administrator. Core samples shall be obtained for acceptance testing in the presence of the Contract Administrator.

The lot size, subplot size and number of cores per subplot shall be according to the Quality Assurance section.

203.07.03.02 Coring

Coring shall be carried out according to CSA A23.2-14C when the shotcrete is between 7 to 10 Days of age. Cores shall be 75 mm in diameter and full depth.

To avoid cutting reinforcing steel, all embedded steel and rock drains in the area shall be located, using a covermeter, prior to taking any cores. Cores for compressive strength testing may contain welded steel wire reinforcement but shall not contain reinforcing steel.

Each core shall be marked legibly with durable ink immediately after removal with the following information:

- a) Contract number.
- b) Lot number.
- c) Sublot number.
- d) Location of each individual core.
- e) Date of shotcrete placement.
- f) Date of extraction.

Cores shall be placed in a plastic bag, sealed to prevent loss of moisture and provided to the Contract Administrator along with MTO Form PH-CC-433-A, Concrete Mix Design Submission Form A, of the concrete mix design and the MTO form PH-CC-340, Field Sample Data Sheet – Concrete, on which the field data for the cores is recorded, for testing by the Owner.

Core holes shall be filled according to OPSS 1350.

203.07.03.03 Preparation for Sounding Acceptance Testing

The Contract Administrator shall be notified in writing when the shotcrete is ready for the sounding acceptance testing. The sounding acceptance testing of the shotcrete shall be completed on the final shotcreted layer by the Contract Administrator.

Provisions shall be made for access to the site and to all areas of the shotcreted face for sounding acceptance testing.

203.07.04 Field Inspection for Cracks

The Contractor shall inspect all concrete to identify and document any cracks including, their location, width, and density. The results of the inspection shall be reported to the Contract Administrator.

Based on criteria in the Field Inspection of Completed Work clause, the Contractor shall identify areas requiring repair or replacement and shall identify the limits of such repair or replacement. This information shall be provided to the Contract Administrator along with a proposal for remedial action to be taken. No repairs shall proceed until the proposal has been accepted by the Contract Administrator in writing. Repair of cracks shall be according to OPSS 932 and shall be completed after the curing period has elapsed.

203.07.05 Rock Drains

When rock drain holes are specified in the Contract Documents, the holes shall be drilled to depths of 3.0 m at an inclination of approximately 10 degrees above the horizontal and throughout the shotcrete layer at 2.0 m to 3.0 m centres.

The drain holes shall then be lined with tightly-fitted PVC pipe that protrudes approximately 25 mm to 75 mm outside of the shotcreted face.

203.07.06 Concrete Buttress

Rock cavities shall be filled with reinforced concrete at locations as specified in the Contract Documents.

Construction of concrete buttress shall be according to OPSS 904.

Dowels shall be installed into the existing rock face as specified in the Contract Documents on a grid pattern and to depths as specified in the Contract Drawings.

The concrete face shall have a smooth surface.

203.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

203.08 QUALITY ASSURANCE

203.08.01 Acceptance of Grout for Rock Bolting

Grout for rock bolting shall be acceptable if all of the requirements of this specification are met, including:

- a) 7-Day compressive strength;
- b) 28-Day compressive strength;
- c) Mixing, handling and curing according to manufacturer's specifications; and
- d) There are no defects detected by inspection according to the Field Inspection subsection.

Unacceptable lots or sublots shall be deemed rejectable.

203.08.02 Acceptance of Rock Shotcrete

Shotcrete shall be acceptable if all of the requirements of this specification are met, including:

- a) 28-Day compressive strength;
- b) Thickness; and
- c) There are no defects detected by inspection according to the Field Inspection subsection.

Unacceptable lots or sublots shall be deemed rejectable.

203.08.03 Field Inspection

203.08.03.01 Field Inspection for Rock Bolting

The Contract Administrator will inspect the plastic grout or anchoring agent during the application process and will reject all or a portion of the work based on the presence of one or more of the defects and deficiencies identified below:

- a) Failure to mix, handle and cure of the grout according to manufacturer's specifications.
- b) Excessive bleeding of grout.
- c) Failure to completely fill the hole or rock bolts which protrude from the hole by an amount greater or less than the length specified.
- d) Improper cleaning of the drilled holes.

If plastic grout or anchoring agent is rejected by the Contract Administrator, the work shall stop and all necessary measures to correct deficiencies shall be taken.

203.08.03.02 Field Inspection for Rock Shotcreting

The Contract Administrator will inspect the plastic shotcrete during the application process and will reject all or a portion of the work based on the presence of one or more of the defects and deficiencies identified below:

- a) Failure to achieve specified surface profile.
- b) Failure to remove all loose and unsound material prior to pre-wetting.
- c) Failure to adequately pre-wet or achieve a saturated surface dry condition of the rock face prior to application of the shotcrete.
- d) Failure to properly control and remove build-up of shotcrete overspray and rebound.
- e) Incomplete consolidation around reinforcing steel, welded wire mesh, rock drains and anchors.
- f) Excessive shotcrete rebound.
- g) Incorporation of sand lenses, excessive voids, delaminations, sags, and sloughing.
- h) Failure to apply shotcrete to the required line, grade, and tolerance.

If plastic shotcrete is rejected by the Contract Administrator, the work shall stop and all necessary measures to correct deficiencies shall be taken.

203.08.03.03 Completed Work

The Contract Administrator will inspect the completed work and any cores removed from the work and will reject all or a portion of the work based on the presence of one or more of the defects and deficiencies identified below:

- a) Debonded or hollow-sounding areas.
- b) Porous or rebound material visible in cores or in the placed shotcrete.
- c) Areas which have visibly sagged in cores or in the placed shotcrete.
- d) Cracks with a width greater than 0.3 mm where the linear measurement of the crack is 2 m or greater per square meter area.

Cracks greater than or equal to 0.3 mm in width shall be repaired according to this specification, if the linear measurement of the crack per square metre is less than 2 m.

203.08.04 Acceptance of Thickness and Compressive Strength of Rock Shotcrete

203.08.04.01 Lot Size

A lot shall consist of the total quantity of shotcrete in the Contract Documents. Each lot shall be divided into sublots of approximately equal size and no greater than 100 m².

The Contract Administrator will determine the subplot size prior to the commencement of the shotcreting operation.

203.08.04.02 Basis of Acceptance

203.08.04.02.01 General

The thickness and 28-Day compressive strength of shotcrete shall be determined based on the average results for three cores removed from each subplot.

203.08.04.02.02 Thickness

Each core shall be measured for length prior to trimming. Four measurements rounded to the nearest millimetre shall be made around the perimeter of each core to determine the actual shotcrete thickness. These measurements shall be taken at the ends of two perpendicular diameters.

The thickness of hardened shotcrete shall be determined according to LS-410. The thickness of a subplot shall be considered acceptable when it meets the following requirements:

- a) The average of the three thickness measurements shall be minimum of 100 mm.
- b) No individual thickness measurement shall be less than 75 mm.

203.08.04.02.03 Compressive Strength

The 28-Day compressive strength shall be determined according to LS-410. The 28-Day compressive strength of a subplot shall be considered acceptable when it meets the following requirements:

- a) The average of the three 28-Day compressive strength tests shall be greater than or equal to 35 MPa.
- b) No individual compressive strength test shall be less than 4.0 MPa below the specified strength.

Sublots with an average compressive strength greater than or equal to 31 MPa and less than 35 MPa shall be considered unacceptable and may be permitted to remain in the Work with a payment adjustment, when the Owner is in agreement. The payment adjustment shall be calculated and applied according to the Basis of Payment section. Sublots with a compressive strength test result less than 31 MPa shall be removed and replaced.

203.08.04.02.04 Referee Testing

Referee testing for a subplot may only be invoked by the Contractor within 3 Business Days of receiving the test results for that subplot.

Referee testing of 28-Day compressive strength or thickness for a subplot shall be done on a new set of three cores removed by the Contractor within 24 hours of invoking the referee testing. Cores for referee testing for each disputed subplot shall be taken in the presence of the Contract Administrator at a location no more than 1 m from the location that each of the disputed acceptance cores were removed. The core size, and core extraction and timing of delivery to the referee laboratory shall be according to the Coring clause.

Referee testing shall be carried out according to the test method specified in the Acceptance Testing of Thickness and Compressive Strength of Rock Shotcrete clause.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor as they become available.

Referee testing of 28-Day compressive strength or thickness for a subplot shall be done on a new set of three cores removed by the Contractor within 24 hours of invoking the referee testing. Cores for referee testing for each disputed subplot shall be taken in the presence of the Contract Administrator at a location no more than 1 m from the location that each of the disputed acceptance cores were removed. The core size, and core extraction shall be according to the Coring clause.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of acceptance and payment for the shotcrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded and not used in the determination of acceptance and payment.

The confirmation value for confirming the compressive strength acceptance test result shall be the greater of 10% of the specified compressive strength, or 10% of the compressive strength acceptance cores, expressed to one decimal place.

The confirmation value for confirming the thickness acceptance test result shall be the greater of 10% of the specified thickness, or 10% of the thickness of the acceptance cores, expressed to the nearest millimetre.

The cost of referee testing shall be as specified in the Contract Documents. When the referee result confirms the acceptance test results, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

203.08.05 Acceptance of Compressive Strength of Grout

203.08.05.01 Lot Size

The lot size shall represent all the grout produced during one day of production.

203.08.05.02 Basis of Acceptance

The 7-Day and 28-Day compressive strength shall be determined according to CSA A23.2-1B. The 7-Day and 28-Day compressive strength of a lot shall be considered acceptable when it meets the minimum requirements of this specification.

Lots with a compressive strength less than the minimum requirements of this specification shall be removed and replaced.

203.08.05.03 Referee Testing

Referee testing for a lot may only be invoked by the Contractor within 3 Business Days of receiving the test results for that lot.

The referee testing process for grout compressive strength is based on duplicate grout cubes cast at the same time as the acceptance grout cubes.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor as they become available.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of acceptance and payment for the concrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded and not used in the determination of acceptance and payment.

The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance grout cubes, expressed to one decimal place.

The cost of referee testing shall be as specified in the Contract Documents. When the referee result confirms the acceptance test results, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

203.08.06 Sounding Acceptance Testing

The sounding acceptance testing shall consist of hammering at 300 mm centres and any areas of concern, to detect any hollow sounding or debonded areas.

Areas of shotcrete that are determined by the Contract Administrator to be inadequately bonded shall be removed and replaced.

203.08.07 Concrete Buttress

Acceptance of concrete buttress shall be according to OPSS 904.

203.09 MEASUREMENT FOR PAYMENT

203.09.01 Actual Measurement

203.09.01.01 Rock Bolting

For measurement purposes, a count shall be made by the Contract Administrator of the number of rock bolts installed.

203.09.01.02 Rock Shotcrete

Measurement shall be by area in square metres of shotcrete.

203.09.01.03 Rock Drains

For measurement purposes, a count shall be made by the Contract Administrator of the number of rock drains installed.

203.09.01.04 Concrete Buttress

Measurement shall be by volume in cubic metres of the reinforced concrete placed.

203.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

203.10 BASIS OF PAYMENT

**203.10.01 Rock Bolting - Item
Rock Shotcreting - Item
Rock Drains - Items
Concrete Buttress - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Replacement of unacceptable rock bolts and rock shotcreting shall be carried out at no additional cost to the Owner.

203.10.01.01 Payment Adjustment for Shotcrete

The payment adjustment factor (Pr_i) for the compressive strength of each shotcrete subplot will be calculated by the following equation:

$$Pr_i = 1.0 - (0.525 - 0.015S)$$

Where:

S = The average 28-Day compressive strength (MPa) for each shotcrete subplot. (For the purpose of calculating the payment adjustment for shotcrete, a value of 35 MPa shall be used for “S” when the average compressive strength is greater than or equal to 35 MPa.)

The payment adjustment factor for the lot (Pr) is calculated by the following equation:

$$Pr = \frac{(Pr_1 \times LQ_1) + (Pr_2 \times LQ_2) \cdots (Pr_n \times LQ_n)}{(LQ_1 + LQ_2 \cdots LQ_n)}$$

Where:

Pr_i = Payment adjustment factor for subplot i.

LQ_i = Quantity of subplot i (m³)

n = The total number of sublots.

The total payment adjustment (Pa) for the lot is calculated by the equation:

$$Pa = \text{Quantity} \times \text{Tender Unit Price} \times Pr$$



CONSTRUCTION SPECIFICATION FOR GRADING

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206.01 SCOPE

This specification covers the requirements for grading, including earth and rock excavation and embankment construction, rock face, and the management of excavated materials.

206.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

206.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

206.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 209	Embankments Over Swamps and Compressible Soils
OPSS 212	Earth Borrow
OPSS 501	Compacting
OPSS 802	Topsoil
OPSS 804	Seed and Cover

Ontario Provincial Standard Specifications, Materials

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade and Backfill Material

Ontario Ministry of Transportation Publications

MTO Form:	
PH-CC-820	Certification of Grade Elevation - Crossfall

206.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Angle of Repose means the maximum angle measured from the horizontal at which fill remains stable.

Backslope means the slope in a cut between the invert of the roadside ditch and the point where the slope intersects original ground.

Benching means the keying into existing slopes by excavating horizontal planes. Benching also means the stepping of cut slopes at intermediate levels in deep cuts.

Berm means an extension of an embankment constructed to a lower height and designed to provide road embankment stability.

Bulking Factor means the ratio of the volume of rock material following excavation, placement, and compacting to the original in situ volume of the same material. The bulking factor for rock shall be 1.35. For rock excavation quantities identified as shatter, the bulking factor shall be 0.35.

Cushion Blasting means the placing of a single row of lightly-loaded closely-spaced holes along the excavation limits as specified in the Contract Documents and firing them coincident with the main excavation blast as the last delay sequence to remove rock inside the cut limits.

Ditching means the excavation in earth or rock for all water courses. The term shall include roadside ditches, all excavation lying beyond the end of drainage structures, and stream and watercourse diversions and corrections.

Earth means all soils, except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials.

Embankment means the material placed within the sideslopes; below the top of subgrade; and above the original ground, excavated base, or theoretical bottom, as applicable, to the limits as specified in the Contract Documents. Widening, flattening, or other placement of material adjacent to or on top of sideslopes beyond that specified in the Contract Documents is excluded.

Existing Rock Surface means either the rock surface that is exposed at ground level prior to the beginning of the Contract or the rock surface that is exposed after the overburden above it has been removed during the Contract.

Frontslope means the slope in a cut section between the edge of shoulder and the invert of the roadside ditch.

Grubbing means the removal of all stumps, roots, embedded logs, debris, and secondary growth.

Line Drilling means the placing of a single row of very closely-spaced holes without explosives along the rock excavation limits as specified in the Contract Documents.

Mucking means the picking up of broken rock prior to haulage.

Overbreak means any broken, displaced, or loosened rock that originates outside the designated rock excavation limits as specified in the Contract Documents, regardless of whether that rock has been excavated, displaced, or loosened due to the inherent character of the rock formation itself or due to any other cause.

Pre-Shearing means the placing of a single row of closely-spaced lightly-loaded holes along the rock excavation limits as specified in the Contract Documents that are fired simultaneously before and independently of the main excavation blast. Pre-shearing is sometimes referred to as pre-splitting.

Reclaimed Asphalt Pavement (RAP) means the processed hot mix asphalt material that is recovered by partial or full depth removal.

Reclaimed Concrete Material (RCM) means removed or processed old Portland cement concrete.

Roadside Ditch means a ditch with one of its slopes coincident with the road frontslope.

Rock means natural beds or massive fragments of the hard, stable, cemented part of the earth's crust, either igneous, metamorphic, or sedimentary in origin, that may or may not be weathered and includes boulders having a volume of 1 m³ or greater.

Rock Face means the uniform, relatively planar, maintenance-free, vertical or near vertical rock surface between the top of the existing rock surface and the designated rock or ditch grade line that is generally characterized by noticeable drill hole traces and a minimum of blast-induced fractures beyond the rock excavation limits.

Rock Surplus means the rock excavation original tender quantity multiplied by the bulking factor, plus the volume of rock material excavated from all other items as specified in the Contract Documents, minus the rock embankment original tender quantity. Rock overbreak and rock materials resulting from scaling are specifically excluded.

Scaling means the removal of loose, broken, or overhanging rock fragments from an existing rock surface or the removal of loose, broken, or overhanging rock fragments from a rock face that remain in place after the rock has been blasted and mucked.

Shale means a fine-grained, low strength, sedimentary rock that undergoes rapid deterioration on exposure.

Shatter means fractured rock broken by the use of explosives or mechanical means and left in place.

Sideslope means the slope in a fill between the edge of shoulder and the point where the slope intersects original ground.

Spall means a rock fragment, chip, or splinter from a rock surface created by weathering, stress relief, blasting, or a combination thereof.

Stripping means the excavation of the upper layer of soil, that is predominantly organic, too soft, or wet and otherwise unsuitable for the construction of embankments that is done prior to and usually independent of earth excavation or the placement of fill materials or both.

Tolerance means a construction working tolerance only that is considered to be:

a) Minus when it is:

- i. narrower than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
- ii. lower in elevation than the Contract standard when pertaining to vertical dimensions.

b) Plus when it is:

- i. wider than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
- ii. higher in elevation than the Contract standard when pertaining to vertical dimensions.

Wall Control Blasting means a blasting method using carefully-spaced and aligned drill holes intended to produce a relatively flat, maintenance-free, rock surface or rock face as specified in the Contract Documents. Wall control blasting techniques are cushion blasting, line drilling, and pre-shearing.

206.04 DESIGN AND SUBMISSION REQUIREMENTS

206.04.01 Submission Requirements

206.04.01.01 Rock Material Management Plan (RMMP)

For each construction stage, the following information shall be submitted to the Contract Administrator a minimum of 5 Business Days prior to undertaking the work of rock excavation or rock embankment:

- a) A plan for rock excavation corresponding to the station intervals as specified in the Contract Documents. The plan shall identify the volume in cubic metres of the following:
 - i. In-situ rock prior to blasting with shatter quantity shown separately.
 - ii. Excavated rock available calculated by applying the bulking factor to the quantity of in-situ rock prior to blasting, less the quantity of shatter.
 - iii. Excavated rock to be placed in rock embankment.
 - iv. Excavated rock within the Contract limits to be processed into granular material or other aggregates as specified in the Contract Documents.
 - v. Excavated rock to be used for other purposes in completing the Work, such as rock protection, rip rap, or river stone and the types and locations of that Work.
 - vi. Excavated rock not incorporated into the Work and the locations and uses of that material.
- b) A plan for the construction of rock embankments that identifies each location and volume in cubic metres where the material is going to be supplied to the corresponding station intervals as specified in the Contract Documents.
- c) The locations and volume in cubic metres for the sources where rock materials are obtained for the rock supply item.
- d) The location and volume in cubic metres for each source when additional rock or granular material or both are required to complete the Work.
- e) The amount of rock surplus, if any, during the applicable construction stage.

The Contractor shall be solely responsible for the assumptions and the reasonableness of the RMMP.

In addition, for each construction stage, on a monthly basis, an updated RMMP shall be submitted to the Contract Administrator which shall include an ongoing tabulation of all rock materials that have been removed by the Contractor from the rock excavation or not incorporated in embankments, shown as a cumulative reduction in rock surplus.

The work of rock excavation or rock embankment shall not commence until the RMMP in accordance with the above requirements is submitted.

206.04.01.02 Trial Section for Modified Layer Compaction Method

If the Contractor wishes to request to use the modified layer compaction method as specified in the Modified Layer Compaction Method clause, a detailed plan shall then be submitted in writing to the Contract Administrator a minimum of 48 hours prior to commencing any work on the required trial section. The plan shall include full details of the placing of material and its compaction, including layer thickness; number and type of compaction units and number of passes.

206.06 EQUIPMENT

206.06.01 Tractor Bulldozer - Crawler Type for Rock Embankment Construction

Tractor bulldozer, crawler type for rock embankment construction required in the General clause of the Rock Embankments clause shall have a minimum net flywheel power of 200 kW.

206.06.02 Rollers for Shale Embankment Construction

Sheepsfoot, packall, padfoot, or tamping foot rollers required for the construction of shale embankments shall weigh a minimum of 18 tonnes and vibratory steel drum or pneumatic-tired rollers shall weigh a minimum of 9 tonnes.

206.07 CONSTRUCTION

206.07.01 General

206.07.01.01 Removal of Ice, Snow, and Frozen Ground

The Contractor shall remove and dispose of all ice, snow, and frozen material from all earth, rock, or granular surfaces prior to placing fill and from all earth, rock, or granular materials being used for backfill, embankments, or any other construction purposes.

206.07.01.02 Compaction

Earth and granular materials shall be compacted according to OPSS 501.

For compaction purposes, reclaimed asphalt pavement (RAP) or reclaimed concrete material (RCM) or both shall be treated as earth or rock when such material is respectively included in an earth embankment or a rock embankment.

206.07.01.03 Earth Borrow

When earth borrow is specified in the Contract Documents, it shall be according to OPSS 212.

206.07.01.04 Tolerances - General

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

206.07.01.04.01 Tolerances for Earth

Upon completion, all earth grade surfaces, excluding swamp excavations, shall be shaped to the grades and cross-sections as specified in the Contract Documents within the following tolerances:

a) Vertical grading tolerances for the finished earth subgrade within the limit of the roadway:

+ 30 mm
- 30 mm

b) Horizontal grading tolerances for the vertical faces of excavations to be backfilled:

+ 100 mm
- 0 mm

- c) Horizontal grading tolerances for ditch slopes, excluding roadside ditches:

+ 300 mm
- 0 mm

Sideslopes beyond the plus tolerance may be accepted by the Contract Administrator when they are not detrimental to the work.

- d) Vertical grading tolerances for all ditching in earth:

+ 30 mm
- 30 mm

- e) Horizontal grading tolerances for the backslopes in earth cut sections:

+ 300 mm
- 300 mm

Backslopes beyond the plus tolerance may be accepted by the Contract Administrator when they are not detrimental to the work.

- f) Horizontal grading tolerances for each sideslope in earth embankment construction:

+ 300 mm
- 0 mm

- g) Horizontal grading tolerances for roadside ditch frontslopes in earth cut sections:

+ 30 mm
- 0 mm

Irrespective of compliance with the above tolerances, the completed slopes shall present a uniform appearance.

206.07.01.04.02 Tolerances for Rock

Completed rock grade surfaces shall be shaped to the grades and cross-sections as specified in the Contract Documents within the following tolerances:

- a) Vertical grading tolerances for the finished rock subgrade within the limits of the roadway:

For cut sections:

+ 30 mm
- 100 mm

For fill sections:

+ 30 mm
- 75 mm

Excavation below the minus tolerances may be accepted by the Contract Administrator when it is not detrimental to the work and is brought up to grade as specified in the Rock Excavation, Grading clause.

- b) Horizontal grading tolerances for vertical rock face cut limits:

+ 0 mm
- 300 mm

Final faces beyond the plus tolerance may be accepted by the Contract Administrator when they are not detrimental to the work.

- c) Horizontal grading tolerances for sloped rock face cut limits:

+ 300 mm
- 300 mm

- d) Horizontal grading tolerances for ditch slopes, excluding roadside ditches:

+ 300 mm
- 0 mm

Excavation beyond the plus tolerance may be accepted by the Contract Administrator when the Owner deems it is not detrimental to the work or contribute to additional rock surplus.

- e) Vertical grading tolerances for all ditching in rock cuts:

+ 30 mm
- 30 mm

Excavation below the minus tolerance may be accepted by the Contract Administrator when it is not detrimental to the work.

- f) Horizontal grading tolerances at the top of each sideslope of rock embankment construction:

+ 300 mm
- 0 mm

206.07.02 Drainage

Excavation operations shall be performed in a manner to avoid water saturation of embankment material and roadway foundation material and to avoid leaving undrained pockets in excavations by providing effective drainage during all stages of the work.

In excavations below subgrade and in stripping operations when provision for surface drainage is impractical, backfill materials shall be placed as soon as possible following the excavation work.

Ditching required to provide for drainage of an embankment shall be completed in advance of the embankment construction. Ditches in roadway cuts shall be constructed as soon as possible to provide drainage from the cuts. Ditches located above and beyond roadway cuts shall be constructed prior to excavating adjacent cuts. When pipe subdrains are required in the bases of roadway cuts, such work shall be carried out at the time that the roadside ditches are being constructed.

206.07.03 Excavation and Grading

206.07.03.01 Earth Excavation - Grading

206.07.03.01.01 General

The work shall include excavating, hauling, handling and placing, shaping, compacting, trimming of earth material, applying temporary cover, and the management of excavated and excess materials as specified in the Contract Documents.

The work shall also include the excavation and removal of pipes and culverts smaller than 200 mm in diameter and expanded polystyrene insulation when located within the limits of the earth excavation, grading work.

Suitable and non-excess earth material excavated from roadway cuts, ditching, and other associated sites shall be used in earth grading and embankment construction, unless otherwise specified in the Contract Documents.

206.07.03.01.02 Stripping

Except when swamp treatment is required, the original ground shall be stripped at the locations and to the depths specified elsewhere in the Contract Documents.

Material meeting the requirements of topsoil according to OPSS 802 that is required for re-use shall be stockpiled as specified in the Contract Documents. Other material obtained from stripping shall be managed as specified in the Management of Excavated Materials clause.

206.07.03.01.03 Excavation Below Subgrade

Unsuitable materials, other than material excavated from swamps, shall be removed below the subgrade to the lengths, widths, and depths as specified in the Contract Documents. The resulting excavation shall be backfilled with material acceptable to the Contract Administrator and compacted according to OPSS 501.

206.07.03.01.04 Swamp Excavation

Swamp excavation shall be according to OPSS 209.

206.07.03.01.05 Backfilling of Overexcavated Areas

When overexcavation occurs, the overexcavated area shall be backfilled with granular material according to OPSS 1010 and compacted according to OPSS 501 at no additional cost the Owner. With the exception of frontslopes and when boulders are encountered in the excavated slopes, backfilling shall not be permitted to obtain the required slopes for excavations.

When boulders are encountered in the excavated slopes, the boulders shall be removed at the direction of the Contract Administrator and the resulting cavity or cavities shall be backfilled with properly-compacted granular material according to OPSS 1010.

206.07.03.02 Rock Excavation - General

Except where shatter is required, drilling shall not be performed outside of or extend beyond the design excavation limits as specified in the Contract Documents.

The use of explosives for rock excavation shall be as specified in the Contract Documents.

All excavated rock, including rock materials resulting from overbreak and scaling, except the quantity of rock surplus, shall be placed in embankments.

Any excavated rock remaining after constructing the embankments shall be managed as specified in the Management of Excavated Materials clause.

206.07.03.02.01 Rock Excavation - Grading

The work shall include drilling and blasting to obtain the required rock excavation and shatter, mucking, and bringing to grade any overexcavation. Hauling shall only be part of the work when the excavated material is part of the rock surplus or is in excess of the rock embankment requirements.

When rock is to be excavated, all overlying stumps, roots, and vegetation shall be managed as excess material as specified in the Contract Documents. When earth overlies the rock to be excavated, the earth shall be removed. This work shall be performed sufficiently in advance of any blasting or rock excavation operations to allow rock cross-sections to be taken.

Scaling shall be carried out during mucking. All rock fragments or boulders either within or outside the excavated areas that are likely to slide or roll down rock cuts or are otherwise deemed to be unstable by the Contract Administrator shall be removed. Cut ditches shall be excavated at the same time as the main excavation.

Excavation below grade in rock cuts shall be brought to grade within the specified tolerances with rock shatter or other approved material at no additional cost to the Owner.

Rock in roadway cuts shall be shattered to a uniform minimum depth of 300 mm below the theoretical rock subgrade for the full width of the cut, including the ditch.

Rock scaling and the removing of all overbreak and scaled materials shall be included in the rock excavation, grading item, unless a rock face item is included in the Contract Documents.

206.07.03.02.01.01 Shale

Shale shall be excavated using methods appropriate for the site conditions. Side slopes in shale shall be as specified in the Contract Documents. Rock face and subgrade shatter are not required in shale.

206.07.03.02.02 Rock Face

The work shall include drilling and blasting using one or more wall control blasting techniques to produce the rock face required in the Contract Documents and all associated scaling, mucking, hauling and management of all overbreak and scaled rock as specified in the Management of Excavated Materials clause.

The Contractor shall decide the required spacing, diameter, and loading of all drill holes for wall control blasting in order to ensure a uniform shear face between the holes and to meet the tolerance requirements stated in the Tolerances for Rock clause for rock face. In no case shall the diameter and spacing of these holes be more than 100 mm and 0.75 m centre-to-centre, respectively,

The Contractor shall also decide the required spacing, diameter, and loading of the adjacent line of production drill holes located inside the controlled blasting limits in order to ensure that wall control blasting is able to produce the required rock face.

However, in no case shall any portion of a production drill hole be within 0.75 m of the line formed by the drill holes for wall control blasting.

206.07.03.03 Excavation for Widening

Excavation that is adjacent to the travelled portion of the roadway shall at no time be in advance of the backfilling operation by a distance greater than the limits as specified in the Contract Documents. Any such excavation shall be backfilled and compacted with material as specified in the Contract Documents, prior to closing down operations each day.

206.07.03.04 Excavation for Pavement Widening

The work shall include excavating a trench adjacent to the existing pavement to the widths and depths as specified in the Contract Documents. Excavated material shall be spread on the adjacent shoulders and slopes.

206.07.03.05 Management of Excavated Materials

Excavated materials shall be used within the Contract limits as specified in the Contract Documents.

When the Contract Administrator has deemed that the Contractor's sequence of operations, inadequate drainage measures, or handling processes or all have caused earth materials that were identified in the Contract Documents as being suitable for embankment or other construction purposes to become unsuitable for such purposes then, at no additional cost to the Owner, the Contractor shall either condition that material until it is suitable or manage it as excess material as specified in the Contract Documents and, if necessary, replace it with an equivalent volume of earth borrow. When the Contractor's operations have caused the material to become unsuitable due to excessive moisture content, conditioning may then involve re-working the material as necessary or spreading out the material in layers or both so that the material is thin enough to allow it to sufficiently dry out.

Quantities of unsuitable earth as specified in the Contract Documents and deemed suitable for use by the Contract Administrator at the time of excavation shall be used to offset borrow quantities.

Rock excavated from within the right-of-way (ROW) may be used for aggregate production up to the rock surplus quantity.

Earth or rock that is surplus to embankment requirements may be placed adjacent to the embankments by widening embankments, flattening side slopes, or constructing berms if optional cross sections or locations or both have been specified for such material in the Contract Documents or as requested by the Contractor and agreed to, in writing, by the Contract Administrator.

Surplus material may only be used within the Contract limits with the written consent of the Contract Administrator.

Surplus materials that cannot be accommodated as above and unsuitable materials shall be managed as excess material as specified in the Contract Documents.

206.07.03.06 Provision for Temporary Cover

Cover used in temporary applications shall be applied according to OPSS 804 to areas as specified in the Contract Documents.

206.07.04 Rock Supply

The work shall include any required clearing, grubbing, and stripping of the source; construction and maintenance of access roads; excavating and hauling of rock materials, regardless of whether the hauling is to the Contract limits or for rock surplus; and source rehabilitation.

The rock surplus quantity, if any, is an entitlement of the Contractor. Excavated rock may be removed for the Contractor's purposes or disposed of as the Contractor deems appropriate up to the rock surplus quantity as the staging of the work allows. All materials removed from rock excavation and not placed in rock embankment shall be deemed to be removed as part of the Contractor's rock surplus quantity.

All materials removed as part of the rock surplus quantity shall be accurately measured as specified in the Measurement of Rock Surplus clause and recorded by the Contractor at no additional cost to the Owner. Whenever such measurements are to be taken, the Contractor shall inform the Contract Administrator at least 1 Business Day in advance of such measurements.

All weighing of materials shall be as specified in the Contract Documents.

Within 7 Business Days of the Contractor taking a set of measurements, the Contractor shall:

- a) Provide the Contract Administrator with a copy of those measurements and the calculations based on those measurements.
- b) Advise the Contract Administrator, in writing, that the locations where the measurements were taken are ready for verification.

In the event that the Contract Administrator chooses to verify those measurements, such verification shall be undertaken within 3 Business Days of the Contract Administrator being advised that the locations are ready for verification and for those 3 Days, the Contractor shall not:

- a) Place rock on or remove rock materials, as the case may be, from the measured locations; or
- b) Impede the Contract Administrator in any way during the verification of those measurements.

206.07.04.01 Measurement of Rock Surplus

Rock removed as part of the rock surplus quantity shall be measured by the Contractor and verified by the Contract Administrator as specified in the Rock Supply subsection using one or more of the following 4 methods given below:

- a) Weighed Aggregate Production Quantity

All locations to be used for stockpiling processed aggregates shall be identified in writing to the Contract Administrator no less than 3 Business Days prior to production.

At each stockpile location, the Contractor shall complete an accurate survey of the initial ground elevations subject to verification by the Contract Administrator prior to any materials, including materials used for a granular pad, are placed at that location.

All aggregate materials removed from each stockpile within the Contract limits shall be weighed by the Contractor for reconciliation with the rock surplus quantity by converting the mass to a bulked broken rock volume using a factor of 0.519 m³/tonne.

Once all of the aggregates have been removed, each stockpile shall be re-surveyed by the Contractor, the measurements verified by the Contract Administrator, and the volume of material remaining determined by the Contractor.

Quantities of rock used for aggregate production and quantities of materials remaining in aggregate stockpiles shall be deducted from the rock surplus quantity.

Any materials that are added to an aggregate production stockpile within the Contract limits that do not come from rock that was excavated on the Contract shall be weighed by the Contractor and subtracted from the weighed aggregate quantity provided. If such materials are not weighed or the Contract Administrator was not given sufficient notice or opportunity by the Contractor to verify the weight of those materials, then no deduction shall be made for those materials.

b) Stockpile Volume

Excavated rock forming part of the rock surplus may be measured in stockpiles constructed by the Contractor. The Contractor shall inform the Contract Administrator, in writing, of the location where each stockpile is to be established a minimum of 3 Business Days prior to commencing any work at that stockpile location. Disposal sites shall be treated as stockpiles.

At each stockpile location, the Contractor shall complete an accurate survey of the initial ground elevations and allow the Contract Administrator to verify those measurements prior to any rock materials are placed at that location.

Once the stockpile has been completed, the stockpile shall then be resurveyed by the Contractor, the measurements verified by the Contract Administrator, and the final volume determined by the Contractor. The Contractor shall not remove any rock material from any such stockpile prior to completion of its final survey and verification by the Contract Administrator.

With the exception of excavated rock placed in rock embankment, the quantity of all other excavated rock placed within the Contract limits (e.g., for widening of pre-existing embankments, construction of access roads, crane bases, etc.) shall be measured in the same manner as the stockpiles described above. Such quantities shall be deducted from the rock surplus quantity.

At the request of the Contract Administrator, the Contractor may be required to conduct backhoe or other subsurface investigations in the Contract Administrator's presence to determine if compressible soils are present at the Contractor's proposed stockpile locations. Backfilling of such investigated areas shall be carried out using properly-compacted material acceptable to the Contract Administrator.

If the Contractor Administrator deems that compressible soils are present, the Contractor shall then re-locate the proposed stockpile or the Contractor shall install monitoring devices at the affected location. Each monitoring device shall consist of a circular 1.0 m diameter 6 mm thick steel plate with a 3.0 m length of 50 mm diameter steel pipe securely welded vertically to the centre of the plate. Whenever the level of rock placement surrounding the monitoring device is vertically within 300 mm of the top of a monitoring device, successive 3.0 m lengths of 50 mm diameter steel pipe shall be welded to the top of that device. The length of each new section shall be added to the original elevation. The Contractor shall be paid to supply and place each monitoring device as specified in the Contract Documents. Any monitoring devices damaged during placement of materials shall be replaced at no additional cost to the Owner.

The Contractor shall survey the top of each monitoring device prior to rock material placement. The Contractor shall resurvey the top of each monitoring device when the placement of rock materials is complete. Both sets of measurements shall be verified by the Contract Administrator. If the difference in elevation between the two surveys is greater than 300 mm, the initial ground elevations for this location shall then be lowered universally by the difference in monitoring device elevation. When more than one monitoring device is placed at a given location, the differences in elevations shall be averaged together.

The Contractor shall ensure that the Contract Administrator has free and unencumbered access to any location where excavated rock is being placed.

c) Weighed Broken Rock

Excavated rock forming part of the rock surplus quantity shall be weighed by the Contractor prior to exiting the Contract limits. The Contract Administrator shall be informed, in writing, at least 2 Business Days in advance that such rock materials are to be weighed as rock surplus, the specific locations where the broken rock material is to be obtained, and the locations where it is to be placed.

Excavated rock weighed as part of the rock surplus shall be converted to a bulked broken rock volume using a factor of 0.519 m³/tonne.

d) In-situ Measure of Distinct Rock Cut

Excavated rock from distinct rock cut locations may be removed as part of the rock surplus specified in the Contractor's RMMP. A distinct rock cut location shall be one that begins with and ends at points of zero rock excavation. The excavated rock shall be used in its entirety as rock surplus material from distinct rock cuts and shall not be split between Contract rock embankment requirements and the rock surplus quantity. This quantity shall be the quantity of the distinct rock cut in cubic meters, multiplied by the bulking factor.

206.07.05 Embankments

Only materials that are specified in the Contract Documents for use in embankments shall be used, unless approved by the Owner, in writing, prior to placement.

Materials shall not be placed over either frozen earth or ice surfaces. Ice, frozen earth, or other unsuitable materials shall not be incorporated into embankments.

RAP materials used in embankments shall be surplus to the recycling requirements of the Contract.

The Contractor shall notify the Contract Administrator, in writing, when an embankment has been completed to the dimensions that are as specified in the Contract Documents, at least 3 Business Days prior to the Contractor places any topsoil or any other material on the embankment slopes.

206.07.05.01 Earth Embankments

206.07.05.01.01 General

Material for earth embankments shall be deposited and spread in uniform layers for the full width of the embankment, except as otherwise permitted for berms. Each layer shall be compacted prior to the succeeding layer is placed. The lower portion of side hill or sloping sections shall be similarly constructed in layers and compacted until the full width surface of the specified cross-section is obtained. The embankment shall be completed thereafter with full width layers or as staged construction allows.

The construction of a core through the embankment and the subsequent completion of the embankment are prohibited, except when core construction is permitted in swamps according to OPSS 209.

Boulders, cobbles, and fragments of rock, RAP, and RCM over 150 mm in their maximum dimension shall not be placed within 300 mm of the surface of the earth grade.

Boulders, cobbles, and fragments of rock, RAP, and RCM up to 0.5 m³ may be incorporated into an earth embankment provided:

- a) They are placed only in the bottom layer of the embankment.
- b) The maximum dimension of the largest particle shall not exceed 800 mm.

- c) They are not located within 300 mm of the final embankment side slopes.
- d) They are not located within 1.0 m of the surface of the earth grade.

Topsoil placed on earth embankments shall be according to OPSS 802.

Berms may be constructed separately, but shall be completed prior to the road embankment is built to a higher level than the berm.

Any excavation necessary for establishing compaction results throughout any embankment or any trial areas such as the one described in the Modified Layer Compaction Method clause shall be done by hand and the excavated areas shall be backfilled with the same material or material otherwise acceptable to the Contract Administrator and properly re-compacted by the Contractor.

206.07.05.01.02 Layer Compaction Method

Earth embankments shall be built using the layer compaction method, unless otherwise specified in the Contract Documents or the requirements specified in the Modified Layer Compaction Method clause have been met.

In the layer compaction method, the embankment material shall be spread out in uniform full width layers not more than 300 mm in depth prior to compaction. Each layer shall be shaped and compacted to the line and cross-section as specified in the Contract Documents prior to the succeeding layer is placed.

All boulders, cobbles, fragments of rock, RAP, and RCM shall have a maximum vertical dimension after placement, not greater than the fully compacted layer depth.

When the ground cannot support construction equipment using this method then, at the discretion of the Contract Administrator, the first layer may be increased in thickness as specified in the Modified Layer Compaction Method clause.

206.07.05.01.03 Modified Layer Compaction Method

The modified layer compaction method may be used if the Contract Administrator deems that it is practical to construct an earth embankment or a portion of an earth embankment in thicker lifts than that specified in the Layer Compaction Method clause.

In this case, the embankment material shall be spread out in uniform full width layers not more than 600 mm in depth prior to compaction. Each layer shall be shaped and compacted to the line and cross-section specified prior to the succeeding layer is placed.

All boulders, cobbles, and fragments of rock shall have a maximum vertical dimension when placed not exceeding the modified layer depth. All RAP and RCM shall have a maximum vertical dimension after placement not exceeding 300 mm.

Prior to placing any material, the Contractor shall provide proof to the Contract Administrator of the ability of the proposed method to achieve the specified density by means of a trial section consisting of a single uniform lift covering a minimum area of 400 m² as specified in the Trial Section for Modified Layer Compaction Method clause. The location and extent of the trial section shall be acceptable to the Contract Administrator.

When it has been successfully demonstrated to the Contract Administrator that compaction can be achieved throughout the entire lift based on the acceptance requirements for a control strip specified in OPSS 501, the procedure that the Contractor used shall then be permitted for the remainder of the work to which it is applicable. Any excavation, backfilling, and re-compaction necessary for establishing the compaction results within the trial section shall be carried out by the Contractor.

If at any time, test results show that the permitted procedure is no longer producing the required degree of compaction, a new trial section shall then be constructed. In this case, the Contractor shall propose changes in the procedure to satisfy the requirements of this specification. Such changes shall be proposed in writing to the Contract Administrator prior to commencing work on the new trial area. Otherwise, the Contractor shall revert back to the layer compaction method as specified in the Layer Compaction Method clause.

206.07.05.02 Rock Embankments

206.07.05.02.01 General

The work shall include hauling, placement, and compaction of excavated rock.

Excavated rock used to construct rock embankments shall be obtained from within the Contract limits. If there is insufficient material to complete the rock embankments, the additional material shall then be provided and paid for under the rock supply item.

All rock from other items as specified in Contract Documents shall be used to construct rock embankments.

Rock embankments shall be constructed by placing embankment materials full width in successive uniform layers.

For rock embankments other than shale, the layers shall not exceed 1.5 m thickness prior to compaction. Material in each layer shall be fully compacted prior to the succeeding layer is placed. Each rock fill layer shall be compacted with a tractor bulldozer, crawler type as specified in the Tractor Bulldozer - Crawler Type for Rock Embankment Construction subsection. The minimum number of complete passes shall be 6 and the maximum number of passes shall be 8. A complete pass shall be defined as 100% coverage of the layer surface. The maximum speed of the equipment during each pass shall be 3.2 km/h.

For all rock embankments, materials shall be placed in their final position by blading. End dumping or depositing of rock over the end of any layer by hauling equipment is not permitted, except as otherwise noted below. Each layer shall be levelled in place and compacted to minimize voids and bridging of large rock fragments within the embankment.

Rock fragments exceeding a maximum of 1.0 m in any dimension shall be well distributed throughout the embankment. Rock fragments up to a maximum of 3.0 m in any dimension may be incorporated into the embankment, provided that the rock fragments are less than two-thirds the remaining embankment height when measured from the bottom of the oversized rock fragment at the point of placement to the top of the rock embankment, and shall be sufficiently spaced to allow free access of the specified equipment to compact the intervening fill.

Placement and compaction in layers is not required when rock is placed under water. In this case, end dumping may be used. However, end dumping shall only be used to an elevation of 1.0 m above the water level that is present at the time of placement. After that, the rock embankment shall be constructed using the equipment and method specified in the paragraphs above. The materials shall be well distributed to form a solid embankment constructed to full width as the work progresses or as staged construction allows.

When a rock embankment is constructed in a wet area such as swamps with full, partial, or no excavation, the direction of the rock placement shall be so that mud waves generated by the rock placement are able to move away from the embankment. Mud waves shall be displaced or removed to prevent their entrapment below or within the embankment.

End dumping from the top of the embankments may also be carried out at locations as specified in the Contract Documents when narrow and relatively shallow widening of an existing embankment is required for the shoulder portion of the highway.

The top surface of the embankment shall be chinked with rock fragments and spalls to form the subgrade prior to the placement of the roadway subbase in order to minimize voids and prevent migration of the subbase material into the rock fill.

Care shall be taken to avoid large boulders and rock fragments protruding above the average embankment surface within a distance of 3 m beyond the edge of shoulder.

With the written approval of the Contract Administrator, dumping of surplus rock over the sides of rock embankments by the Contractor is permitted as follows:

- a) After the rock embankments have been completed to the grades and tolerances specified in the Contract Documents and all such measurements have been verified by the Contract Administrator.
- b) Only in areas that do not affect features that are located within the right-of-way (e.g., ditches, culverts, and signs) or the right-of-way limits and shall not detrimentally affect stability or drainage or cause other potentially negative impacts.
- c) At the direction of the Owner.

206.07.05.02.02 Shale Embankments

Shale embankment materials shall be deposited and spread in uniform layers for the full width of the embankment. Layers shall not exceed 450 mm in thickness prior to compaction. When a harder, more durable rock (e.g., limestone) is present as an integral part of a shale formation, no pieces shall be placed in the embankment that after placement are greater than 150 mm measured vertically or greater than 600 mm measured parallel to the embankment layers, respectively.

Compaction of each layer shall be in two stages using equipment specified in the Rollers for Shale Embankment Construction subsection. In the first stage, a minimum of 2 passes shall be made with a static sheepsfoot, packall, padfoot, or tamping foot type roller. In the second stage, a minimum of 2 passes shall be made with a vibratory steel drum or pneumatic-tired roller. The maximum speed of rollers shall not exceed 5 km/hr.

206.07.06 Rock Backfill to Structure

When rock backfill to structures is specified, the rock backfill shall only be comprised of rock fragments no larger than 250 mm in their greatest dimension and free of all debris, earth, topsoil, wood, chemical, or other contamination.

Rock backfill shall be placed in a manner that the structure is not damaged. Dumping of rock backfill against a structure shall not be permitted.

206.07.07 Quality Control

206.07.07.01 Grade Checks

The Contractor shall be responsible for carrying out all quality control (QC) grade checks to ensure that horizontal and vertical grading tolerances are met.

A competent survey crew shall carry out grade checks on all finished earth and rock grade surfaces. QC of earth and rock grade surfaces shall be based on horizontal and vertical grading tolerances as specified in the Tolerances for Earth and Tolerances for Rock clauses, respectively. The grade shall be certified at the stations and offsets shown in the grading templates or where grading templates are not available, at the frequency requirements specified for the layout elsewhere in the Contract Documents.

206.07.07.01.01 Submission of Grade Checks

The Contractor shall submit all grade checks relating to horizontal and vertical grading tolerances, including all non-compliances, to the Contract Administrator within 2 Business Days following completion of the grade.

When grading templates are available, the Contractor shall sign and certify on the grading template that the components of the work indicated on that template have been correctly constructed to the specified line and grade tolerances. If a template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 to the Contract Administrator.

206.07.07.02 Compaction Quality Control

The Contractor shall use Method B according to OPSS 501 for quality control of compaction.

206.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

206.08 QUALITY ASSURANCE

206.08.01 Grade Checks

The Owner may conduct random QA grade checks to verify horizontal and vertical grading tolerances.

Provided that the Owner's grade checks conform to those determined by the Contractor, no action shall be taken. If discrepancies between QA and QC grade checks occur, the Owner may then conduct additional QA grade checks at the Owner's discretion.

If the finished grade or cross-section is found to be outside the specification limits specified in the Tolerances - General clause, then:

- a) The Contract Administrator shall notify the Contractor.
- b) The Contractor shall be charged for each station where the finished grade is outside of the specification limits, at the rate specified in the Finished Grade Checks Outside Specification Limits subsection.
- c) The Contractor shall then bring the earth or rock grade surface to within the specified tolerances for grade, at no additional cost to the Owner.

206.09 MEASUREMENT FOR PAYMENT

206.09.01 Actual Measurement

206.09.01.01 Earth Excavation, Grading

Measurement for earth excavation, grading shall be the in-place volume of earth in cubic metres computed from field measurements of cross-sections taken both prior to grubbing and upon completion of the work.

When benching is required to key-in new fills into existing slopes, the quantity of materials that are excavated as part of that operation shall not be included in the measurement for payment.

206.09.01.01.01 Overbuilding, Earth

When the Contract requires earth borrow, the quantity of material placed beyond the earth grading tolerances shall be deducted from the measured quantity of earth borrow on a cubic metre for cubic metre basis, with no correction for changes in the density of the material.

206.09.01.02 Excavation for Pavement Widening

Measurement of excavation for pavement widening shall be the horizontal length in metres along each edge of the existing pavement when widening is specified in the Contract Documents.

206.09.01.03 Rock Excavation, Grading

206.09.01.03.01 General

Measurement of rock excavation, grading shall be the in-place volume in cubic metres computed from field measurements of cross-sections bounded by the original rock line after the earth overburden has been removed and the theoretical rock face and the bottom excavation limits designated in the Contract Documents. Where shatter is specified, the bottom of the cut shall be 300 mm below the designated rock grade.

The quantity of rock excavation shall also include:

- a) All shatter that is specified in the Contract Documents.
- b) Any rock that is excavated beyond the limits that are as specified in the Contract Documents at the Contract Administrator's written instructions.

206.09.01.03.02 Overbuilding, Rock

When the Contract has a rock supply item, the quantity of excavated rock placed beyond the rock grading tolerance at the top of subgrade and beyond the angle of repose for rock fills shall be deducted from the rock surplus quantity on a cubic metre for cubic metre basis with no correction for changes in density of the material.

206.09.01.03.03 Boulders

Measurement of each boulder classified as rock shall be by volume in cubic metres computed on the basis of the product of the actual rock measurement of the 3 maximum rectilinear dimensions in metres of the boulder.

206.09.01.04 Rock Face

Measurement of rock face shall be by area of the rock face in square metres.

206.09.01.05 Rock Supply

The quantity of rock supply shall be determined in cubic metres either at the end of a distinct stage or at the end of the Contract.

The quantity shall be determined as one of the following:

- a) The rock surplus quantity less the quantities of rock materials removed as part of the rock surplus and measured as specified in the Measurement of Rock Surplus clause.
- b) The quantity of rock materials determined by the Contract Administrator required to complete the embankments.
- c) The total of both a) and b).

At the discretion of the Contract Administrator, earlier access to the rock supply item may be granted; however, the quantities shall be reconciled at the end of the stage or Contract.

The rock supply quantity shall be measured in-situ by the Contractor in neat lines at the source. The in-situ volume shall be the rock supply quantity divided by the bulking factor.

For rock materials supplied under the rock supply item for the completion of rock embankments, any rock materials remaining at the rock supply source after rock embankment construction has been completed or otherwise used on the Contract as specified in the Management of Excavated Materials clause, shall be paid for as specified in the Rock Supply subsection under the Basis of Payment section.

The Contract Administrator shall be informed in writing 2 Business Days prior to commencing drilling operations at the rock supply source or 2 Business Days prior to removing rock from the rock pile or both. The Contract Administrator reserves the right to verify any measurements at any source. The Contractor shall give the Contract Administrator complete access to all such sources.

206.09.01.06 Rock Embankment

Measurement of rock embankment shall be by volume in cubic metres of rock embankments. Adjustments to the Plan Quantity shall be limited to those supported with topographic survey information.

206.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

206.10 BASIS OF PAYMENT

206.10.01 Earth Excavation, Grading - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for earth grade checks, including provision of all labour, Equipment, and Material to conduct quality control testing shall be included in the Contract price as part of the work of earth excavation, grading.

206.10.02 Excavation for Pavement Widening - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract Administrator directs that material excavated under this item is to be handled other than as specified in the Excavation for Pavement Widening clause, then such material shall be managed in accordance with the Contract Documents and treated as a Change in the Work.

Material used to backfill the excavation shall be paid for at the Contract price for the tender item of the type of material used.

206.10.03 Rock Excavation, Grading - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When a rock face item is not included in the Contract, rock scaling and the removing of all overbreak and scaled materials shall be included in the rock excavation, grading item.

When a rock embankment item is not included in the Contract, the work of rock embankment shall be included in the rock excavation, grading item.

When excavated rock is to be used for any other Contract item work (e.g., rock embankment, granular materials, or rip-rap), the hauling costs are deemed to be included in payment for the work associated with the appropriate tender item. However, when excavated rock is not to be used for any other Contract item work, the hauling costs are then deemed to be included in payment for the work under the rock excavation, grading item.

Payment for rock grade checks, including provision of all labour, Equipment, and Material to conduct quality control testing, shall be included in the Contract price as part of the work of rock excavation, grading.

When drilling, blasting, and mucking are required as a part of the work for this tender item, the following progress payments shall be made:

- a) 33% of the progress volume for drilling.
- b) 33% of the progress volume for blasting.

206.10.04 Rock Face - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

On completion of drilling and blasting, a progress payment of 50% of this tender item shall be made.

On completion of mucking, a progress payment of an additional 25% of this tender item shall be made.

When the Contract does not contain a separate tender item for rock face, the Contract price for rock excavation, grading, shall include full compensation for all labour, Equipment, and Material to do the work of rock face.

206.10.05 Rock Supply - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, and all costs for fees and royalties.

When drilling, blasting, and mucking are required as a part of the work for this tender item, the following progress payments shall be made:

- a) 33% of the progress volume for drilling.
- b) 33% of the progress volume for blasting.

The unit price tendered for this item is excluded from the provisions specified in the Contract Documents for renegotiation of unit prices.

For rock materials supplied under the rock supply item for completion of rock embankments as specified in the Contract Documents, any rock materials remaining at the rock supply source after completion of all rock excavation and rock embankment construction shall be paid at 50% of the tender unit rate for rock supply.

As specified in part b) of the Measurement of Rock Surplus clause, the Contractor shall be paid \$400.00 for each monitoring device used to monitor compressible soils, regardless of the number of additional pipe sections that are required.

206.10.06 Rock Embankment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for rock embankment, the Contract price for rock excavation, grading shall include full compensation for all labour, Equipment, and Material to do the work of rock embankment.

206.10.07 Backfill for Overexcavation

Payment shall not be made for backfill of any overexcavation in excess of the specified tolerances.

206.10.08 Backfill for Subexcavation

Material used to backfill subexcavations and transition or grade point treatments shall be paid for at the Contract price for the tender item of material used.

206.10.09 Finished Grade Checks Outside Specification Limits

As specified in the Grade Checks subsection of the Quality Assurance section, for each station where the QA grade check of the finished grade is outside of specification limits, the Contractor shall be charged \$250.00.

Appendix 206-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
EMBANKMENTS OVER SWAMPS AND COMPRESSIBLE SOILS**

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209-A	Commentary

209.01 SCOPE

This specification covers the requirements for the construction of embankments over swamps and compressible soils using the excavation, floatation, or displacement method.

209.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

209.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

209.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 212	Earth Borrow

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Geotextiles

209.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Displacement Method means to build the embankment directly on the swamp such that the underlying swamp material is displaced away from the embankment fill.

Earth means earth as defined in OPSS 206.

Floatation Method means to build the embankment directly on the swamp minimizing the displacement of the swamp material.

Rock means rock as defined in OPSS 206.

Swamp Material means the material within the swamp excavation, floatation, or displacement limits, except rock, masonry, natural wood, and manufactured products. Wood that has decomposed and breaks down readily upon handling shall be considered swamp material.

Swamp Wave means the swamp material that is displaced as a result of placement of embankment material.

209.05 MATERIALS

209.05.01 Embankment Material

Embankment material shall consist of earth, rock, select subgrade material, or other material specified in the Contract Documents.

209.05.01.01 Earth Borrow

Earth borrow shall be according to OPSS 212.

209.05.01.02 Select Subgrade Material

Select subgrade material shall be according to OPSS 1010.

209.05.02 Geotextiles

Geotextiles shall be according to OPSS 1860 and be of the type, class, and filtration opening size (FOS) range specified in the Contract Documents.

209.06 EQUIPMENT

209.06.01 Rented Swamp Excavator

The type of swamp excavator equipment shall be as specified in the Contract Documents.

The minimum size and requirements shall be a 26,500 kg crawler mounted hydraulic backhoe with a minimum 12 m reach and a 1 m³ bucket or a 40,000 kg crawler mounted dragline with a 1.15 m³ bucket. The bucket shall be suitable for swamp excavation.

209.06.02 Spreading, Levelling, and Compacting Equipment

When the floatation method is used, spreading, levelling, and compacting equipment shall be restricted to a gross weight that is not detrimental to the structural integrity of the root mat.

209.07 CONSTRUCTION

209.07.01 General

The work of embankment construction shall be carried out using one or more of the following methods specified in the Contract Documents:

- a) Excavation Method
- b) Floatation Method

c) Displacement Method

209.07.02 Clearing and Close Cut Clearing

Prior to beginning embankment construction, the required clearing and close cut clearing shall be completed according to OPSS 201.

209.07.03 Excavation Method

The work shall include the excavation of all material, except rock, from within the limits specified in the Contract Documents and the handling, placing, shaping, trimming, and hauling of excavated material.

Excavation shall be to the full width and full depth in one operation prior to backfilling.

Excavated material shall be placed clear of the sides of the embankment limits and any drainage facilities. The operations of excavating and backfilling shall be carried out simultaneously.

209.07.03.01 Embankment Construction and Backfill

Backfill shall be placed according to OPSS 206. However, when wet conditions exist, backfill material other than rock may be placed up to 600 mm above water level without compaction.

Embankment material placed subsequent to the backfill material shall be placed according to OPSS 206.

209.07.04 Floatation Method

The work shall consist of controlled placement of embankment material, removal of surcharges specified in the Contract Documents from above the subgrade, and hauling and incorporating of the surcharge material into the work according to OPSS 206.

209.07.04.01 Swamp Waves

Swamp waves shall not be excavated or otherwise disturbed.

209.07.04.02 Embankment Construction

The embankment shall be constructed according to OPSS 206, except that vibratory compaction equipment shall not be used within 1.0 m of the original surface of the swamp.

Each layer shall be built using an outside to inside sequence by keeping the outer one-third portions of the layer at least 30 m ahead of the centre portion.

209.07.04.03 Geotextile

When geotextile is to be placed, the area specified in the Contract Documents for geotextile shall be close cut cleared and cleared of objects that may damage the geotextile. Close cut clearing shall be carried out in such a manner as not to damage the structural integrity of the root mat.

The placement operation shall be such that the geotextile is not exposed to daylight for more than 72 hours.

Adjacent sections of the geotextile shall be overlapped a minimum of 1.0 m or shall be sewn together according to OPSS 1860.

Should the geotextile be damaged, it shall be repaired by placing a piece of geotextile large enough to cover the damaged section meeting the above requirements for overlapping.

If the geotextile is damaged due to the Contractor's operation during embankment construction, the embankment material shall be removed from the geotextile.

209.07.05 Displacement Method

The work shall consist of controlled placement of the embankment material, excavation of swamp waves and displaced material, removal of surcharges specified in the Contract Documents, and hauling and incorporating of this material into the work according to OPSS 206.

209.07.05.01 Embankment Construction

The embankment shall be built in such a manner as to displace as much of the material underlying the embankment as possible. An inside to outside construction sequence shall be used, keeping the inside one-third portion 30 m ahead of the outside portions.

When a stable platform has been established, embankment material placed 300 mm above original ground shall be placed according to OPSS 206.

209.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

Manufactured products shall not be used in the right-of-way.

Excavated swamp material shall be used as much as possible within the right-of-way adjacent to an embankment and conforming to standard right-of-way offset. This shall be done by widening embankments, flattening side slopes, and constructing modified cross-sections as specified in the Contract Documents. Such material shall be trimmed to provide smooth contours and to provide drainage.

The volume of excavated material to be used within the Contract limits or designated areas shall be as specified in the Contract Documents.

209.09 MEASUREMENT FOR PAYMENT

209.09.01 Actual Measurement

209.09.01.01 Excavation

Measurement shall be by volume in cubic metres by the method of average end areas. The quantity for payment shall be the lesser of the following:

- a) Actual excavation.
- b) Excavation to the length, width, and depth as specified in the Contract Documents.

209.09.01.02 Rental of Swamp Excavation Equipment

Measurement shall be by time in hours that the equipment is actually engaged in the work.

When the excavated material has been placed in a location that will not interfere with subsequent excavation, measurement shall not be made for the handling required in grading, levelling, and trimming of such material.

209.09.01.03 Select Subgrade Material

Measurement shall be by mass in tonnes or by volume in cubic metres as specified in the Contract Documents.

209.09.01.03.01 Cubic Metre Measurement

When measurement of select subgrade material is in cubic metres, one of the following methods, as specified in the Contract Documents, shall be used to calculate the volume of the material:

a) End Area Method

Volume of material shall be measured in their original location and computed in cubic metres by the method of average end areas.

Original cross-sections shall be taken after the area has been cleared, grubbed, and stripped of unsuitable surface material. These operations shall be completed a minimum of 3 Working Days in advance of excavation to allow for the required cross-sectioning.

b) Truck Box Method

Material shall be measured in cubic metres, loose, by predetermined truck box capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Each truck shall be uniquely and readily identifiable.

209.09.01.04 Geotextile

Measurement shall be by area, in place, in square metres, with no allowance for overlaps.

209.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

209.10 BASIS OF PAYMENT

209.10.01 Excavation

Payment for swamp excavation shall be at the Contract price for the tender item Earth Excavation, Grading, according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

209.10.02 Rental of Swamp Excavation Equipment, Dragline - Item Rental of Swamp Excavation Equipment, Hydraulic Backhoe - Item

Payment at the Contract price for the above tender items shall be full compensation for furnishing and operating the minimum size equipment specified, including mats when necessary, for the excavation and for the management of the material adjacent to the excavation.

When the Contract Administrator approves the use of larger equipment, the Contract price per hour shall be adjusted by adding to the Contract price the difference between the rate set out in the Contract Documents for the minimum size equipment specified and the rate set out in the Contract Documents for the larger equipment to be employed.

209.10.03 Floatation and Displacement Method

Payment shall not be made for swamp material displaced by floatation or displacement.

**209.10.04 Select Subgrade Material - Item
Geotextile - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Repairs to geotextile damaged by the Contractor's operation shall be at no additional cost to the Owner.

209.10.05 Management of Swamp Material Excavated by Equipment Rental

All costs associated with the management of material are deemed to be included in the Contract unit price for rental of equipment.

Material resulting from the operation of the above equipment shall be managed as specified in the Contract Documents.

Appendix 209-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR EARTH BORROW

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212-A	Commentary

212.01 SCOPE

This specification covers the requirements for earth borrow.

212.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

212.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

212.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-702	Determination of Particle Size Analysis of Soils

MTO Form:

PH-D-10	Aggregate Sample Data Sheet

212.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Access Road means a private road built or an existing road used by the Contractor to gain access to the Work or to a source of material.

Borrow means earth material acquired from outside the right-of-way to complete the Work.

Haul Road means any public road, excluding the road under Contract, that forms part of a material haul route.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received from the Contractor meet the specified requirements.

Referee Testing means testing of a material attribute for the purpose of resolving acceptance issues at the request of the Contractor or the Owner.

212.04 DESIGN AND SUBMISSION REQUIREMENTS

212.04.01 Submission Requirements

A minimum of 14 Days prior to borrow material being used in the Work, the Contractor shall provide a list of intended borrow sources and the tonnage that is expected to be used from each source to the Contract Administrator.

A minimum of 48 hours prior to the placement of borrow in the Work, the following shall be submitted to the Contract Administrator:

- a) Written proof for the right to occupy and operate each borrow source, including all appropriate permits.
- b) Identification and description of any frost-susceptible materials that the Contractor intends to use as borrow and a detailed plan describing where the Contractor intends to use it.

212.05 MATERIALS

212.05.01 Earth Borrow

Earth borrow shall consist of earth as defined in OPSS 206 and shall be free from organic and foreign material.

Earth borrow with at least 50% of its particles by mass between 5 and 75 μm in size, as determined using LS-702, shall be considered frost-susceptible.

212.07 CONSTRUCTION

212.07.01 General

The work required for borrow shall include clearing, grubbing, and stripping of a borrow source according to OPSS 201 and 206; construction and maintenance of access roads; maintenance and restoration of haul roads; excavating, hauling, placing, and compacting borrow; and borrow source rehabilitation.

The construction of embankments and backfill areas with borrow shall be according to OPSS 206 and OPSS 401, respectively.

Frost-susceptible material shall not be placed in the following areas:

- a) Within the zone between the frost penetration depth specified elsewhere in the Contract Documents and the final grade that will be established within the roadway upon completion of construction.
- b) In any other areas, specified elsewhere in the Contract Documents.

When borrow is stockpiled prior to use, material from different sources shall be stockpiled separately from each other.

212.07.02 Owner's Properties

Unless otherwise specified, material shall not be supplied from the Owner's properties.

212.07.03 Clearing, Grubbing, and Stripping

Borrow sources shall be cleared, grubbed, and stripped of any unsuitable materials. These operations shall be completed a minimum of 3 Working Days in advance of any excavation where cross-sections are required.

Stripped material shall be piled sufficiently back from the face of the pit or quarry to prevent the contamination of the face material. The stripped material shall be piled such that the distance from the face being worked to the stripped material shall be:

- a) For pits, at least equal to the depth of the face or 5 m, whichever is the greater distance.
- b) For quarries, at least 5 m.

212.07.04 Haul Roads

Inspection of all haul roads prior to construction use shall be undertaken jointly by the Contract Administrator, the Contractor, and the owner of the haul road.

All required restoration work shall be performed when haul roads are damaged due to hauling operations.

Acceptable material shall be chosen and properly placed on the haul road to:

- a) Provide safe passage and control of traffic at all times; and
- b) Repair that road to the pre-contract condition upon completion of the hauling operations both to the satisfaction of the Contract Administrator and the owner of the road.

212.07.05 Borrow Source Rehabilitation

The borrow source shall be rehabilitated to comply with all applicable federal, provincial, and municipal requirements.

212.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

212.08 QUALITY ASSURANCE

212.08.01 General

The Contract Administrator reserves the right to visually inspect borrow and reject any borrow material that does not meet the requirements specified herein and elsewhere in the Contract Documents.

All samples shall be obtained and delivered to the QA laboratory according to the Contract Documents. The data to be included with all samples shall be according to the requirements of the MTO form PH-D-10.

212.08.02**Acceptance of Earth Borrow**

At the discretion of the Owner, the Quality Assurance (QA) laboratory designated by the Owner may carry out QA testing for the purposes of ensuring that earth borrow being placed above the frost penetration depth in the areas listed in the General subsection of the Construction section is not frost-susceptible.

For earth borrow material being placed within the frost penetration depth in the areas specified above, lots may be established at the discretion of the Contract Administrator, in accordance with the schedule shown in Table 1. In addition, any single lot or series of lots may be terminated and a new lot or series of lots re-established, at the discretion of the Contract Administrator.

A minimum of one randomly-obtained duplicate sample shall be obtained from each lot. Additional samples may also be taken at the discretion of the Contract Administrator. In the event that the Contractor is unavailable to take a designated sample for a lot, then no further earth materials from that lot shall be placed above the frost penetration depth until the designated sample is taken.

The Contract Administrator shall document and seal each sample container according to the Contract Documents.

For each duplicate sample, one sample shall be tested for QA purposes and the remaining sample shall be retained for referee testing, if necessary.

If a sample is found to contain more than 50% of its particles by mass between 5 and 75 μm when tested in accordance with LS-702, the Contract Administrator shall then notify the Contractor, in writing, within 2 Business Days of receiving the results, that any material within that lot represented by that sample including any material already within the Work or in stockpiles is frost susceptible and not acceptable for use above the frost penetration depth, wherever specified in the Contract Documents.

In addition, any of the material within that lot which has already been placed within the areas listed in the General subsection of the Construction section shall be removed at no additional cost to the Owner.

212.08.02.01**Referee Testing**

The Contractor may invoke referee testing for any lot by submitting a written request to the Contract Administrator within 2 Business Days following notification from the Contract Administrator that the sampled material has been determined to be frost-susceptible.

The retained duplicate QA sample shall be used for referee testing. However, if a referee sample is not available, the Contractor shall then be responsible for obtaining a new sample from a location to be decided on by the Contract Administrator, at no additional cost to the Owner.

Referee testing shall be carried out, as specified herein and elsewhere in the Contract Documents.

All referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and the referee results shall be binding on both the Owner and the Contractor.

212.09 MEASUREMENT FOR PAYMENT

212.09.01 Actual Measurement

212.09.01.01 Earth Borrow

Measurement of earth borrow shall be by volume in compacted cubic metres, excluding the volume of any boulders that cannot be accommodated in the Work.

Earth borrow shall be measured at the Contract site using the method of average end areas and surveyed cross-sections taken both prior to and after the placement of the material in the Work.

However, for borrow quantities that are less than 1,000 m³, in areas where surveying may be impractical such as where borrow is being placed in areas of standing water, or where materials that are not designated as borrow are being placed and compacted in the same area and at the same time as borrow, then the truck box method may be used, at the discretion of the Contract Administrator.

In this case, each truck carrying borrow shall be readily-identifiable and the loose volume that it contains shall be calculated based on an estimated percentage of the truck box capacity which has been pre-determined from measurements taken by the Contract Administrator. The Contract Administrator shall then determine the compacted in-place volume of the borrow by dividing the estimated volume of the material within the truck box by an appropriate bulking factor determined by the Owner.

212.10 BASIS OF PAYMENT

212.10.01 Earth Borrow - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and replacement of localized soft spots identified by the Contract Administrator or removal of unacceptable material or both shall be at no additional cost to the Owner.

The Owner shall be responsible for the cost of referee testing, provided that the referee test results show that the material meets the applicable specifications. Otherwise, the Contractor shall be responsible for the costs.

212.10.02 Haul Roads

Payment at the Contract price for the appropriate tender items used to perform maintenance and restoration of haul roads shall be full compensation for all labour, Equipment, and Material to maintain and restore haul roads.

When the Contract does not include the appropriate tender items, prices shall be negotiated.

212.10.03 Access Roads

No separate or additional payment shall be made for the cost of construction and maintenance of access roads.

TABLE 1
Lot Schedule for Sampling and Testing Earth Borrow
Placed Above the Frost Penetration Depth

Expected Quantity from Each Source m ³	Lot Size
< 10,000	One lot
> 10,000 (Note 1)	10,000 m ³ lots up to 50,000 m ³ and 50,000 m ³ lots thereafter
Notes: 1. When the quantity of borrow is insufficient for a complete lot and is: a) less than one-half the quantity of a complete lot, then that quantity shall be added to the previous lot; or b) greater than or equal to one-half the quantity of a complete lot, then that quantity shall form its own lot.	

Appendix 212-A, November 2013
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR WICK DRAIN INSTALLATION

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220-A	Commentary

220.01	SCOPE

This specification covers the requirements for the supply and installation of wick drains, including granular blanket.

220.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

220.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

220.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

Canadian General Standards Board (CGSB)

CAN/CGSB 148.1 No.10-94	Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size

ASTM International

D 638-10	Standard Test Method for Tensile Properties of Plastics
D 3776/D 3776M-09ae2	Standard Test Methods for Mass per Unit Area (Weight) of Fabric
D 4491-99a(2009)	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D 4533-11	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D 4632-08	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4716-08	Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4833-07	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
D 5199-12	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

220.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in accordance with the requirements of the Contract Documents.

Geotechnical Instrumentation means equipment used to monitor the progress of settlement, displacement, and pore water pressure measurements and includes such equipment as piezometers, settlement cells, standpipes, settlement profilers, inclinometers, and settlement rods.

Granular Blanket means a layer of free draining granular material used to provide drainage of excess pore pressures due to soil consolidation.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Recognized Specialist Subcontractor means a subcontractor retained by the Contractor that has proven satisfactory experience in work of this type and magnitude and has completed a minimum of five wick drain installation projects in the last five years.

220.04 DESIGN AND SUBMISSION REQUIREMENTS**220.04.01 Submission Requirements****220.04.01.01 Qualifications**

Prior to the commencement of the Work, the qualifications of the recognized specialist subcontractor shall be submitted to the Contract Administrator.

At least one month prior to commencing the installation of wick drains, the qualifications of the QVE undertaking the certification of the work shall be submitted to the Contract Administrator.

220.04.01.02 Materials

At least 3 weeks prior to the installation of wick drains, the Contractor shall submit to the Contract Administrator the following:

- a) A minimum one metre sample of the wick drain.
- b) The manufacturer's technical specifications indicating that the materials meet the requirements shown in Table 1.
- c) A certificate for each production lot supplied indicating that the wick drain supplied was produced and tested according to the requirements shown in Table 1.

The Contractor shall have test results available for the aggregates to be used in the work. At the request of the Contract Administrator, the Contractor shall make available or submit quality control test results. When more than one aggregate source is used for supplying material, test data from each source shall be submitted separately.

220.04.01.03 Installation Procedures

At least 3 weeks prior to the installation of wick drains, the Contractor shall submit to the Contract Administrator the details of the sequence and method of installation outlining the following:

- a) Size, type, weight, maximum pushing force, and configuration of the installation rig.
- b) Dimensions of the mandrel to be used.
- c) Details of wick drain anchorage.
- d) Detailed description of proposed installation procedures.
- e) Alternative methods for overcoming obstructions.
- f) Methods for splicing wick drains.

220.04.01.04 Certificates of Conformance

The following certificates of conformance shall be signed and sealed by the QVE and shall be submitted to the Contract Administrator:

- a) At least 3 weeks prior to the installation of wick drains, a certificate of conformance stating that the equipment, materials, and procedures are capable of achieving successful wick drain installation according to the requirements of the Contract Documents.
- b) Upon completion of the wick drain installation and prior to the placement of any overlying material, a final certificate of conformance stating that the work has been carried out according to the submitted installation procedures and the requirements of the Contract Documents.

220.05 MATERIALS

220.05.01 Wick Drains

Wick drains shall be prefabricated and shall consist of a continuous plastic drainage core wrapped in a non-woven geotextile. The geotextile, core, and composite wick drain shall meet the requirements shown in Table 1.

All wick drains shall be free of defects, rips, holes, and flaws.

220.05.02 Granular Blanket

The granular blanket shall be Granular B, Type I, Type II, or Type III, according to OPSS 1010, except that 100% shall pass the 37.5 mm sieve.

220.06 EQUIPMENT

The equipment used to install wick drains shall be of the type that minimizes the disturbance to the drainage blanket or the native subsoil during the installation operation.

Falling weight impact hammers shall not be permitted.

220.07 CONSTRUCTION

220.07.01 Operational Constraints

When a site is designated as an environmentally sensitive area, jetting techniques shall not be permitted.

Wick drains shall be installed subsequent to the construction of the granular blanket and prior to the installation of monitoring instruments and placement of any overlying material. Wick drains shall be protected by a minimum of 2 m of earth fill or 4 m of rock fill before the ground freezes. Wick drains shall not be installed in frozen ground.

Installation of the wick drains shall be coordinated with the placement of geotechnical instrumentation as specified in the Contract Documents. Wick drains shall be installed in a manner that does not disturb geotechnical instrumentation already in place. Geotechnical instrumentation damaged as a result of Contractor's activities shall be replaced by the Contractor.

220.07.02 Transportation and Storage

During transportation and storage, the wick drain materials shall be protected from damage.

The storage area shall be so that the wick drain materials are protected from sunlight, dirt, dust, mud, debris, and all other detrimental substances.

220.07.03 Granular Blanket

The granular blanket shall be placed subsequent to the excavation of unsuitable material and any backfilling specified in the Contract Documents.

The granular blanket shall be placed and compacted to the limits and grades specified in the Contract Documents.

The granular blanket shall be placed according to the earth embankment requirements of OPSS 206 and compacted to a minimum 90% of its maximum dry density measured according to OPSS 501.

When the granular blanket is placed under water, it shall be placed by end dumping.

220.07.04 Trial Wick Drains

Prior to the installation of wick drains within the areas designated in the Contract Documents, the Contractor shall demonstrate that the proposed materials, equipment, and installation method produce a satisfactory wick drain installation in accordance with these specifications. The Contractor shall install a minimum of 10 trial wick drains at permanent installation locations designated by the Contractor Administrator.

Provided the trial wick drains are installed to the satisfaction of the Contract Administrator, they shall be incorporated as part of the permanent installation.

The QVE shall monitor the wick drain installation on a full-time basis. If at any time the QVE considers that the method of installation does not produce a wick drain that satisfies the contract requirements, the method or equipment or both, as necessary, shall be altered to comply with the requirements of the Contract Documents.

220.07.05 Installation

220.07.05.01 General

Wick drains shall be installed to the depths specified in the Contract Documents.

Wick drains shall be installed using a mandrel advanced through the granular blanket and the underlying soil. The mandrel shall protect the wick drain material from damage during installation and shall be withdrawn after the installation of the wick drain. The mandrel shall be provided with an anchor plate to prevent soil from entering the bottom of the mandrel during installation and to anchor the bottom of the wick drain at the required depth at the time of mandrel removal. The projected cross-sectional area of the mandrel and anchor combination shall not exceed 7,700 mm².

Augering or vibratory equipment may be used within the granular blanket and underlying soils to facilitate the installation of wick drains. The use of augering or vibratory equipment shall not extend more than 1 m into the soil to be consolidated.

220.07.05.02 Layout

Wick drains shall be located and staked out by the Contractor. The spacing of the wick drains shall not vary more than 150 mm from the spacing specified in the Contract Documents.

220.07.05.03 Vertical Alignment

Wick drains shall be installed vertically, within a tolerance of not more than 10 mm per 500 mm. The Contractor shall maintain a suitable method of verifying the vertical alignment of the mandrel and of determining the depth of the wick drain at all times.

220.07.05.04 Splices

Splices in the wick drain shall be made so as to ensure continuity and to prevent reduction in the wick drain discharge capacity. Splices shall be a minimum of 150 mm in length.

220.07.05.05 Cut-Off

The wick drain shall be cut at the surface of the granular blanket so that at least a 150 mm length protrudes above the top of the granular blanket at each wick drain location.

220.07.05.06 Obstructions

Where obstructions are encountered below the working surface that cannot be penetrated by the wick drain installation equipment, the Contractor shall complete the wick drain from the elevation of the obstruction to the working surface and notify the Contract Administrator. At the direction of the Contract Administrator, the Contractor shall attempt to install a new wick drain within a 500 mm radius of the obstructed wick drain. A maximum of two attempts shall be made as directed by the Contract Administrator.

220.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

220.08 QUALITY ASSURANCE

220.08.01 Certificate

Certificates for each production lot indicating that the wick drain supplied was produced and tested according to the requirements of this specification shall be provided by the manufacturer for all wick drains delivered to the Contract.

220.08.02 Rejected Drains

Wick drains that are damaged or that do not meet the requirements of this specification shall be rejected and replaced. Replacement wick drains shall be installed within a 500 mm radius from the location of the rejected wick drain, as directed by the Contract Administrator.

220.09 MEASUREMENT FOR PAYMENT

220.09.01 Actual Measurement

220.09.01.01 Wick Drains

Measurement shall be by length in metres for all accepted wick drains, including the protruding portion up to 150 mm per installation.

Properly installed obstructed wick drains and replacement wick drains shall be measured for payment.

220.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

220.10 BASIS OF PAYMENT

220.10.01 Wick Drains - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Geotechnical instrumentation damaged as a result of the Contractor's activities shall be replaced at no additional cost to the Owner.

Payment shall not be made for rejected wick drains or delays or expenses incurred by the Contractor as a result of improper or unacceptable material or installation.

All labour, Equipment and Material required for the granular blanket shall be paid for with the appropriate road base or subbase item, Granular B Type I, Granular B Type II, Granular B Type III, as specified.

TABLE 1
Wick Drain Property Requirements

Component	Property		Test Method	Unit	Requirement
Core	Physical	Material	--	--	Polypropylene, Studded or Grooved
		Thickness	ASTM D 5199	mm	≥ 2
		Mass	ASTM D 3776	g/m	≥ 40
	Mechanical	Tensile Strength	ASTM D 638	N	≥ 800
Geotextile	Physical	Material	--	--	Polypropylene, Non-Woven
		Mass	ASTM D 5261	g/m ²	≥ 110
	Mechanical	Grab Tensile Strength	ASTM D 4632	N	≥ 600
		Puncture Strength	ASTM D 4833	N	≥ 200
		Trapezoidal Tear	ASTM D 4533	N	≥ 250
		Filtration Opening Size (FOS)	CAN/CGSB 148.1, Method No. 10	µm	≥ 40
		Permittivity	ASTM D 4491	s ⁻¹	≥ 0.5
Composite Wick Drain	Physical	Width	--	mm	≥ 100
		Thickness	ASTM D 5199	mm	≥ 3
	Mechanical	Discharge Capacity @ 10 kPa	ASTM D 4716	m ³ /s	$\geq 1.2 \times 10^{-4}$
		Discharge Capacity @ 240 kPa	ASTM D 4716	m ³ /s	$\geq 1.0 \times 10^{-4}$

Appendix 220-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR RESTORING UNPAVED ROADWAY SURFACES

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301.10	BASIS OF PAYMENT

301.01 SCOPE

This specification covers the requirements for the restoration of unpaved roadway surfaces in preparation for its subsequent cover with a granular or surfacing course.

301.02 REFERENCES

This specification refers to the following standards, specifications, and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314 Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

301.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Restored Surface means unpaved roadway surfaces prepared to the required grades and density and ready for a subsequent cover of granular or surfacing courses.

Scarification means uniform loosening of the roadway surface to remove damaged areas such as ravelling and potholes.

Surfacing Course means any wearing course or courses placed on the roadway and consisting of hot mix asphalt (HMA), Portland cement concrete, bituminous cold mix, or surface treatment.

Unpaved Roadway Surface means surfaces that are typically existing granular, but may include sub-grade soil surfaces.

301.07

CONSTRUCTION

301.07.01

Method

Restoring roadway surfaces shall consist of the following:

- a) The scarification of the existing surface specified in the Contract Documents to a depth sufficient to remove potholes but not less than 75 mm.
- b) Restoring or reshaping the scarified material.
- c) Compaction of the scarified materials according to OPSS 501.
- d) Ensuring that the restored surface is within tolerance.

The scarified surface shall be maintained to the profile, cross-section, and density specified in the Contract Documents until Contract Completion or, if applicable, until any subsequent granular or surfacing course is completed.

Prior to scarification, roadway surfaces not more than 150 mm above grade shall be loosened and the materials removed to grade. Materials loosened from the roadway surface and reshaped or incorporated during the restoring operation shall not require loading, hauling, or moving other than by blading.

Contaminated or otherwise, unsuitable material, encountered during restoring operations shall be removed to a depth not greater than 150 mm and replaced with Granular A, according to OPSS 1010, and then compacted according to OPSS 501.

301.07.02

Surface Tolerances

The surface of the unpaved roadway shall be restored to the specified tolerances for the following types of surfacing courses.

301.07.02.01

Granular Courses

The restored surface shall not deviate more than the following:

- a) 30 mm from the specified grade and cross-section.

- b) 30 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the subgrade for granular courses.
- c) 15 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the granular surface for granular courses.

301.07.02.02 Bituminous Courses

The restored surface shall not deviate more than the following:

- a) 30 mm from the specified grade and cross-section.
- b) 30 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the subgrade to receive full depth HMA.
- c) 10 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare the granular surface to receive HMA.

301.07.02.03 Portland Cement Concrete Courses

The restored surface shall not deviate more than the following:

- a) 10 mm from the specified grade and cross-section.
- b) 10 mm at any place as measured in any direction with a 3 m straight edge when the work is to prepare a granular surface to receive concrete pavement or concrete base.

301.07.03 Surface Widths

The restored surface width shall be as specified in the Contract Documents.

301.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

301.09 MEASUREMENT FOR PAYMENT

301.09.01 Actual Measurement

301.09.01.01 Restoring Roadway Surfaces

Measurement of restored roadway surfaces shall be by area in square metres.

301.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

301.10 BASIS OF PAYMENT

301.10.01 Restoring Roadway Surfaces - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

301.10.02 Water

Payment for water for compaction shall be according to OPSS 501.

301.10.03 Additional Materials

Payment for additional granular materials shall be according to OPSS 314.



**CONSTRUCTION SPECIFICATION FOR
SINGLE AND DOUBLE SURFACE TREATMENT**

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304.10	BASIS OF PAYMENT

304.01 SCOPE

This specification covers the requirements for surface preparation, application of bituminous binder, and application of aggregate for single and double surface treatment.

304.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1103 Emulsified Asphalt

Ontario Ministry of Transportation Publications

MTO Forms:
PH-CC-349 Bituminous Material Product Sample Form

304.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance hole, catch basin, valve chamber, and water valve covers and similar Utility access covers located within the paved portion on the roadway.

Binder means an emulsified asphalt with or without polymer modification used to bind aggregates.

Double Lap means the coverage produced from the application of binder where the binder from each spray bar nozzle overlaps the binder application from the adjacent nozzle by one half.

Double Surface Treatment means two successive single surface treatments.

End Nozzle means a spray bar nozzle which delivers binder to the inside half of a standard spray pattern.

Single Surface Treatment means a single application of bituminous binder followed by a single application of Class 1, Class 2, Class 3, Class 4, Class 5, or Class 6 aggregate.

Triple Lap means the coverage produced from the application of binder where the binder from each spray bar nozzle overlaps the binder application from the adjacent nozzle by two thirds.

304.05 MATERIALS

304.05.01 Aggregates

Aggregates shall be according to OPSS 1006 and as specified in the Contract Documents.

304.05.02 Binders

Binders shall be according to OPSS 1103.

304.06 EQUIPMENT

304.06.01 Binder and Aggregate Application Rate

The following equipment shall be supplied for the determination of binder and aggregate application rates:

- a) A portable electronic balance with the following characteristics:
 - i. five digit display,
 - ii. accuracy to 0.1%,
 - iii. capacity 10 kg,
 - iv. minimum platform size of 300 mm by 400 mm.
- b) Sheet metal trays, each 500 mm x 500 mm inside dimension ± 1 mm, with sides 7 mm in height ± 1 mm. The sheet metal shall be a minimum of 18 gauge (approximately 1.3 mm) with soldered corners.

- c) One 5 kg test mass.
- d) A carpenter's level for levelling the balance.

304.06.02 Mechanical Aggregate Spreader

The mechanical aggregate spreader shall be designed and manufactured to be self-propelled and capable of continuously and uniformly distributing aggregate at the specified application rate.

304.06.03 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

304.06.04 Pressure Distributor

The pressure distributor shall be designed and manufactured to spray binder on the road surface. The pressure distributor shall be capable of applying binder at the specified rates and in a continuous and uniform manner both longitudinally and transversely for a full lane width at variable speeds.

304.06.05 Rollers

304.06.05.01 General

Rollers shall be ballasted according to the manufacturer's recommendations.

304.06.05.02 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be self-propelled and be according to Table 1. The wheels shall be mounted with smooth tread rubber tires. Tire inflation pressure shall be a minimum of 350 kPa when the tires are cold. All tires shall have equal pressure. Each roller shall be equipped with a suitable tire pressure gauge for checking tire inflation pressure.

304.06.05.03 Steel Drum Rollers

Steel drum rollers shall be single drum vibratory rollers according to Table 2 and shall be operated in the static mode, if the drum is not rubber coated. Drive wheels shall not mark the aggregate.

304.06.06 Rotary Power Brooms

Brooms shall be capable of cleaning gravel, sand, dirt, and other debris from the roadway surface.

304.07 CONSTRUCTION

304.07.01 Operational Constraints

Surface treating operations shall not be carried out when the ambient temperature at the work location is less than 10 °C or where climatic or site conditions preclude the curing of the binder.

The application of binder and aggregate shall terminate one hour before sunset.

Surface treatment shall not be carried out prior to May 15th south of a line through Pembroke, Magnetawan, and Pointe au Baril Station or prior to June 1st north of the line.

Surface treatment shall not be carried out after September 1st except with the approval of the Contract Administrator. Surface treatment may be extended to September 30th provided a high float emulsion is used.

304.07.02 Surface Preparation

Existing bituminous surfaces shall be clean and free of all debris and standing water before application of binder.

Where a binder is to be applied on a granular surface, the surface shall be free of standing water and shall be prepared by dampening, fine grading, and compacting immediately prior to the application of the binder. The surface shall be finish rolled to ensure a compacted smooth and float free surface.

304.07.03 Binder Application Temperatures

Binder application temperatures shall be according to OPSS 1103.

304.07.04 Application of Binder

After the surface has been prepared, the binder shall be uniformly sprayed on the road surface at the specified application rate. When binder is to be applied to two adjacent lanes, the application of binder on the initial pass shall be done without the use of an end nozzle. When binder is applied to the adjacent lane, the nozzle positioned closest to the first application of binder shall be an end nozzle.

The spray bar height shall be adjusted to ensure that there is triple lap of the binder application. A written request may be submitted to the Contract Administrator to allow the use of a double lap application.

Longitudinal joints shall be constructed to ensure full coverage on the centreline.

The application of binder shall terminate at the same station for both lanes at the end of each Day.

All Roadway appurtenances within the area to be surfaced shall be properly covered and protected immediately prior to the surface treatment.

304.07.05 Application of Aggregate

Aggregate shall be uniformly applied at the rate specified. The distance between the pressure distributor and the spreader shall be less than or equal to 30 m.

If excess aggregate is present when constructing a double surface treatment, the excess shall be removed prior to the second application of binder.

304.07.06 Rolling

Immediately after spreading, the aggregate shall be rolled with a minimum of two pneumatic-tired rollers. The entire treated area shall receive two passes from each pneumatic-tired roller.

When the surface treatment is placed on a prepared granular grade, one pneumatic-tired roller shall be replaced by a steel drum roller. The entire treated area shall receive two passes from the pneumatic-tired roller and one pass from the steel drum roller.

Rollers shall be operated at such a speed as to prevent aggregate pick-up, but in no case shall the speed of rollers exceed 10 km/h.

All rolling shall be completed within 300 m of the aggregate spreader. When the combination of rollers is not sufficient to maintain the completed rate of progress, additional rollers shall be used.

304.07.07 Traffic Convoy

When as specified in the Contract Documents, traffic shall be convoyed according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the surface treatment is able to carry traffic without damage.

304.07.08 Protection of the Work

Signs indicating fresh surface treatment, or similar wording, shall be erected at the limits of the Working Area and any intersections throughout the Working Area immediately after placement of surface treatment and shall remain in place for a minimum of 72 hours.

304.07.09 Material Sampling and Testing

304.07.09.01 Binder

Binder field samples shall be obtained and provided for testing purposes as specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and making arrangement with Contract Administrator for delivery of samples to the laboratory designated in the Contract Documents within 2 Business Days of sampling.

A lot shall be deemed to be the quantity of work completed with a shipment (truck tank) of binder. A sample of binder shall be taken at the job site from each shipment of binder and this sample shall represent the lot.

Each binder sample shall consist of a minimum size of two full 4-litre samples of material. The sample containers shall be new triple tight cans with lids or suitable plastic containers of similar capacity which can be closed to prevent any leakage.

Sample containers shall be supplied and filled, leaving only sufficient space to allow for liquid expansion. The sample shall be taken from a sampling spigot on the transfer line, or, if one is not available, from the end of the transfer line. Each sample shall be taken after sufficient material has been drawn from the truck tank to purge the transfer line.

The sample shall be identified using a MTO PH-CC-349, Bituminous Material Product Sample Form, obtained from the Contract Administrator. In addition, the form shall be placed on each pail and labelled as "A1 of 2" or "A2 of 2". The form is only for use by the Owner in the identification of the sample for Contract administration purposes.

304.07.09.02 Aggregates

Aggregate samples shall be provided for testing purposes as specified in the Contract Documents.

304.07.09.03 Determination of Binder and Aggregate Application Rates

The application rate for the binder and the aggregate shall be as specified in the Contract Documents.

Compliance to the specified application rates of binder and aggregate shall be demonstrated to the Contract Administrator. At the Contract Administrator's option, this compliance may include a minimum 300 m one lane width trial section to ensure that the binder and aggregate are applied at the specified rate.

304.07.09.03.01 Sampling Frequency

Field sampling shall be carried out in the presence of the Contract Administrator to determine the binder application rates:

- a) at the start of each Day's work. If two distributors are provided, the binder application rate of one distributor shall be determined at this time.
- b) when approximately half of the total Day's production is completed. If two distributors are provided, the binder application rate of the second distributor shall be determined at this time.

Field sampling shall be carried out to determine the aggregate application rates at the start of each Day's work.

304.07.09.03.02 Procedure

Each section of road used to obtain the application rates shall be a maximum of 50 m in length. Field sampling shall be conducted in the presence of the Contract Administrator to determine the binder and aggregate application rates as follows:

- a) Set up and level the balance in a firm location protected from the wind.
- b) Check the tolerance of the balance with the 5 kg test mass.
- c) Obtain the tare mass (in kg to three decimal places) of two clean trays and record.
- d) Place the two trays in the centre of the lane being treated approximately 30 cm apart and parallel to the centreline.
- e) Remove the first tray after the binder has been sprayed and before the aggregate has been applied.
- f) Remove the second tray after the binder and aggregate have been applied and before rolling.
- g) Obtain and record the gross mass (in kg to three decimal places) of each tray.
- h) Carefully patch the marks left by the trays using the binder and aggregate as specified in the Contract Documents. The patches shall be rolled.
- i) Clean the trays for reuse.

304.07.09.03.03 Calculations

The calculations specified in Table 3 shall be performed in the presence of the Contract Administrator:

304.07.10 Remedial Work

Damaged areas shall be repaired until such time as the work has been accepted by the Contract Administrator.

304.07.11 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

304.08 QUALITY ASSURANCE

304.08.01 Acceptance

304.08.01.01 Binder

Acceptance of the binder shall be based on testing conducted by the Owner or the Owner's agent according to OPSS 1103.

The Contract Administrator shall determine the acceptability of each lot according to OPSS 1103. Lots that are not acceptable shall be removed and replaced or accepted with a payment adjustment.

If the Contractor elects to repair the lot in lieu of a payment adjustment, the lot shall be repaired and re-evaluated to the satisfaction of the Contractor Administrator.

304.08.01.02 Binder Application Rate

The binder application rate is acceptable when the rate is within a tolerance of + 5% of the specified rate. Otherwise, the binder application rate is unacceptable, and work shall stop. Field sampling shall be repeated in a maximum of 50 m sections until one of the following is obtained:

- a) When two consecutive acceptable binder test results are obtained, work may proceed.
- b) When four unacceptable binder test results are obtained before two consecutive acceptable test results, the pressure distributor shall be permanently removed from the Working Areas.

304.08.01.03 Aggregate Application Rate

The aggregate application rate is acceptable when the rate of aggregate application is within a tolerance of +10% of the specified rate. Otherwise, the aggregate application rate is unacceptable and work shall stop. Work may proceed when the application rate has been adjusted to the desired rate.

304.09 MEASUREMENT FOR PAYMENT

304.09.01 Actual Measurement

304.09.01.01 Binder

Measurement of binder shall be by mass in kilograms.

304.09.01.02 Class 1, 2, 3, 4, 5 or 6 Aggregate

Measurement of aggregate shall be by mass or volume as specified in the Contract Documents

304.09.01.02.01 By Mass

Measurement of aggregate shall be by mass in tonnes.

304.09.01.02.02 By Volume

Measurement of aggregate shall be by volume in cubic metres, loose, by predetermined truck capacities. The predetermined capacity of each truck shall be that computed from its box dimensions.

Loading of each truck shall be kept to not less than the predetermined capacity. It is not permitted to load trucks in excess of this capacity to allow for bulking, and no deduction shall be made for any settlement of the load during transportation, provided that such settlement is not caused by spillage or leakage.

Each truck shall be uniquely and readily identifiable.

304.09.01.03 Traffic Convoy

Measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is convoying traffic.

304.10 BASIS OF PAYMENT

304.10.01 Binder "type" - Item
Class 1 Aggregate - Item
Class 2 Aggregate - Item
Class 3 Aggregate - Item
Class 4 Aggregate - Item
Class 5 Aggregate - Item
Class 6 Aggregate - Item
Class 1 Aggregate, From Stockpile - Item
Class 2 Aggregate, From Stockpile - Item
Class 4 Aggregate, From Stockpile - Item
Class 6 Aggregate, From Stockpile - Item
Traffic Convoy - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for any lot of binder which does not meet all Contract requirements shall be subject to a payment adjustment, except when the lot sample has been arranged for delivery within 2 Business Days of sampling and testing is not started within 14 Days of sampling.

A calculated payment adjustment shall be determined, through a system of adjustment points based on test results for any lot sample when tested providing the sample remains in a condition suitable for testing. Where more than one test result is available on any one sample, the test result with the least deviation from the specification limit shall be used to calculate the payment adjustment. The payment adjustment percentage for the lot is the total number of adjustment points for each sample divided by 25.

A fixed payment adjustment of 20% of the Contract price shall be made for lots for which the following conditions apply:

- a) The lot sample contains insufficient material for testing; or
- b) The lot sample does not remain in a condition suitable for testing within 14 Days after sampling (e.g., broken emulsion or foam-over during distillation).

304.10.02 Adjustment Points for Emulsified Asphalt Binders

The total number of adjustment points shall be equal to the summation of the number of units that each test deviates from the specification limits times the multiplier as specified in Table 4, plus:

- a) 1000 adjustment points for failure of the particle charge test when the binder type is RS-2, CRS-2, RS-2P, or CRS-2P, HFMS-2(ON) and;

- b) 200 adjustment points for failure of the coating ability and water resistance test when the binder type is HF-100S, HF-150S, HF-250S, HFMS-2(ON), HF-100SP, HF-150SP or HFMS-2P(ON).

Prior to the summation, all adjustment points shall be rounded to one decimal place according to LS-100.

TABLE 1
Requirements for Pneumatic-Tired Rollers

Roller Class	Minimum Mass t	Minimum Mass per Tire kg
R1	8	900
R2	18	2500
R3	25	3600

TABLE 2
Requirements for Steel Drum Rollers

Minimum Drum Diameter mm	Minimum Drum Width mm	Minimum Static Mass per mm of Drum Width kg
1500	2100	2

TABLE 3
Determination of Aggregate Application Rate

Steps	Name	Descriptions	Calculations
1	NMB	<u>Net Mass of the Binder</u> Obtain the net mass of the binder applied to the first tray	$NMB = \text{Gross Mass} - \text{Tare Mass}$
2	BAR	<u>Binder Application Rate</u> Calculate the binder application rate to two decimal places (kg/m ²)	$BAR = NMB \times 4$
3	NMBA	<u>Net Mass of Binder and Aggregate</u> Obtain the net mass of binder and aggregate on the second tray	$NMBA = \text{Gross Mass} - \text{Tare Mass}$
4	NMA	<u>Net Mass of Aggregate</u> Obtain the net mass of aggregate on the second tray	$NMA = NMBA - NMB$
5	AAR	<u>Aggregate Application Rate</u> Calculate the aggregate application rate to one decimal place (kg/m ²)	$AAR = NMA \times 4$

TABLE 4
Tests, Units and Multipliers for Emulsified Asphalt Binder

Test	Unit	Multiplier
Residue by Distillation	%	200
Viscosity (less than minimum)	SFs	30
Viscosity (greater than maximum)	SFs	5
Demulsibility (Note 1)	%	50
Residue Penetration @ 25°C	0.1 mm	15
Settlement (Note 2)	%	30
Storage Stability (Note 3)	%	50
Oil Portion of Distillate, by Volume of Emulsion (Note 4)	%	50
Sieve Test	%	1000
Residue Float Test @ 60°C	s	2
Ash Content of Residue, by Mass	%	1000
Residue Elastic Recovery @ 10°C (Note 5)	%	30
Residue Force Ductility @ 800% Elongation, 5 cm/min. pull rate @ 4°C (Note 6)	kg	1000
Residue Apparent Viscosity @ 60°C (Note 7)	Pa.s	10 (Note 8)
Residue Ductility @ 25°C (Note 9)	cm	10
Notes: 1. For all emulsified asphalt binder types except HF250S. 2. For emulsified asphalt binder types RS-2 and CRS-2 only. 3. For emulsified asphalt binder types HF-100S, HF-150S, HF-250S, HFMS-2(ON), HF-100SP, HF-150P, HFMS-2P(ON), HFRS-2, RS-2P, and CRS-2P only. 4. For emulsified asphalt binder types CRS-2, HF-100S, HF-150S, HF-250S, HFMS-2(ON), CRS-2P, HF-100SP, HF-150SP, and HFMS-2P(ON) only. 5. For emulsified asphalt binder types RS-2P, CRS-2P, HF-100SP, HF-150SP and HFMS-2P(ON) only. 6. For emulsified asphalt binder types RS-2P, CRS-2P, HF-100SP and HFMS-2P(ON) only. 7. For emulsified asphalt binder types HF-100S, HF-150S, and HF-250S only. 8. The multiplier will be used when the apparent viscosity of distillation residues falls below the minimum requirement according to OPSS 1103. 9. For emulsified asphalt binder types RS-2, CRS-2 and HFRS-2 only.		



CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING

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305.01	SCOPE

This specification covers the requirements for material, surface preparation, supply and application of sealer to granular shoulders, shoulder rounding, and all other designated areas.

305.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 304	Single and Double Surface Treatment
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Materials

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1103	Emulsified Asphalt
OPSS 2510	Tall Oil Pitch Emulsion

Ontario Ministry of Transportation, Publications

MTO Laboratory Testing Manual:
LS-100 Rounding-Off of Test Data and Other Numbers

ASTM International

D5/D5M-20	Standard Test Method for Penetration of Bituminous Materials
D113-17	Standard Test Method for Ductility of Asphalt Materials
D1310-14(2021)	Standard Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
D6930-19	Standard Test Method for Settlement and Storage Stability of Emulsified Asphalts
D6933-18	Standard Test Method for Oversized Particles in Emulsified Asphalts (Sieve Test)
D6997-12(2020)	Standard Test Method for Distillation of Emulsified Asphalt
D7402-09(2017)	Standard Practice for Identifying Cationic Emulsified Asphalts
D7496-18	Standard Test Method for Viscosity of Emulsified Asphalt by Saybolt Furol Viscometer
D8078-18e1	Standard Test Method for Ash Content of Asphalt and Emulsified Asphalt Residues

305.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Lot means a specific quantity of material or a specific amount of construction obtained from a single source and produced by the same process.

305.05 MATERIALS

305.05.01 Sealers

Sealers may consist of one or more of the following materials:

- a) Type I: Emulsified asphalt primer shall be according to OPSS 1103.
- b) Type II: Solvent-free emulsified asphalt shall be according to OPSS 1103.
- c) Type III: Tall oil pitch (TOP) emulsion shall be according to OPSS 2510.

305.06 EQUIPMENT

305.06.01 Pressure Distributor

The pressure distributor used for sealer application shall be according to OPSS 304 and shall include an attachment for hand spraying, when applicable.

305.06.02 Rollers

Rollers shall be steel-drum or pneumatic-tired according to OPSS 304.

305.07 CONSTRUCTION

305.07.01 Operational Constraints

A sealer shall only be applied when:

- a) The ambient temperature is a minimum of 5 °C and rising.
- b) The designated area to be sealed is not frozen.
- c) Precipitation is not occurring or imminent.
- d) A minimum period of 24 hours has passed after precipitation has stopped for Type III emulsion application.
- e) The surface is free of standing water.
- f) The wind is not strong enough to cause drifting of sealer spray.
- g) The shoulder is smooth and is according to the crossfall and grade specified in the Contract Documents.

305.07.02 Surface Preparation

Prior to applying sealer, the granular shoulder shall be rolled with a minimum of two passes, as soon as is practical. The shoulder rounding surface shall not be rolled.

Granular materials to be sealed with Type I or Type II sealers shall be uniformly dampened immediately prior to application of sealer.

The moisture content of granular materials to be sealed with a Type III sealer shall be according to the manufacturer's recommendations.

305.07.03 Application

The sealer types and the locations where they shall be used are as specified in the Contract Documents.

Sealers shall be uniformly applied in all areas using a pressure distribution system.

Sealer application rates and temperatures shall be according to Table 1.

Sealers shall be overlapped a minimum of 100 mm onto adjacent paved surfaces.

All other application requirements shall be according to the manufacturer's recommendations and the application performed to the satisfaction of the Contract Administrator.

305.07.04 Material Sampling and Testing

305.07.04.01 General

The general requirements of samples for quality assurance, referee and other testing by the Owner shall be as specified in the Contract Documents.

Arrangement shall be made with the Contract Administrator for delivery of samples to the laboratory as specified in the Contract Documents within 2 Business Days of sampling.

305.07.04.02 Sampling

The Contract Administrator shall randomly-choose one sample of sealer from the designated truck tanker representing each lot.

Duplicate samples shall be taken from a sampling spigot on the transfer line or, if one is not available, from the end of the transfer line. Each sample shall be taken after sufficient material has been drawn from the truck tank to purge the transfer line. Sample containers shall be filled, leaving sufficient space to allow for expansion.

Sample containers for each portion of each duplicate sample shall be triple tight one-litre cans for Type III sealers or triple tight four-litre pails, or suitable plastic containers of similar capacity that can be closed to prevent any leakage for Type I or Type II sealers.

Identification tags, provided by the Contract Administrator, shall be attached to each sample container.

305.07.05 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

305.08 QUALITY ASSURANCE

305.08.01 General

The Owner reserves the right to make inspections, take samples, and perform quality assurance (QA) tests, at such times and locations as the Owner may consider necessary.

305.08.02 Acceptance of Granular Sealer

305.08.02.01 Lot Size

Lot sizes shall be according to Table 2. If the remaining quantity after completing a lot is less than one-half the quantity for a complete lot, then that quantity shall be added to the previous lot. Otherwise, the remaining quantity shall form its own lot.

305.08.02.02 Sealer Quality

One of duplicate samples shall be tested for material properties by the QA laboratory according to OPSS 1103 for Type I and Type II sealers, and OPSS 2510 for Type III granular sealers, respectively.

A lot of sealer shall be deemed to be acceptable, if all the test results and other requirements according to OPSS 1103 for Type I and Type II sealers, and OPSS 2510 for Type III granular sealers are respectively met.

A lot of sealer not meeting all the sealer quality requirements shall be subjected to a payment adjustment according to the Payment Adjustments for Sealers clause.

The Owner shall be responsible for all costs associated with QA testing for acceptance.

305.08.02.03 Referee Testing

Referee testing may be invoked for one or more tested attributes of a lot by submitting a written request to the Contract Administrator, within 2 Business Days following notification that the sealer does not meet the requirements of this specification.

The referee laboratory shall be designated by the Owner. The other duplicate sample representing the lot shall be tested according to OPSS 1103 for Type I and Type II sealers, and OPSS 2510 for Type III granular sealers, respectively.

All referee test results for any lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted based on the referee test results:

- a) The lot shall be subject to a payment adjustment according to the Payment Adjustments for Sealers clause; and
- b) The Contractor shall be responsible for the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory, at the rates specified in the Contract Documents.

When the referee results indicate that the refereed lot is acceptable, the Owner shall bear the cost.

305.08.03 Repairs

The Contract Administrator shall visually inspect the work to determine if the completed work contains any of the following defects:

- a) Uneven application of sealer.
- b) Surface damage.
- c) Flushing.
- d) Bleeding.
- e) Contamination.

Any defects identified shall be repaired to the approval of the Contract Administrator.

Defects other than uneven application of sealer shall be repaired by removing all defective areas of sealed granular material, then replacing it with clean, compacted Granular A according to OPSS 1010 and OPSS 501.

All repaired areas and uneven application of sealer shall be resprayed with the same sealer type or a sealer with a lower sealer type number, as originally specified in the Contract Documents.

305.09 MEASUREMENT FOR PAYMENT

305.09.01 Granular Sealing

305.09.01.01 Actual Measurement

Measurement shall be by the area sealed in square metres or by mass in kilograms of sealer used, as specified in the Contract Documents.

305.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurements shall be based on the units shown in the clause under Actual Measurement.

305.10 BASIS OF PAYMENT

305.10.01 Granular Sealing

305.10.01.01 Granular Sealing - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustment.

Granular sealing damaged by the Contractor's operations or identified by the Contract Administrator as being inadequately treated shall be repaired and resprayed.

Granular sealing damaged by others shall be repaired and resprayed and shall be administered as a Change in the Work.

305.10.01.02 Payment Adjustments for Sealers

305.10.01.02.01 General

Payment for any lot of sealer that does not meet all Contract requirements shall be subject to a payment adjustment. A calculated payment adjustment shall be determined through a system of adjustment points based on the test results for any lot sample, provided the sample remains in a condition suitable for testing.

Adjustment points related to the test results for each test shall be individually rounded to one decimal place according to LS-100.

The total number of adjustment points for the tested sample representing a lot shall be divided by 25 to obtain the payment adjustment, expressed as a percentage for the lot.

A fixed adjustment of 50% of the Contract price shall be made for lots to which at least one of the following conditions apply:

- a) The lot sample contains insufficient material for testing; or
- b) The lot sample does not remain in a condition suitable for testing for 14 Days after sampling (e.g., broken emulsion or foam over during distillation).

305.10.01.02.02 Adjustment Points for Type I and Type II Sealers

For each lot, the total number of adjustment points shall be equal to the summation of the number of units that each test deviates from the specification limits times the multiplier specified for each test in Table 3, plus:

- a) 1,000 adjustment points, if the test result for the ASTM D7402, the particle charge test, fails to meet the requirement according to OPSS 1103; and
- b) 1,000 adjustment points, if the test result for ASTM D6930, the storage stability test, 24 hour, fails to meet the requirement according to OPSS 1103.

305.10.01.02.03 Adjustment Points for Type III Sealers

For each lot, the total number of adjustment points shall be equal to 62.5 for every 0.1% less than 8% solids for the sample tested according to the procedure given in OPSS 2510 plus an additional 1,000 adjustment points, if the material is determined to be anionic according to the Particle Charge Test, ASTM D7402.

TABLE 1
Application Rates and Temperatures

Type of Sealer	Application Rate (kg/m ²)		Application Temperature
	Hand-Sprayed Areas	Machine-Applied/Other Areas	
I	3.4	2.6	At Manufacturer's Recommendations
II			
III	5.5	4.5 (Note 1)	Ambient Temperature (Note 2)
Notes: 1. Type III sealers shall be applied in 2 coats with 12% solids or 3 coats with 8% solids for emulsions to deliver a total of 4.5 kg/m ² . 2. Type III sealers shall not be applied if there is any chance that the ambient temperature will reach 0 °C or below within 24 hours after application.			

TABLE 2
Lot Sizes

Tender Quantity in m ² or kg		Lot Size (Maximum)
Sealed Area in m ²	Mass of Sealer Used in kg	
< 500	< 1500	Sampling and Testing at CA's Discretion
500 to 5,000	1,500 to 15,000	One lot
> 5,000 to 10,000	> 15,000 to 30,000	5,000 m ² / 15,000 kg
> 10,000 to 50,000	> 30,000 to 150,000	10,000 m ² / 30,000 kg
> 50,000	> 150,000	20,000 m ² / 60,000 kg

TABLE 3
Tests, Units, and Multipliers for Type I and Type II Sealers

Test Method	Test Description	Unit	Type I Multiplier	Type II Multiplier
ASTM D6997	Residue by Distillation	%	200	200
ASTM D6997	Oil Portion of Distillate, By Volume	%	50	50
ASTM D7496	Viscosity at 50 °C, Less Than Minimum	Saybolt Furol Seconds	30	-
	Viscosity at 50 °C, Greater Than Maximum	Saybolt Furol Seconds	5	-
	Viscosity at 25 °C, Less Than Minimum	Saybolt Furol Seconds	-	30
	Viscosity at 25 °C, Greater Than Maximum	Saybolt Furol Seconds	-	5
ASTM D6933	Sieve Test	%	-	1000
ASTM D1310	Flash Point, Open Tag	°C	10	-
Tests on Residue				
ASTM D5M	Residue Penetration at 25 °C	0.1 mm	15	15
ASTM D8078	Ash Content, By Mass	%	1000	1000
ASTM D113	Residue Ductility at 25 °C	cm	10	10



CONSTRUCTION SPECIFICATION FOR PATCHING OF ASPHALT PAVEMENT

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307.01 SCOPE

This specification covers the requirements for patch repairs to asphalt pavement using emulsified asphalt patching material, or proprietary cold patching material (PCPM).

307.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1153 Emulsified Asphalt Patching Material and Proprietary Cold Patching Material

307.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Binder means the approved bituminous binding material conforming to the manufacturer's product specification.

Proprietary Cold Patching Material (PCPM) means a cold patching mix consisting of binder and aggregates, and manufactured by a specific company at their terminal, without further blending or modification prior to distribution to the work site.

307.04 DESIGN AND SUBMISSION REQUIREMENTS

307.04.01 Submission Requirements

Submission requirements for emulsified asphalt patching material or PCPM shall be according to OPSS 1153.

307.05 MATERIALS

307.05.01 Emulsified Asphalt Patching Material

Emulsified asphalt patching material shall be according to OPSS 1153.

307.05.02 Proprietary Cold Patching Material

The PCPM shall be according to OPSS 1153.

307.06 EQUIPMENT

307.06.01 Placement and Compaction

Method, equipment, and hand tools used for placing and compaction of patching material shall ensure durable work.

307.07 CONSTRUCTION

307.07.01 General

Asphalt repairs using patching material shall be carried out at the locations specified in the Contract Documents.

307.07.02 Stockpiling

If stockpiling of patching material is required, stockpiles shall be built to a maximum height of 3 m, and at locations specified in the Contract Documents or agreed between Contractor and Contractor Administrator. Stockpiles shall be constructed in such a manner that compaction, other than by the weight of the material itself, shall not result.

Equipment shall not be run over the surface of the stockpile.

307.07.03 Delivery

The mixture shall be transported in vehicles with smooth metal boxes in good and leak-proof condition, previously cleaned of all foreign materials.

Truck boxes shall be lightly coated with a uniform application of a release agent just prior to loading. If liquid agent is used, the truck boxes shall be drained after each application and prior to loading.

307.07.04 Surface Preparation

The surface on which the patching material is placed shall be free of dirt, sand, foreign matter and loose material. Standing water in the repair area shall be removed prior to placement of patching material, or follow the manufacturer's installation instructions if PCPM is used.

307.07.05 Placement and Compaction

307.07.05.01 General

At the time of use, stockpiled patching material shall exhibit uniform coating, good cohesion and workability.

During the patching operation the mixture placed shall adhere to the adjacent surfaces.

For repairs, patching material shall be placed in the repair area and compacted as specified in the Contract Documents. Placement and compaction of the patching material shall be sufficient to meet the requirements according to the Surface Appearance subsection.

For repairs greater than 50 mm in depth, the patching material shall be placed in lift thicknesses of maximum 50 mm in depth and each lift shall be compacted prior to the addition of the next lift.

307.07.06 Surface Appearance

After placement and final compaction of the patching material, patches shall be free of defective areas, including, but not limited to wheel track marking, ravelling, uneven surface, and fat spots.

307.07.07 Material Sampling and Testing

Patching material samples shall be provided when requested by the Owner. Samples may be requested before or during the construction. The samples shall be taken from the stockpile, truck, or during placement of the material.

Samples required for stripping resistance, workability, and cohesion testing shall be a minimum 25 kg. Samples required for extraction and gradation testing shall be a minimum 15 kg.

All samples shall be obtained, labeled and packaged in the presence of the Contract Administrator. Sample containers shall be supplied and shall be metal containers equipped with a wire handle and a tight fitted lid. Samples shall be labelled with the following information:

- a) Contract Number.
- b) Sampling date.
- c) Mixture type and name.
- d) Sampling location.
- e) Manufacturer's name.
- f) Contractor's name.
- g) Weather conditions at the time of sampling.
- h) Sampler's name.

Completed samples shall be submitted to the Contract Administrator for delivery to the Owner's designated laboratory.

307.07.08 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

307.08 QUALITY ASSURANCE

307.08.01 Acceptance

The Contract Administrator shall determine the acceptance of all patching work based on all of the following:

- a) Visual observation of the patching material - During the time of patching, the mix used shall exhibit uniform coating, good cohesion, and workability.
- b) Surface appearance of the patch at the time of patching - All patches after final compaction shall be free of defective areas, including, but not limited to wheel track marking, raveling, uneven surface, and fat spots. Areas showing such defects shall be deemed rejectable.
- c) Continuity with adjacent surfaces.
- d) Conformance of the patching materials to the mixture property testing requirements - Test results for stripping resistance, workability and cohesion not meeting the mixture property testing requirements according to OPSS 1153 shall be deemed rejectable.

307.08.02 Testing

Patching material samples may be taken and tested by the Owner to ensure the material is according to OPSS 1153 and this specification.

The Owner may request the Contractor to provide test results showing that the patching material possesses the mixture property testing requirements according to OPSS 1153.

307.08.03 Rejection

All material and patches rejected by the Contract Administrator shall be removed and replaced. The replaced portion of the work shall meet the requirements of this specification.

307.09 MEASUREMENT FOR PAYMENT

307.09.01 Actual Measurement

307.09.01.01 Emulsified Asphalt Patching Material Proprietary Cold Patching Material

Measurement of patching material shall be by mass in tonnes.

307.10 BASIS OF PAYMENT

**307.10.01 Emulsified Asphalt Patching Material - Item
Proprietary Cold Patching Material - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR TACK COATING AND JOINT PAINTING

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308.10	BASIS OF PAYMENT

308.01 SCOPE

This specification covers the requirements for the placement and acceptance of tack coating, and joint painting.

308.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result
OPSS 914 Waterproofing Bridge Decks with Hot Applied Asphalt Membrane

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-100 Rounding-Off of Test Data and Other Numbers
LS-325 Field Verification of Tack Coat Application Rate

MTO Forms:

PH-CC-139 Bituminous Mix and Core Sample Identification
PH-CC-325 Method B: Field Verification of Tack Coat Application Rate
PH-CC-326 Method C: Field Verification of Tack Coat Application Rate by Tack Coat Distributor's Display

ASTM International

D5/D5M-20 Test Method for Penetration of Bituminous Materials
D2995-23 Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
D6997-12(2020) Test Method for Distillation of Emulsified Asphalt

American Association of State Highway and Transportation Officials (AASHTO)

R 66-16 (2020) Standard Practice for Sampling Asphalt Materials
TP 114-18 (2022) Provisional Standard Method of Test for Determining the Interlayer Shear Strength (ISS) of Asphalt Pavement Layers

308.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Binder Course means as defined in OPSS 313.

Emulsified Asphalt means as defined in OPSS 1103.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Joint means as defined in OPSS 313.

Lot means as defined in OPSS 313.

Protection Board means as defined in OPSS 914.

Surface Course means as defined in OPSS 313.

Tack Coat Break means when the water separates enough from the emulsified asphalt for the colour to change from brown to black.

Tack Coat Set means when all the water from the emulsified asphalt has evaporated, leaving only the residual asphalt cement.

308.04 DESIGN AND SUBMISSION REQUIREMENTS

308.04.01 Submission Requirements

308.04.01.01 Tack Coat and Joint Painting Material

At least 5 Business Days prior to the first use of tack coat and/or joint painting material, the following documentation shall be submitted to the Contract Administrator:

- a) Type and grade of emulsified asphalt to be used as tack coat and joint painting material;
- b) Supplier and applicator of the material;

- c) Safety data sheet and any other information for the safe handling, transportation, and storage of the material;
- d) Typical test results; and
- e) Minimum residue, minimum application rates, and residual application rates.

Proposals for the use of alternative tack coat and joint painting material, shall be submitted in writing to the Contract Administrator at least 10 Business Days prior to the intended use of the alternate material. The Contract Administrator shall respond in writing within 5 Business Days of receiving the proposal. The alternate material shall not be used until the Contract Administrator has granted permission in writing.

The proposal shall include the following:

- a) The reason for the use of the alternate material;
- b) Type and grade of emulsified asphalt to be used as alternate tack coat and joint painting material;
- c) Safety data sheet and any other information for the safe handling, transportation, and storage of the material;
- d) Testing protocols to be used in confirming the properties of the material;
- e) Typical test results; and
- f) Minimum residue, minimum application rates, and residual application rates.

308.05 MATERIALS

308.05.01 Tack Coat and Joint Painting Material

Tack coat and joint painting material shall consist of SS-1, SS-1H, or SS-1HH emulsified asphalt diluted up to a maximum of 50% with water (maximum dilution 1:1). Diluted tack coat materials shall meet the requirements specified in Table 1.

Tack coat and joint painting material shall be homogenous after mixing and maintain their physical and engineering properties for at least 24 Days from the Day of delivery of the tack coat to the paving site. The undiluted material shall be according to OPSS 1103.

308.06 EQUIPMENT

308.06.01 Joint Painting Distributors

A hand-held pressure applicator may be used for joint painting.

308.06.02 Tack Coat Distributors

For main lane paving, tack coat shall be applied using self-propelled or tow-along pressure distributors capable of applying the material at the specified application rate and in a continuous and uniform manner both longitudinally and transversely for the full lane width. The distributors shall be equipped with a volume-metering system of sufficient sensitivity to measure the quantity of tack coat dispensed. The distributors shall be equipped, maintained, and operated to provide uniform heating and application rates as specified.

The distributor's metering system shall be accompanied by documentation confirming that it is calibrated within the past 12 months by the manufacturer, or its authorized representative, and such documentation shall be submitted to the Contract Administrator.

The use of a hand-held pressure applicator is acceptable for tack coating protection board and small irregularly shaped areas such as tapers.

308.07 CONSTRUCTION

308.07.01 Operational Constraints

Surfaces to be tack coated and joint painted shall be free of all water and contamination, such as dirt, mud, loose aggregate, or debris. Protection board shall be dry and clean prior to the application of the tack coat.

Tack coating and joint painting shall be placed sufficiently ahead of the paving operation to allow for the tack coat set to occur prior to paving. Application of tack coating and joint painting shall only be applied to areas scheduled for HMA paving operations for that day or night.

Paving and construction equipment shall not be permitted onto the tack coated surfaces until after tack coat break and set has occurred. HMA shall not be placed on tack coated areas until tack coat set has occurred. Traffic shall be prevented from travelling upon the tack coated areas.

Construction traffic shall be limited from travelling upon the tack coated areas and construction trucks shall not be lined up on the tack coated areas. All other traffic shall be prevented from travelling upon the tack coated areas.

308.07.02 Tack Coat Application

Tack coat shall be applied to the following:

- a) Protection board;
- b) New and existing pavement surfaces including, but not limited to, HMA and Portland cement concrete;
- c) Milled pavement surfaces;
- d) Expanded asphalt surfaces;
- e) Cold in-place recycled surfaces;
- f) Hot in-place recycled surfaces;
- g) The surfaces of all new and existing binder courses;
- h) The surfaces of padding and levelling courses; and
- i) Other areas specified in the Contract Documents.

308.07.03 Tack Coat Application Rates

The tack coat shall be applied at the application rate specified in Table 2. When a proposal to use an alternative tack coat material has been accepted, the application rates shall be as specified in the accepted proposal.

308.07.04 Joint Painting

Joint faces shall be painted with a thin, uniform, and continuous coating of joint painting material to the satisfaction of the Contract Administrator. The joint between echelon paved lanes is not required to be painted. The joint between pavement lanes paved with an infrared joint heater shall not be painted.

308.07.05 Material Sampling and Testing

308.07.05.01 General

Sampling frequency and sample size shall be according to Table 3.

308.07.05.02 Tack Coat

Tack coat samples for testing shall be representative of the material being used on site and shall be obtained at the paving site according to AASHTO R 66 in the presence of the Contract Administrator. A set of two samples shall be taken from each subplot. One of these samples shall be for quality assurance (QA) testing and the other shall be for referee testing. All required samples for acceptance and referee purposes shall be acquired at the same time and location as selected by the Contract Administrator.

The minimum quantity of each of the QA and referee samples shall be 1 litre. Only new containers shall be used for sampling purposes. Sample containers shall be triple tight 1 litre cans or suitable plastic containers of similar capacity that can be closed to prevent any leakage.

Samples shall be taken from a sampling spigot on the transfer line or, if one is not available, from the end of the transfer line. Each sample shall be taken after sufficient material has been drawn from the distributor truck tank to purge the transfer line. Sample containers shall be supplied and filled, leaving sufficient space to allow for expansion.

308.07.05.03 Pavement Core Samples for Interlayer Shear Strength Testing

The Contract Administrator shall submit in writing the random surface core sample locations. One core shall be obtained from the pavement surface from each lot no later than the next Business Day after the completion of paving. The cores shall be taken in the presence of the Contract Administrator for information purposes. Each core shall meet the following requirements:

- a) The pavement cores shall be approximately 150 mm in diameter (145 mm to 150 mm) with the entire surface of the perimeter perpendicular to the top surface of the core within 6 mm;
- b) Pavement cores shall be taken full depth, where possible, so that no prying action is needed to extract the cores from the pavement. As a minimum, the pavement core shall consist of two asphalt layers (i.e., full top layer and one underlying layer);
- c) For composite pavements, the core shall be extracted only from the asphalt layers and shall not go into the concrete base; and
- d) If a pavement core debonds at the interface during the coring operation, an additional pavement core shall be taken, and a note of the occurrence shall be added to the MTO form PH-CC-139, Bituminous Mix and Core Sample Identification.

Prior to coring at the core location, the direction of travel shall be marked using a permanent marker with a straight line arrow across the diameter parallel to the traffic flow so that it can be identified once the core is removed. A MTO form PH-CC-139, Bituminous Mix and Core Sample Identification, shall be filled out in full and submitted with the core samples. Cores shall not be taken on bridge decks. Cores shall be taken a minimum of 1.0 m away from other cores.

The traffic direction, lot and subplot numbers shall be clearly marked using a permanent marker on all cores.

HMA and compaction requirements for filling the sample holes shall be the same as the adjacent undisturbed pavement. Sample holes shall be cleaned, dried, filled, and then compacted using mechanical self-powered gas-powered, electric-powered, or air-powered compactor immediately after sampling.

308.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

308.08 QUALITY ASSURANCE

308.08.01 Acceptance Criteria for Tack Coat

Acceptance of the tack coat shall be based on the following criteria:

- a) Tack coat material:
 - i. Percent residue.
- b) Field application:
 - i. Field tack coat application rate.
 - ii. Appearance/coverage.

308.08.02 Acceptance of Tack Coat Material

308.08.02.01 General

The Owner shall conduct tests, carry out calculations and provide test results according to Table 4. Test results shall be submitted to the Contractor as they become available to the Contract Administrator.

The Contract Administrator shall determine the acceptability of tack coat.

308.08.02.02 Lot and Sublot Sizes

The Contract Administrator shall determine the size and location of the lots for each tack coat application rate, after discussion with the Contractor and before HMA production. There shall be separate lot(s) for each specified application rate for tack coat material used on the Contract. The lots shall be divided into sublots. Sublot size shall be the quantity used to cover an area of 40,000 m², however, sublot sizes may be adjusted to ensure a minimum of three sublots per lot. A sublot may be terminated at the Contractor Administrator's option when HMA production for the work ceases for a period of 20 Business Days or more.

308.08.02.03 Basis of Acceptance

308.08.02.03.01 General

Tack coat material acceptance is based on the percent residue of the diluted material according to Table 1 for each sublot. The percent oil portion of distillate and penetration shall be reported for each sublot for information purposes only.

308.08.02.03.02 Weighted Lot Mean for the Percent Residue

The weighted lot mean for the percent residue (WM_{pro}) shall be calculated using the following equation:

$$WM_{pro} = \frac{((PR_1 \times A_1) + (PR_2 \times A_2) + \dots + (PR_n \times A_n))}{(A_1 + A_2 + \dots + A_n)}$$

Where:

- WM_{pro} = Weighted lot mean for the percent residue shall be calculated to one decimal place according to LS-100.
- PR_n = Percent residue for sublot n
- A_n = The area of sublot n in square metres
- n = The number of sublots with percent residue equal to or greater than 26.5%

Sublots with percent residue equal to or greater than 26.5% shall be accepted into the work with a payment adjustment according to the Payment Adjustment for Tack Coat clause.

Sublots with percent residue less than 26.5% shall be deemed rejectable and shall not be included in the weighted lot mean for percent residue payment factor calculation.

308.08.02.03.03 Residue Penetration

One penetration test shall be performed on the residue obtained by the distillation test on the diluted material for each subplot. The penetration test results shall be reported for information purposes only.

308.08.02.03.04 Referee Testing

Referee testing for percent residue, penetration, and oil portion of distillate for a given subplot can only be invoked by the Contractor within 2 Business Days of the Contractor receiving the subplot results and if the referee sample received by the laboratory is in a condition suitable for testing.

All referee test results shall replace the respective QA test results for acceptance of the applicable subplot and shall be binding on both the Owner and the Contractor.

If the referee percent residue subplot test result is less than 27.5%, then the Contractor shall bear the cost of the referee testing at the rates specified in the Contract Documents.

308.08.03 Acceptance of Field Application

308.08.03.01 General

The Owner's acceptance of field application shall consist of the field application rate and appearance meeting the requirements of the Contract Documents.

The Contract Administrator shall determine the acceptability of tack coat and joint painting.

All material and work shall be visually inspected by the Contract Administrator. Visually defective material and work shall be rejected or repaired to the Contract Administrator satisfaction.

308.08.03.02 Verification of Field Tack Coat Application Rate

Verification of field tack coat application rate for each subplot shall be conducted by the Contract Administrator by using one of the following options and testing frequency as determined by the Contract Administrator:

- Option 1: An initial verification of field application rate on a 100 m trial section at the start of the application of tack coating the first subplot and then on every subplot thereafter by using LS-325 Method A (ASTM D2995) or B (Simplified Method).
- Option 2: An initial verification of field application rate on a 100 m trial section at the start of application of tack coating the first subplot by using LS-325 Method A (ASTM D2995) or B (Simplified Method) then on every subplot thereafter by using LS-325 Method C (Tack Coat distributor's Display Method).
- Option 3: An initial verification of field application rate on a 100 m trial section at the start of application of tack coating the first subplot and then on every subplot thereafter using the LS-325 Method C (Tack Coat Distributor's Display Method).

Sublots with field tack coat application rates less than the minimum application rates for tack coat specified in Table 2 shall be deemed rejectable.

308.08.03.03 Joint Painting Application Rate Acceptance

Joint painting shall provide a thin, uniform, and continuous coating to the satisfaction of the Contract Administrator.

308.08.03.04 Appearance Acceptance

The tack coat and joint painting application shall be visually uniform and shall fully cover the area specified in the Contract Documents. Areas of insufficient or non-uniform coverage shall be re-sprayed by the Contractor at no additional cost to the Owner. Where tack coating is performed using hand-held devices, the visual appearance of such areas shall be consistent with the adjacent areas of machine applied material. Tack coat and joint painting deemed by visual appearance to be non-uniform or to have uncoated surfaces or to have patches of bare material due to tracking by vehicles or dirty or does not fully cover the areas specified in the Contract Documents, shall be deemed rejectable.

308.08.04 Disposition of HMA Produced with Rejectable Tack Coat

The Owner shall review the laboratory testing and field application rate test results and determine the disposition of the HMA placed on any tack coat that is deemed rejectable.

HMA placed on tack coat for which both laboratory testing and field application results are rejectable shall be subject to repair or payment adjustment. The Owner shall determine if HMA placed on a rejectable tack coat subplot may remain in the work without repairs, with a payment adjustment accepted by the Owner. When test results indicate non-conformance with the Contract Documents, all costs to the Owner to establish the degree and extent of the non-conformance shall be the responsibility of the Contractor.

308.09 MEASUREMENT FOR PAYMENT

308.09.01 Actual Measurement

Measurement of Tack Coat shall be by area in square metres.

308.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

308.10 BASIS OF PAYMENT

308.10.01 Tack Coat - Item

308.10.01.01 General

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, except that:

- a) Payment for joint painting shall be made under the appropriate hot mix tender item.
- b) Payment for tack coating of concrete surfaces completed in association with bridge deck waterproofing shall be included in the bridge deck waterproofing item and payment for tack coating of the protection board shall be paid under the Tack Coat item.
- c) When a payment adjustment applies according to the Payment Adjustment for Tack Coat clause.

308.10.01.02 Payment Adjustment for Tack Coat

The payment adjustment for each lot of tack coat shall be calculated using the following equation:

$$\text{Payment Adjustment} = A_{\text{Total}} \times \text{Price} \times \text{TODRF} (1.00 - \text{PRPF})$$

Where:

- A_{Total} = Total tack coated area in square metres of sublots included in the weighted lot mean percent residue.
- TODRF = Tender opening date reduction factor according to Table 5.
- Price = The price shall be the tender item price for the tack coat material or the negotiated price of the alternate material if the Owner accepted the use of that material.
- PRPF = Percent residue payment factor from Table 6 using the weighted lot mean percent residue (WM_{pro}) calculated for the lot according to the Weighted Lot Mean for the Percent Residue clause.

TABLE 1
Tack Coat Material
Requirements (Maximum Dilution 1:1)

Emulsified Asphalt Type/Grade	Test Method	SS-1	SS-1H	SS-1HH
Minimum Residue by Distillation, % by Mass	ASTM D6997	27.5	27.5	27.5
Maximum Percent Oil Distillation	ASTM D6997	1.5	1.5	1.5
Penetration on Residue (at 25 °C, 100 g, 5 s), 0.1 mm	ASTM D5	100-200	40-100	20-55

TABLE 2
Application Rate Requirements for Tack Coat Material

Surface Type	Minimum Residual Application Rate, kg/m²	Minimum Application Rate for Undiluted Tack Coat, kg/m² (Note 2)	Minimum Application Rate for Diluted Tack Coat, kg/m² (Note 4)	Range of Application Rate for Diluted Tack Coat, kg/m² (Note 5)
Existing pavement surfaces, milled pavement surfaces, full-depth reclamation with expanded asphalt stabilization surfaces (Note 1) and any binder course surface that has been left open to traffic over at least one winter.	0.10 kg/m ²	0.18 kg/m ² (Note 3)	0.35 kg/m ²	0.35 - 0.45 kg/m ²
Cold in-place recycled surfaces, cold in-place recycled expanded asphalt mix surfaces, hot in-place recycled surfaces, and new surfaces that have been paved in the same calendar year.	0.07 kg/m ²	0.13 kg/m ² (Note 3)	0.25 kg/m ²	0.25 - 0.35 kg/m ²
Protection board.	0.14 kg/m ²	0.25 kg/m ²	0.50 kg/m ²	0.50 - 0.60 kg/m ²

Notes:

1. SS-1H and SS-1HH tack coat not permitted on full depth reclamation with expanded asphalt stabilization surfaces.
2. Undiluted tack coat with a minimum residue of 55%.
3. If undiluted tack coat is used, consult with the tack coat distributor's manufacturer or equipment supplier for any equipment limitations.
4. Diluted tack coat with a minimum residue of 27.5%.
5. Range of application rate is provided for equipment variability.

A. kg/m² can be interchangeable to l/m² considering specific gravity of 1.00.

TABLE 3
Sampling Frequency and Sample Size for Tack Coat Material

Sample Type	Frequency	Minimum Sample Quantity	Labelling
QA and Referee	Every Sublot	One Litre Each	• Tack Coat Material Type • Supplier
Pavement Core Sample for Interlayer Shear Strength (ISS) Test by QA Laboratory	Every Lot	One Core Every Lot	• Attach completed MTO form PH-CC-139, Bituminous Mix and Core Sample Identification • ISS Testing • Traffic direction marked with an arrow on ISS core • Tack Coat Material Type • Field Application Rate • Surface Type on which tack coat was applied • Supplier • Mix Type

TABLE 4
Testing Requirements for Tack Coat Material

Properties and Attributes	Testing Method	Calculations, Values, and Results Required
Test on Emulsified Asphalt		
Residue by Distillation, % by Mass	ASTM D6997	• % Residue to 0.1%, • Weighted Lot Mean to 0.1%
Percent Oil Distillation	ASTM D6997	% Oil Distillate to 0.1% (For information purposes only)
Test on Residue		
Penetration (at 25 °C, 100 g, 5 s)	ASTM D5	Penetration Units to 1 dmm (For information purposes only)
Assessment of Field Application		
Verification of Field Tack Coat Application Rate	LS-325	• Application Rate of Tack Coat in the Field • Complete and submit MTO form PH-CC-325, Field Verification of Tack Coat Application Rate (LS-325-Method B-Using Simplified Procedure) and MTO form PH-CC-326, Field Verification of Tack Coat Application Rate (LS-325-Method C-Using Tack Coat Distributor's Display), as applicable
Appearance	Visual Assessment	Visual assessment of uniformity and coverage
Test on Pavement Cores - Interlayer Shear Strength (ISS) Test		
Interlayer Shear Strength (ISS) test on Pavement Cores (Bond Strength Test)	AASHTO TP 114. This test to be conducted on field pavement cores. No normal load is required during testing.	ISS, Ultimate Applied Load (For information purposes only)

TABLE 5
Tender Opening Date Reduction Factor for Tack Coat Payment Factor

Year of Tender Opening	Tender Opening Date Reduction Factor (TODRF)
2023 and 2024	0.75
2025 and beyond	1.00

TABLE 6
Payment Factors for Weighted Lot Mean Percent Residue

% Residue - Weighted Lot Mean (WM_{pro})	Percent Residue Payment Factor (PRPF)
≥ 27.5	1.00
26.5 - 27.4	0.75



Note: The PROV published in April 2023 replaces OPSS 311 COMMON, September 1988 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
ASPHALT SIDEWALK, DRIVEWAY, BOULEVARD
AND SIDEWALK RESURFACING**

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311.10	BASIS OF PAYMENT

311.01 SCOPE

This specification covers the requirements for the construction of asphalt sidewalk, driveway and boulevard on prepared base and for the resurfacing of existing sidewalk.

311.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 102 Weighing of Materials

Ontario Provincial Standard Specifications, Material

OPSS 1103 Asphalt Emulsion
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

311.05 MATERIALS

311.05.01 Hot Mix

The hot mix for this work shall conform to OPSS 1151 except that the final mix gradation may be altered by the Engineer to adjust the percentage of coarse aggregate.

311.05.02 Asphalt Emulsion

The asphalt emulsion shall be undiluted SS-1 and shall conform to OPSS 1103.

311.06 EQUIPMENT

311.06.01 Roller

A hand operated roller weighing not less than 135 kg or an approved power roller shall be used.

311.07 CONSTRUCTION

311.07.01 General

The hot mix shall be placed on the prepared base or on the surface of the existing sidewalk to line, grade, and dimensions as shown in the Contract. The prepared base shall be dry, well compacted and approved by the Engineer before work commences.

Hot mix shall not be placed unless the surface is dry and the air temperature is at least 7 °C. Hot mix shall not be dumped faster than it can be properly raked and screeded.

Areas inaccessible to the roller shall be compacted with hand operated hot tampers.

The sidewalk, driveways and boulevard shall not be opened to pedestrians or vehicles until the mix has cooled sufficiently to prevent deformation.

Forms or other approved means shall be used to obtain proper line and neat uniform edges.

311.07.02 Sidewalk Resurfacing

The surface of the existing sidewalk on which asphalt is to be placed shall be thoroughly cleaned. Loose and broken material shall be removed from locations designated in the Contract and disposed of outside the contract limits.

Sound concrete and/or asphalt surfaces which are to remain shall be uniformly sprayed with SS-1 Emulsion at the rate of 0.5 kg/m². The emulsion shall form a continuous film over the surface and shall be allowed to dry until it reaches the required state of tackiness before the resurfacing course is laid.

311.07.03 Tolerances

The surface, after compaction, shall be smooth and true to the established grade and of a uniform texture.

The surface of the finished sidewalk, driveway and boulevard shall be free from depressions exceeding 5 mm as measured with a 3 m straight edge placed anywhere on the sidewalk parallel to the centreline.

311.09 MEASUREMENT FOR PAYMENT

311.09.01 Actual Measurement

**311.09.01.01 Asphalt Sidewalk
Asphalt Driveway
Asphalt Boulevard
Sidewalk Resurfacing**

Measurement will be of the area in place in square metres.

311.09.02 Plan Quantity Measurement

**311.09.02.02 Asphalt Sidewalk
Asphalt Driveway
Asphalt Boulevard
Sidewalk Resurfacing**

Measurement is by Plan Quantity, as may be revised by Adjusted Plan Quantity, of the horizontal area in square metres.

311.09.03 Hot Mix

Measurement for payment of hot mix designated for this work shall be in tonnes conforming to OPSS 102.

311.10 BASIS OF PAYMENT

**311.10.01 Asphalt Sidewalk - Item
Asphalt Driveway - Item
Asphalt Boulevard - Item
Sidewalk Resurfacing - Item**

Payment at the contract price for the above tender item(s) shall be full compensation for all labour equipment and materials to do the work.

311.10.02 Hot Mix

Hot mix designated for this work will be paid for at the contract price for the appropriate hot mix tender item.



**CONSTRUCTION SPECIFICATION FOR
ASPHALT CURB AND GUTTER SYSTEMS AND
ASPHALT SURFACING OF GUTTERS**

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312.09	MEASUREMENT FOR PAYMENT
312.10	BASIS OF PAYMENT
312.01	SCOPE

This specification covers the requirements for the construction of asphalt curb and gutter, gutter outlets, spillways and for the asphalt surfacing of asphalt or concrete gutter.

312.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 313	Hot Mix Asphalt – End Result
OPSS 314	Untreated Subbase, Base, Surface, Shoulder, Select Subgrade and Stockpiling

Ontario Provincial Standard Specifications, Material

OPSS 1103	Emulsified Asphalt
OPSS 1151	Superpave and Stone Mastic Asphalt Mixtures

312.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Curb and Gutter means curb, gutter or combinations of curb and gutter.

Curb and Gutter Systems means curb and gutter, setbacks, gutter outlets, concrete spillways, bullnoses or any combination of them, including catch basin frames and grates which lie within the flow lines of the curb and gutter system.

312.05 MATERIALS

312.05.01 Hot Mix

Asphaltic concrete shall be according to OPSS 1151. The type of hot mix asphalt (HMA) shall be as specified in the Contract Documents.

312.05.02 Emulsified Asphalt

Emulsified asphalt shall be undiluted SS-1 according to OPSS 1103.

312.06 EQUIPMENT

312.06.01 Asphalt Paver

The asphalt paver shall be equipped with a template capable of obtaining the cross section specified in the Contract Documents.

312.06.02 Roller

The hand-operated roller shall weigh not less than 135 kg.

312.06.03 Asphalt Curb Machine

The asphalt curb machine shall be equipped with a template capable of obtaining the cross section specified in the Contract Documents.

312.07 CONSTRUCTION

312.07.01 General

The HMA specified shall be placed on the prepared base or on the surface of the existing curb and gutter to the lines, grade, and dimensions specified in the Contract Documents.

Asphalt curb and gutter may, at the Contractor's option, be placed integrally with an adjacent lane of HMA. The placement of the curb and gutter shall be done using a curb attachment on the paver.

HMA shall be compacted using a roller. Areas inaccessible to the roller shall be compacted by hand operated hot tampers.

312.07.02 Operational Constraints

Operational constraints for the placing of HMA for asphalt curb and gutter construction shall be according to OPSS 313.

Asphalt curb and gutter shall not be placed unless the ambient air temperature is at least 2 °C.

312.07.03 Foundation and Backfill

The foundation shall be excavated, backfilled, and compacted to the grade and shape required to allow for placement of the HMA curb and gutter system to the line, grade, and dimension specified in the Contract Documents.

Excavation and embankment construction shall be according to OPSS 206.

Granular base and granular backfill construction shall be according to OPSS 314.

312.07.04 Surface Preparation of Gutter

The surface of the asphalt or concrete gutter on which asphalt is to be placed shall be cleaned of all dirt, loose and broken materials. The sound asphalt or concrete gutter shall be sprayed with emulsified asphalt at the rate of 0.5 kg/m². The application of emulsion shall extend onto the pavement for a width of 0.15 m. The emulsion shall form a continuous film over the surface and shall be allowed to cure until it reaches the required state of tackiness before the asphalt surfacing is placed.

312.07.05 Finishing

After the compacted HMA has cooled to ambient temperature, the exposed vertical surfaces of the asphalt curb and gutter system shall be sprayed to 0.15 m beyond the front edge with emulsified asphalt at a rate of 0.5 kg/m². The emulsion shall be applied before the surface becomes contaminated with any material.

312.07.06 Tolerances

The surface after compaction shall be of uniform texture, smooth and true to the line, grade, and dimensions specified in the Contract Documents. The surface shall be free from depressions exceeding 5 mm as measured from the bottom edge of a 3 m straight edge placed anywhere along the surface of the HMA and parallel to the edge.

312.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

312.09 MEASUREMENT FOR PAYMENT

312.09.01 Actual Measurement

312.09.01.01 Asphalt Curb and Gutter Asphalt Surfacing of Gutters

Measurement shall be by length in metres along the flow line of the gutter and will be of the total length of curb and gutter. Such measurements shall include the spaces occupied by setbacks, gutter outlets and frames and grates.

312.09.01.02 Asphalt Spillways

Measurement of asphalt spillways shall be by length in metres along the flow line from the end of the gutter outlet to the spillway termination.

312.09.01.03 Asphalt Gutter Outlets

For measurement purposes, a count shall be made of the number of setbacks and gutter outlets installed without separation into types.

312.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

312.10 BASIS OF PAYMENT

**312.10.01 Asphalt Curb and Gutter - Item
Asphalt Surfacing of Gutters - Item
Asphalt Spillways - Item
Asphalt Gutter Outlets - Item**

Payment at the Contract price for the above item(s) shall be full compensation for all labour, Equipment and Material to do the work.

312.10.02 Hot Mix

Hot mix designated for this work shall be paid for at the Contract price for the appropriate hot mix asphalt tender item.

312.10.03 Granular Materials

Granular materials required for the work shall be paid for at the Contract price for the appropriate granular tender item.



CONSTRUCTION SPECIFICATION FOR HOT MIX ASPHALT – END RESULT

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313.01 SCOPE

This specification covers the requirements for the placement, compaction, and acceptance of hot mix asphalt (HMA).

This specification also covers the requirements for the placement, compaction, and acceptance of HMA produced using warm mix asphalt (WMA) technology when the tender item title includes “Warm Mix”.

313.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 308	Tack Coat
OPSS 914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane

Ontario Provincial Standard Specifications, Material

- OPSS 1101 Performance Graded Asphalt Cement
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

- LS-100 Rounding-Off of Test Data and Other Numbers
LS-101 Calculation of Per Cent within Limits
LS-262 Bulk Relative Density of Compacted Bituminous Mixtures
LS-264 Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265 Determination of Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-266 Determination of VMA in Compacted Bituminous Mixtures
LS-282 Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-294 Measuring Pavement Lift Thickness
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-310 Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
LS-317 Determination of the Severity of a Segregated Asphalt Pavement Surface
LS-604 Relative Density and Absorption of Coarse Aggregate
LS-605 Relative Density and Absorption of Fine Aggregate

ASTM International

- D6752 - 18 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
E178 - 16 Standard Practice for Dealing with Outlying Observations

American Association of State Highway and Transportation Officials (AASHTO)

- M 320-17 Standard Specification for Performance Graded Asphalt Binder
R 35-17 Superpave Volumetric Design for Hot - Mix Asphalt
T 166-16 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 283-14 Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
T 312-19 Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor

313.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Ambient Air Temperature means the air temperature measured in the shade and away from the paving operations.

Anti-Stripping Treatment (AST) means as defined in OPSS 1151.

Asphalt Cement (AC) means asphalt binder as defined in OPSS 1101.

Attribute means one of the following properties: designated large sieve (DLS), 4.75 mm sieve, 75 µm sieve, AC content, air voids, lift thickness, VMA, draindown, or compaction.

Binder Course means a HMA course between a surface course and either a granular base course or stabilized base course, an existing pavement, or another HMA binder course.

Crack means a break in the pavement surface, a separation of the pavement or aggregates at the surface of the pavement, and separation of pavement joints, and includes breaks and separations previously repaired by sealing.

Design Lift Thickness (T_D) means the thickness in millimetres as specified in the Contract Documents of:

- a) A specified lift of asphalt mix measured by square metres, or
- b) For multiple binder course lifts of the same tender item, it means the combined specified thicknesses in millimetres of the successive binder course lifts of the same tender item, at the same location measured by square metres.

Designated Large Sieve (DLS) means a sieve size specifically designated for each mix type for gradation testing. The designated sieve for the following mix types is:

- a) 25.0 mm for Superpave 37.5;
- b) 19.0 mm for Superpave 25.0;
- c) 12.5 mm for SMA 19.0 and Superpave 19.0;
- d) 9.5 mm for SMA 12.5 and Superpave 12.5, 12.5FC 1 and 12.5FC 2; and
- e) 4.75 mm for SMA 9.5 and Superpave 9.5.

Draindown means that portion of SMA mixture, fines and AC, that separates and flows downwards through the mixture.

Fat Spot means an area of pavement where asphalt mastic has migrated to the surface creating a substantially blacker area than the surrounding pavement.

Field Adjustment to the Job Mix Formula means a change in the target gradation, AC content, or both of a mix, within limits as specified in the Contract Documents without a redesign of the HMA, resulting in an adjusted JMF.

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete and includes mix produced using WMA technologies. HMA may include recycled or specialty mixes.

Hot Mix Asphalt Miscellaneous means HMA that is placed in areas other than the roadway as specified in the Contract Documents.

Job Mix Formula (JMF) means the percentage passing on each designated sieve of the total mass of aggregate and the amount of AC as a percentage by mass of the mixture that are based on mix design procedures as specified in the Contract Documents.

Joint means a vertical contact between a HMA pavement course and any HMA pavement or any rigid object that exists at the time the HMA is laid.

Levelling Course means a HMA course of variable thickness used for correcting crossfall and profile deficiencies in the existing pavement prior to placing a HMA binder or surface course. Levelling course may also be referred to as a padding course.

Lift Thickness means the thickness in millimetres, measured according to LS-294, of:

- a) A single lift of asphalt mix measured by square metres, or
- b) For multiple binder course lifts of the same tender item, it means the combined thickness of all placed and compacted successive binder course lifts of the same tender item, at the same location measured by square metres.

Loose Mix means a representative sample of uncompacted HMA for testing mix properties.

Lot means a specific quantity of Material or a specific amount of construction.

Mean means the arithmetic average of the test results within a lot.

Mid-Lane Segregation means a continuous or discontinuous longitudinal “streak” of segregation, typically no greater than 300 mm in width located anywhere across the width of the lane.

Mix Properties means the AC content, gradation, air voids, and VMA.

Other Segregation means discrete areas or patches of regular, irregular, or chevron shape segregation.

Outlier means a test result that for a specific significance level is determined by statistical analysis not to be part of the test result population.

Padding means a HMA layer used to eliminate transverse and longitudinal irregularities on an existing surface before placing the binder or surface course.

Paving in Echelon means two or more pavers are used to pave multiple adjacent lanes simultaneously.

Payment Adjustment Sieves means the DLS, 4.75 mm, and 75 µm gradation sieves.

Percent within Limits (PWL) means an estimate of the percentage of the lot that is within specification limits, determined by using the mean and standard deviation of the lot.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 1101.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements as specified in the Contract Documents.

Quality Control (QC) means a system or series of activities carried out by the Contractor to ensure that Materials supplied to the Owner meet the requirements as specified in the Contract Documents.

Random Sample means a sample from a location chosen by the Contract Administrator based on random numbers such that any portion of a lot or subplot has an equal probability of being selected.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full depth removal.

Segregation means a condition of the pavement characterized by areas with comparatively coarser or finer texture than that of the surrounding pavement, with severity levels:

- a) Slight Segregation - a pavement matrix is in place between the coarse aggregate particles; however, there are slightly more, coarse aggregate particles in comparison with the surrounding acceptable mix.
- b) Medium Segregation - the pavement has significantly more, coarse aggregate particles than the surrounding acceptable mat and usually exhibits some lack of surface matrix.

- c) **Severe Segregation** - the pavement appears very coarse, with coarse aggregate particle against coarse aggregate particle and the pavement has little or no matrix.

Small Quantity Lot means any lot with one or two sublots.

Standard Deviation means the square root of the value determined by summing the squares of the difference between each test result and the mean of the test results divided by the number of test results minus one.

Stone Mastic Asphalt (SMA) means HMA consisting of a gap graded, stone-on-stone coarse aggregate skeleton with an asphalt cement-rich mortar.

SMA Mixes means SMA 9.5, SMA 12.5, and SMA 19.0.

Straight Edge means a straight edge made of metal with a level recessed in its upper surface parallel to the lower edge.

Superpave means a system for specifying material components and asphalt mix design using the Superpave gyratory compactor. It is an acronym for Superior Performing Asphalt Pavements.

Surface Course means the HMA wearing course of any flexible or composite pavement.

Through Lane means a traffic lane not intended for entering or exiting the roadway and does not include shoulders. Where there is more than one roadway, through lane refers to the traffic lane for the higher-class roadway. Freeway to freeway ramps, HOV lanes, and truck climbing lanes are considered through lane.

Vertical Surface means all edges of concrete curbs, catch basins, appurtenances, longitudinal joints, and transverse joints for application of joint painting material.

Voids means air voids and voids in mineral aggregate (VMA).

Warm Mix Asphalt (WMA) means warm mixed, warm laid asphaltic concrete produced using technologies that allow for the mixing, handling and compaction of the asphaltic concrete mixture at a temperature typically 20 to 50 °C lower than conventional HMA.

Waxed-based WMA Technology means a WMA technology that uses in whole or in part synthetic natural wax components.

313.04 DESIGN AND SUBMISSION REQUIREMENTS

313.04.01 Submission Requirements

Prior to the start of paving, the purchase price of the AC, in the form of a purchase order or other document signed by the Contractor's senior financial officer, shall be submitted to the Contract Administrator.

If there is intent to store HMA production in a silo, the planned times of HMA production shall be submitted to the Contract Administrator with one Business Day advance notice.

Prior to the start of paving on bridge decks, the mass of the rollers, except for Class V rollers, to be used on bridge decks shall be submitted to the Contract Administrator in writing. The minimum compaction temperature for HMA or WMA recommended by the AC supplier shall also be submitted to the Contract Administrator in writing.

A copy of the Technical Data Sheet and Safety Data Sheet of the release agent(s) shall be submitted to the Contract Administrator.

313.05 MATERIALS

313.05.01 Hot Mix Asphalt

The HMA shall be according to OPSS 1151. Asphalt cement, tack coat, anti-stripping treatments, release agents, and other additives shall be compatible with the other components of the HMA.

313.05.02 Tack Coat

Tack coat shall be according to OPSS 308.

313.05.03 Release Agents

No release agents shall be used that may adversely affect the quality or performance of the HMA. Release agents shall be used according to the proprietary requirements.

Petroleum based release agents, excess water, or excess release agents shall not be used.

313.05.04 Warm Mix Asphalt

The WMA shall be according to OPSS 1151 and the following:

The mix shall be produced at a facility capable of producing the mix according to the WMA technology supplier's instructions for the use of their WMA technology. All information required for the proper preparation, handling, storage, and use of the WMA materials shall be obtained from the WMA technology supplier.

The use of waxed-based or sulfur-based WMA technologies shall not be permitted.

313.05.05 Grit for Stone Mastic Asphalt

Grit for SMA shall be as specified in the Contract Documents.

313.06 EQUIPMENT

313.06.01 Rollers

A Class R Roller is a self-propelled pneumatic-tired roller.

A Class S Roller is self-propelled steel-drum, tandem, or three-wheel roller.

A Class V Roller is a self-propelled vibratory roller specifically designed for HMA compaction having either dual vibratory rolls or a combination of vibratory roll and pneumatic tires with a contact area equal to or greater than 70% of the roll width.

313.06.01.01 Rollers for Granular Grade Preparation

Finish rolling for granular grade shall be accomplished using, as a minimum:

- a) A Class S roller with a minimum mass of 7 tonnes and minimum mass of 3.5 kg per mm total roll width,
or

- b) A Class V roller with a drum width of at least 1.2 m.

313.06.01.02 Rollers on Bridge Decks

Compaction shall be accomplished using, as a minimum:

- a) A Class S roller with a minimum mass of 9 tonnes and minimum mass of 4.5 kg per mm total roll width, and
- b) A Class R roller with a minimum mass of 18 tonnes and minimum mass of 2,500 kg per tire.

If Class V rollers are used, they shall be used in static mode.

At the Contract Administrator's request, rollers shall be weighed in the presence of the Contract Administrator or a representative.

313.06.02 Diamond Grinding

A diamond grinder shall be power-driven, self-propelled, and designed for grinding HMA. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 1.2 m wide. The grinder shall be equipped with the capability to adjust the depth, slope, and crossfall to remove HMA to the required profile and shall also include a slurry pick-up system.

313.07 CONSTRUCTION

313.07.01 Quality Control

The QC procedures shall be conducted to ensure HMA meets the requirements of the Contract Documents. Interpretation of QC inspections, test results, and measurements and the determination of any action to be taken shall be carried out to ensure that the work is according to the requirements of the Contract Documents.

A single sample for QC purposes may be obtained at the same time and location as QA acceptance samples. No additional loose mix samples shall be taken from the placed mix.

Up to three cores may be taken in each surface lot for additional samples for QC purposes. For binder courses, obtainment of one thickness core from each subplot for each binder lift shall be permitted prior to placement of the surface course. Cores shall not be spaced closer than one metre from any other core. If further additional samples are required, a written request shall be made to the Contract Administrator and samples shall only be taken upon written approval of the Contract Administrator. All sample locations shall be restored as specified in the Contract Documents.

313.07.02 Laboratory Correlations

On request, the Contract Administrator shall provide the opportunity to conduct a correlation of mix properties or compaction or both between the QA and QC laboratories prior to placement of HMA. The correlation may occur once for each mix type and shall be a maximum of three samples per mix type.

The Contract Administrator shall be provided with the samples and all information required to conduct the correlation testing. The Contract Administrator shall submit the QA test results on completion of the correlation testing.

313.07.03 Preparation of Foundation and Existing Pavement

Prior to placing any course of HMA on:

- a) A granular grade, a Class S roller or an equivalent Class V roller shall be used to finish roll the grade ahead of the paver. The granular grade after rolling shall be a compacted, smooth, float-free surface, free from contamination of foreign materials. Any distortion that will impact the specified thickness of the pavement to be placed shall be repaired.
- b) The HMA or concrete surfaces, the HMA and concrete surfaces shall be clean and free of all loose, broken, and foreign materials.
- c) Milled surfaces, the milled surface shall be clean of all loose, broken, and foreign materials and shall be swept with a power broom.

The existing surface being prepared by milling or padding or a combination, shall be prepared such that each lift can be placed and compacted to the thickness as specified in the Contract Documents, provided such corrections do not reduce the thickness of existing pavement materials or underlying materials by more than 5 mm below the general profile of the surrounding existing unground or unmilled pavement surface.

313.07.04 Correction of Pavement Beneath Surface Courses

Corrections may be made to any pavement course underlying the surface course by padding, milling, grinding, or a combination in order to meet the surface smoothness requirements. A plan shall be submitted to the Contract Administrator identifying the limits and types of corrections. The correction work shall be subject to approval of the Contract Administrator. Padding shall be completed using a mix type acceptable to the Owner. The thickness of those pavements after milling or grinding shall not be reduced by more than 5 mm below the general profile of the surrounding unground or unmilled pavement surface. The milled surface shall not exceed 25 mm from ridge to ridge, and the ridge to valley depth of the milled surface shall not exceed 10 mm.

313.07.05 Tack Coat

Tack coat shall be applied to surfaces according to OPSS 308 prior to placing HMA.

313.07.06 Transportation of Hot Mix Asphalt

Truck boxes used to transport HMA shall be clean and, if required, lightly coated with a uniform application of a release agent. Truck boxes shall be drained after each application and before loading.

313.07.07 Placing Hot Mix Asphalt

313.07.07.01 Operational Constraints

Paving shall not be carried out if the roadbed is frozen. When placing the mixture on a granular grade, the granular grade shall not be saturated and shall be free of standing water. The surface of a pavement upon which HMA is to be placed shall be clean and dry at the time of HMA placement.

For paving on bridge decks, a HMA course shall not be placed over the waterproofing membrane and protection board until a minimum 4 hours has elapsed following completion of the waterproofing system or until the waterproofing system has set sufficiently that the integrity of the waterproofing system is not jeopardized. After completion of the waterproofing system and prior to paving, a Request to Proceed shall be submitted to the Contract Administrator. Paving shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

A HMA course shall not be placed upon a previously laid course until the temperature of the previous course is 50 °C or less. For a HMA lift thickness of 60 mm or less, this temperature shall be measured at the surface. For a HMA lift thickness greater than 60 mm, this temperature shall be measured internally.

The HMA binder courses shall be not placed unless the ambient air temperature is at least 2 °C. The HMA surface courses shall not be placed unless the ambient air temperature is at least 7 °C.

Public traffic shall not be permitted on freshly laid HMA until the temperature of the mat is 50 °C or less.

When WMA is used, the WMA technology supplier's recommendations for placing the WMA mix shall be followed. Placement and compaction temperatures of WMA shall be according to the WMA technology supplier's recommendations but shall also meet the operational constraints listed in this clause.

A lot shall be closed before paving begins on a different lot using the same tender item, the same mix design or both; unless otherwise allowed by the Contract Administrator.

313.07.07.02 Paving

313.07.07.02.01 General

Levelling, binder, and surface courses shall be laid by means of mechanical self-propelled pavers. Prior to roller compaction, obvious defects in the HMA placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected. Excess HMA shall not be cast onto the surface of the freshly laid mat. After final compaction of each course the surface shall be smooth and true to the established crown and grade, uniform in texture and shall be free of any defects, including but not limited to, cracks, segregation, fat spots, oil spills, chatter, and roller marks.

If actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct to cease paving until the problem has been corrected.

All through lane paving courses shall be completed prior to the placement of adjacent sideroads, speed change lanes, and other paved areas.

The HMA shall be placed and compacted to the thickness as specified in the Contract Documents for each lift.

At the end of each completed portion of the lanes and prior to opening them to traffic, the ends of completed sections of HMA course shall be temporarily ramped down to the existing pavement according to the Temporary Ramp Downs clause.

If paving is being carried out under lane closures, paving shall be completed to the same station for the full pavement width, including paved shoulders, prior to the roadway being reopened to traffic except as noted in the Partial Paving of Full Pavement Width clause.

313.07.07.02.02 Paving in Echelon

For the purpose of laying levelling, binder and surface courses as specified in the Contract Documents, paving in echelon may be used as an option.

When paving in echelon, the pavers shall be operated at the same time within 60 m of the next paver so that a hot joint is obtained between the lanes of HMA being placed. Should one paver break down while placing levelling, binder, or surface course, the Contract Administrator may permit the Day's work to be completed with the remaining paver only.

313.07.07.02.03 Paving on Bridge Decks

The temperature of the HMA immediately after spreading shall be equal to or greater than the minimum temperature recommended by the AC supplier. When the HMA is produced using WMA technology, the temperature of the WMA immediately after spreading shall be equal to or greater than the minimum temperature recommended by the WMA technology supplier. Breakdown rolling shall commence immediately after spreading.

313.07.07.02.04 Paving Widening and Irregular Sections

The HMA shall be placed in widenings such that the top of the compacted HMA is placed flush with the top of the existing pavement. When stepped joints are specified in the Contract Documents, the layers placed in the widening shall be placed flush with the top of each step in separate operations. HMA shall be placed in the widening using equipment specially designed for this purpose.

In turnouts, driveways, and other irregular sections, other methods may be used to spread and finish the HMA, such methods shall be subject to the approval of the Contract Administrator.

313.07.07.02.05 Partial Paving of Full Pavement Width

Partial paving of the full pavement width is permitted except when one or more of the following conditions exist:

- a) When the ramping height would be greater than 50 mm,
- b) At the longitudinal edges that will form the hot joint of lanes to be paved in echelon when specified under the Paving in Echelon clause, or
- c) The pavement slope would cause water to accumulate at the edge of the ramping and extend onto an adjacent lane or shoulder that will be open to traffic.

When partial paving of the full pavement width is permitted, temporary longitudinal and transverse ramp downs shall be placed regardless of the difference in height elevations between adjacent pavement surfaces.

313.07.07.02.06 Temporary Ramp Downs

The HMA courses shall be temporarily ramped down to the existing pavement at a slope not steeper than 50H:1V transversely. Transverse ramp downs shall not form part of the permanent pavement and shall be removed prior to paving of the adjacent section.

Where longitudinal ramp downs are permitted or if, due to unforeseen circumstances such as equipment breakdown occurring during paving, paving cannot be completed to the same station across the full pavement width, the HMA course shall be temporarily ramped down to the existing pavement at a slope of 10H:1V. Only one temporary longitudinal ramp down shall be in place across the width of the pavement at any time. The temporary longitudinal ramp down shall not form part of the permanent pavement and shall be removed prior to paving the adjacent section. The adjacent paving shall be completed such that the ramping is not in place more than five Days, unless a written request is submitted to the Contract Administrator and a written approval is provided by the Contract Administrator allowing the ramp downs to remain in place for more than five Days.

Loose particles generated during construction of the longitudinal or transverse ramp downs or both shall be removed from the roadway surface prior to re-opening the roadway to traffic. Temporary ramp downs shall remain intact and in place until they are removed prior to paving the adjacent section.

Temporary ramp downs shall be removed to produce a straight clean vertical surface for the full depth of the course prior to paving the adjacent lane or shoulder. After removal of the temporary longitudinal ramp down, traffic shall not be permitted to cross over the vertical surface at the longitudinal edge before the adjacent paving is completed.

313.07.07.03 Longitudinal and Transverse Joints

313.07.07.03.01 General

All joints shall be made to obtain a complete bond between the two pavement edges and a smooth riding surface. The existing or previously placed pavement edge shall be a straight clean vertical surface for the full depth of the course. Where ramping or damage has occurred, trimming shall be required. All dirt or other foreign material and all loose material shall be removed from all vertical surfaces.

313.07.07.03.02 Longitudinal Joints

The longitudinal joints shall be parallel to the lane and visually uniform longitudinally. The width of subsequent courses shall be staggered to an offset of 150 to 300 mm so that longitudinal joints do not coincide. The longitudinal joints in the surface course shall be offset 50 mm from the edge of the demarcation between the lanes as specified in the Contract Documents.

313.07.07.03.03 Transverse Joints at Limits of Paving

Joints between HMA pavement laid under this Contract and existing HMA courses not laid under the Contract shall be constructed as follows:

- a) Where a binder course is placed flush against an existing HMA pavement and a butt joint is to be made, the existing pavement shall be trimmed back to form a straight vertical surface.
- b) Where a surface course is placed flush against an existing HMA pavement, a butt joint shall be prepared by removing the existing pavement to the full depth of the existing surface course to form a straight vertical surface and for a longitudinal distance not less than 5 m so that the surface course placed has a thickness equal to the full depth of the existing surface course over the 5 m section.
- c) Where a binder course and surface course are not placed flush against an existing HMA pavement, the binder course shall be feathered out removing the existing surface course to a minimum depth of not less than 40 mm to form a straight vertical surface and for a longitudinal distance not less than 5 m so that the surface course placed has a minimum thickness of 40 mm over the 5 m section.
- d) Where multiple courses are placed flush against an existing HMA pavement, the joint for each course shall be offset at least 150 mm from the joint on the course below.

At the limits of paving, the placement width of the HMA pavement shall match the width of the existing adjacent pavement.

313.07.07.04 Compaction

Compaction of the HMA shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat as specified in the Contract Documents. Class R rollers shall not be used to compact SMA.

At all places not accessible to rollers, the HMA shall be compacted by mechanical self-powered gas-, electric-, or air-powered equipment.

313.07.07.05 Gritting of Stone Mastic Asphalt

Hot grit shall be embedded in the SMA surface as specified in the Contract Documents.

313.07.08 Field Adjustments to the Job Mix Formula

Adjustment to the JMF to more closely reflect the mix being produced shall be permitted. The number of field adjustments to the JMF shall be limited to three for each mix design submitted, one prior to the start of production and a maximum of two during production. Field adjustments to the JMF shall be limited in scope such that the net impact of all field adjustments to the JMF does not exceed any of the maximum field adjustments to the JMF in Table 1 in comparison to the original JMF submitted under the current mix design.

JMF adjustments shall not be permitted once placement of the specific mix type has been completed. The adjusted JMF shall be submitted in writing on a form supplied by the Contract Administrator. Upon receipt of the JMF adjustment submission, the Contract Administrator shall give a written confirmation of receipt of the adjusted JMF. Within one Business Day of receipt of the JMF adjustment, the Contract Administrator shall give written notice confirming conformance to the Contract requirements or advising of any non-conformance. The revised JMF may be applied to the lot being placed at the time the confirmation of receipt of the revised JMF is issued and the previous lot, if requested by the Contractor as part of the written submission for a JMF change. If this request is not made, the revised JMF shall only apply to the lot placed after receipt of the revised JMF.

313.07.09 Sampling

313.07.09.01 Asphalt Cement

Samples of the AC shall be taken according to OPSS 1101.

When the selected WMA technology requires that additives be added to the AC, the samples for acceptance of the AC shall be taken after the additive has been added.

313.07.09.02 Hot Mix Asphalt Aggregates for Density Testing

Samples for RAP and the aggregates identified in the mix design for each mix type using methods as specified in the Contract Documents shall be procured. The first set of samples shall be taken no later than 10 Days prior to the start of production of the first lot of HMA. Subsequent samples shall be taken immediately following the completion of 15,000 tonnes $\pm$ 1,000 tonnes of mix production and thereafter at further intervals of 20,000 tonnes as required. The aggregate and RAP sampling program shall be established in consultation with the Contract Administrator prior to paving. If the sampling interval needs to be reduced to reflect changes in the aggregate properties, the Contract Administrator shall be notified and samples shall be taken as warranted only when directed by the Contract Administrator.

A set of two samples shall be taken. One of these samples shall be for QA testing and the other shall be for referee testing. Samples for QA and referee testing shall be obtained concurrently.

Each sample shall be clearly identified as to the date of sampling, the lot number, and the tender item hot mix tonnage being produced when the sample was taken.

313.07.09.03 Hot Mix Asphalt Mix Properties

Samples shall be appropriately labelled with the Contract number, highway number, Region, lot number, subplot number, mix type, lift number, station, and date and time of sampling.

Each random sample location or the tonnage from which the sample is to be taken shall be as designated by the Contract Administrator. A set of two samples shall be taken as per Table 2. One of these samples shall be for QA testing and the other shall be for referee testing. Samples for QA and referee testing shall be obtained concurrently.

When the mass of the sample does not meet the requirements of Table 2, the sample shall be discarded and a new one taken immediately.

The SMA sample for draindown testing shall coincide with one of the other subplot samples as designated by the Contract Administrator. The samples shall be transferred to a clean stainless steel bowl or pan of suitable size, immediately after splitting, for delivery to the QA laboratory.

If the Owner's QA laboratory chooses LS-292 for each mix design, two sets of samples shall be provided consisting of:

- a) 2 one-litre cans of AC,
- b) 25 kilograms of each aggregate type, and
- c) 1 kilogram of baghouse fines, if used in the mix design.

One sample is for Owner's QA testing and the other for referee testing for the purpose of ignition oven calibration, including aggregate correction factors. The samples shall be submitted to the Owner's QA laboratory at least five Business Days prior to the start of paving with the applicable HMA type. If materials have changed from the mix design, an additional two sets of samples as detailed above shall be provided.

313.07.09.04 Compaction

Upon completion of each subplot, the Contract Administrator shall submit in writing notification of each random sample location. Pavement core samples shall be obtained in duplicate from each subplot no later than the next Business Day after the completion of the subplot. Each core shall meet the following requirements:

- a) Have a minimum nominal diameter of 150 mm and a maximum nominal diameter of 200 mm, and
- b) Consist of the full layer being sampled and at least one underlying layer, if one is present.

Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement. Cores for compaction shall not be taken on bridge decks.

Each set of samples shall be taken from the same lane, same transverse offset, and at a spacing of $1.0 \text{ m} \pm 0.1 \text{ m}$ between each individual core edge.

Cores shall not be damaged during coring operations or in transit. If a core is damaged, a replacement core shall be extracted at a location adjacent to the original core.

Core samples shall also include design lift thickness on the label. The lot and subplot numbers shall be clearly marked with a permanent marker on all compaction cores.

HMA and compaction requirements for filling the sample holes shall be the same as the adjacent undisturbed pavement. Sample holes shall be cleaned, dried, and filled and then compacted using a mechanical self-powered gas-, electric-, or air-powered compactor immediately after sampling.

A one litre sample of the release agent(s) shall be delivered to the Contract Administrator upon request.

313.07.09.05**Warm Mix Asphalt**

Samples of WMA shall be obtained at the paver from sublots according to Table 2 for moisture sensitivity testing. The sublots are to be selected randomly from the sublots identified for mix properties by the Contract Administrator. These samples shall be designated for QA testing for moisture sensitivity according to AASHTO T 283. A complete sample data sheet shall accompany the samples. The data sheet shall also identify corresponding mix properties lot/sublot number and that the samples are for moisture sensitivity testing. Moisture sensitivity testing is required for information only.

313.07.09.06**Lift Thickness**

For HMA tender items measured by square metres, single cores consisting of all lifts placed shall be used to evaluate the lift thickness of all lifts. Sample locations shall be determined based on the surface area of the upper most lift placed as specified in the Contract Documents.

All areas of hot mix paving as specified in the Contract Documents, including paved shoulders, shall be sampled for lift thickness with the following exceptions:

- a) Detours and other temporary pavement.
- b) Hot mix asphalt miscellaneous.
- c) Bridge decks.

Upon completion of each subplot of the upper most lift specified, the Contract Administrator shall submit in writing notification of the location to be used for sampling. After the completion of the subplot of the upper most lift specified, one pavement core sample shall be obtained from each subplot no later than the next Day. This one core shall be used for both QA and referee testing.

Each core shall have a nominal diameter of 50 mm and shall consist of all the specified hot mix lifts placed in the subplot and at least one underlying hot mix layer if one exists. Each core shall have its vertical side cored perpendicular to the upper surface of the core. Each sample shall be placed in a suitable container to protect the sample integrity during transport and until testing. The subplot number shall be clearly marked with a permanent marker on each core. In addition, the sample documentation as specified in the Contract Documents shall also note the number of lifts for which the thickness measurements are required and mix type for each.

No replacement thickness cores shall be obtained for QA or referee testing. When a core thickness is reported as "indeterminate", a new 150 mm core shall be taken centered over the subplot's previously taken 50 mm core.

Holes resulting from the removal of thickness core samples shall be cleaned, dried, and filled with a material acceptable to the Contract Administrator immediately after sampling.

313.07.10**Identification of Warm Mix Asphalt Paving Limits**

When WMA is used, GPS coordinates for the WMA paving limits shall be submitted to the Contract Administrator no later than seven Days after completion of WMA paving.

313.07.11**Management of Excess Material**

Management of excess material shall be according to the Contract Documents.

313.08 QUALITY ASSURANCE

313.08.01 Acceptance Criteria

Acceptance of HMA shall be based on the following criteria:

- a) AC Physical Requirements
- b) Mix Properties and Compaction
- c) Surface Tolerance
- d) Surface Appearance
- e) Surface Smoothness
- f) Lift Thickness
- g) Geometrics and Longitudinal Joint Location

313.08.01.01 Asphalt Cement Physical Requirements

The Contract Administrator shall determine the acceptability of the AC according to OPSS 1101 and requirements as specified in the Contract Documents.

When the selected WMA technology requires that additives be added to the AC, acceptance of the AC shall be based on the samples that contain the WMA additive subject to the conditions as specified in the Contract Documents. An allowance request may be made for the impact of the WMA and AST on a PGAC grade for QA or referee purposes provided that when production begins a complete AASHTO M 320 test results for the following is submitted to the Contract Administrator:

- a) AC with WMA and AST at the percentage identified in the mix design.
- b) AC without the additives.

The combined allowance shall be limited to a maximum 2 °C colder than the high temperature grade or a maximum of 2 °C warmer than the low temperature grade.

313.08.01.02 Mix Properties and Compaction

313.08.01.02.01 Lot Size

313.08.01.02.01.01 General

Before HMA production for the tender item starts, a discussion with the Contract Administrator shall happen regarding their determination of the size and location of the lots and sublots. Guidelines for the breakdown of the tender item quantity into lots are as listed in Table 3.

When only one or two sublots are completed at the end of paving for the tender item due to a change in the JMF or when a delay of more than 20 Business Days occurs in placing the complete lot, the test results obtained shall be considered as part of the previous lot and the previous lot shall then have 11 or 12 sublots. When only 3 to 9 sublots are completed due to the above circumstances, then the 3 to 9 sublots shall be considered as a lot.

When a delay of more than 20 Business Days occurs in placing the complete lot and this lot shall be completed during the same calendar year, a request in writing prior to the end of the 20 Business Days may be submitted to the Contract Administrator that the lot be continued upon the resumption of paving for that tender item. If the request is not made or is not accepted by the Contract Administrator, the lot shall be terminated and evaluated for acceptance.

313.08.01.02.01.02 Optional Surface Trial

When the surface hot mix tender item is 5,000 tonnes or more, an optional trial of one lot, not exceeding 500 tonnes, with one subplot shall be permitted. The trial shall be placed in a binder course, and the lift thickness shall not be greater than 60 mm. If this optional trial is chosen, the Contract Administrator shall be advised in writing prior to placing the trial lot. The optional trial shall not be placed in a critical location such as bridge decks. The optional trial lot will be treated as a small quantity lot for basis of acceptance and payment.

313.08.01.02.01.03 Lot Size for Bridge Decks

Hot mix placed on a bridge deck should be treated as a separate lot. Where hot mix is placed in multiple stages, each stage shall be treated as a separate lot.

The lot shall be either a single subplot or divided into three approximately equal sublots as determined by the Contract Administrator in consultation with the Contractor.

313.08.01.02.01.04 Lot Size for Tonnage Tender Items

Lot size is generally 5,000 tonnes. Sublots are generally 500 tonnes, however, subplot sizes may be adjusted to ensure a minimum of three sublots per lot.

When the tender item quantity is less than 1,000 tonnes, the lot(s) shall be divided into at least three sublots as determined by the Contract Administrator, unless such division is deemed impractical by mutual agreement.

313.08.01.02.01.05 Lot Size for Square Metre Tender Items

For lift thicknesses in the order of 40 to 55 mm, lot size is generally 40,000 m² with sublots of 4,000 m², however, subplot sizes may be adjusted to ensure a minimum of three sublots per lot. For lift thicknesses in the order of 60 to 100 mm, the lot size would generally be adjusted to 25,000 m² with sublots of 2,500 m².

When the tender item quantity is less than 4,000 m², the lot(s) shall be divided into at least three sublots as determined by the Contract Administrator, unless such division is deemed impractical by mutual agreement.

313.08.01.02.02 Acceptance Testing

The Owner shall conduct tests, carry out calculations, and provide values according to Table 4. The Contractor shall be provided with results from the completed tests.

The QA laboratory shall conduct density tests for RAP and aggregates identified in the mix design for each mix type using methods as specified in the Contract Documents.

When new aggregate samples are received, QA density testing on the new aggregate samples shall be conducted and the calculation of VMA for the subsequent lot(s) shall be based on the densities of the most recent QA samples submitted. When a change in aggregate density is noted, a request shall be made to the Contract Administrator that new samples be obtained between routine random samples. It shall also be stated in the sample request if the current lot will be closed or if the lot will be completed and the new density tests results will not be used for calculation of VMA until the next lot. The submitted request shall meet Contract Administrator's satisfaction prior to changes being made to sampling.

313.08.01.02.03 Basis of Acceptance

Acceptance for all mixes for mix properties and compaction is based on the lot PWL for each attribute, excluding VMA. PWL shall be determined using lot test results, LS-101, and lower and upper limits as specified in Table 5. The PWL of the lot for each criterion shall be used to determine the payment adjustment factor from Table 6. If the PWL is less than 50% for AC content, air voids or compaction, or less than 25% for any payment adjustment sieve, the lot is rejectable and shall be subject to repair or payment adjustment. VMA shall meet the minimum mix design requirements according to OPSS 1151 for each lot and payment shall be based on the lot mean as specified in the Payment Factor for Voids clause. If the VMA payment factor is less than 0.500, the lot shall be considered rejectable. SMA lots shall be considered rejectable if the draindown is more than 0.3%.

Small quantity lots shall not be subject to payment adjustment unless the mix is rejectable. Acceptance for these lots shall be on a subplot by subplot basis. The subplot shall be considered acceptable if the AC content, gradation, air voids, and compaction of each subplot comply with the limits specified in Table 5, and the VMA shall be no more than 0.50% below the design minimum. Mix that does not comply with the requirements shall be considered rejectable.

The Contract Administrator shall determine if a rejectable lot may remain in the work without repairs. When the Contract Administrator has determined that a rejectable lot may remain in the work without repair, the lot shall be subjected to an additional payment adjustment reflecting the extent of the non-conformance as determined by the Contract Administrator. If repair of the lot is chosen in lieu of a payment adjustment or if the Contract Administrator determines that a rejectable lot requires repair, the lot shall be repaired and re-evaluated as specified in the Repairs for Mix Properties and Compaction clause.

313.08.01.02.04 Referee Testing

A single request for referee testing for a given lot can only be invoked within five Business Days after the Contract Administrator's calculated QA payment factors for that lot have been received. Referee testing for aggregate density can only be invoked within five Business Days after the QA test results for aggregate density have been received.

For mix properties and compaction, a request may be made for testing by a referee laboratory for the entire lot or a maximum of two sublots from that lot. For all sublots in the referee request, referee testing shall fall into one of three categories:

- a) Mix properties only,
- b) Compaction only, or
- c) Mix properties and compaction.

A request may be made for referee testing for determining the draindown of a SMA sample.

The referee laboratory shall use the same test method as the QA laboratory except that when the QA laboratory chooses LS-292, the referee laboratory shall use that method provided the calibration requirements are met. If they are not met, the referee laboratory shall use LS-282.

When referee testing of mix properties is invoked, the referee laboratory shall conduct all necessary testing with the exception of the combined aggregate density which shall be supplied by the Contract Administrator.

When referee testing for compaction is invoked, the referee laboratory shall determine the MRD of the referee loose mix sample for the subplot and this value shall be used in the calculation of compaction for the referee core.

The results generated by the referee laboratory shall be used to re-evaluate the lot to determine the payment factors for the acceptance of the disputed properties for the disputed lots of HMA. The referee test results are binding on both the Owner and the Contractor.

313.08.01.02.05 Outliers in Referee Results

Where an entire lot of three or more sublots has been referee tested, an individual value for any attribute of a subplot's test result excluding VMA may be questioned. The request shall be made within three Business Days after receiving all the test results for the lot and only when the payment factor for the attribute with an outlier is less than 1.0. The validity of the questioned attribute shall be ascertained in accordance with ASTM E 178 using a T test at a 10% significance level.

If the T test procedure shows that the questioned value of the attribute is not an outlier then the test result shall be used in the calculations. If the T test procedure shows that the questioned value of the attribute is an outlier then the test result for the subplot shall be checked for mathematical errors. If there are no mathematical errors, the subplot with the outlier is treated as a lot with one subplot and the remaining sublots shall form a separate lot with no further consideration for outliers.

If only two sublots remain, the two sublots shall be treated as two separate lots each with one subplot.

313.08.01.03 Surface Tolerance

The surface tolerances of any pavement surface shall be such that when tested with a 3 m straight edge placed anywhere including the edge of the pavement and in any direction on the surface except across the crown or drainage gutters, there shall not be a gap between the bottom of the straight edge and the surface of the pavement:

- a) Greater than 6 mm for all binder courses, levelling courses, and padding, or
- b) Greater than 3 mm for all surface courses.

Traffic control shall be provided, as required, for the Owner to conduct surface tolerance measurements. All tolerance-related repairs shall be carried out according to the Repairs subsection.

Longitudinal joints shall be constructed such that the elevation difference across the longitudinal joints shall not exceed 5 mm when measured with a straight edge placed on the asphalt surface with the higher elevation and overhanging the joint by not more than 50 mm. All joints which exceed the 5 mm tolerance shall be repaired such that the tolerance is met.

313.08.01.04 Surface Appearance

The HMA deemed by visual appearance to have flushing, bleeding, segregation, fat spot, surface damage, cracking, chatter, or surface contamination but not limited to these, shall be considered deficient material or work. Traffic control shall be provided for all surface appearance assessments. Deficient material, mixture, and work shall be removed and replaced, or repaired, or assessed a payment reduction.

313.08.01.04.01 Segregation

The HMA exhibiting medium or severe mid-lane segregation shall be assessed a payment reduction or shall be repaired at the discretion of the Contract Administrator.

From the time the Contract Administrator provides notification of mid-lane segregation, a maximum of 500 tonnes of HMA may be placed to demonstrate the effectiveness of any repairs or adjustments or both made to a defective paver. The repairs or adjustments or both shall be demonstrated to the Contract Administrator. If the repairs or adjustments or both to the paver do not eliminate mid-lane segregation to the satisfaction of the Contract Administrator within the allowable 500 tonnes of HMA, then the use of that paver shall be discontinued.

Other segregation shall be addressed in accordance with the following:

- a) Slightly segregated mix shall be accepted into the work with no payment reduction.
- b) Medium segregation in levelling courses or padding with a thickness greater than 40 mm and binder courses shall normally be left in place with no payment reduction. Any areas of medium segregation that deteriorates prior to being overlaid by another pavement course shall be repaired at no cost to the Owner.
- c) Medium segregation in surface courses shall be assessed a payment reduction or repaired at the discretion of the Contract Administrator.
- d) Severely segregated mix shall be repaired by removal and replacement.

Levelling courses and padding with a total thickness less than 40 mm, bullnoses, and tapers that were not machine-laid and any areas of handwork shall not be assessed based on segregation but based on other workmanship-related problems. However, if they deteriorate prior to being overlaid by another pavement course, the Contract Administrator shall assess the causes of the deterioration before determining responsibility for the cost of repairs.

313.08.01.04.02 Challenging Severity of Segregation

A challenge in writing of the severity of any segregated area assessed as either medium or severe may be submitted within five Business Days of receiving the Owner's first visual assessment. The written challenge shall list the dimensions and assessment of the severity of each disputed segregated area.

For Contracts with up to 30,000 tonnes of HMA, a maximum of two separate written challenges for each tender item shall be permitted. For Contracts with more than 30,000 tonnes of HMA, a maximum of four separate written challenges for each tender item shall be permitted. Each written challenge may involve more than one disputed segregated area.

The Owner or a representative of the Owner, who did not carry out the original assessment and who is not the Contract Administrator, shall make a second visual assessment of the disputed areas. All necessary surface preparations and traffic control shall be provided so that this second visual assessment shall be carried out within five Business Days after the Contract Administrator has received the written challenge. The results of that second visual assessment shall be binding on both the Owner and Contractor.

A further challenge may be made to the Owner's second visual assessment of the segregation severity, if the segregation has occurred in any one of the mixes listed in Table 7. Such a challenge shall be made in writing within five Business Days of receiving the Owner's second visual assessment. Such a challenge shall be resolved by the Owner or a representative of the Owner determining the Macrottexture Ratio, according to LS-317. All necessary surface preparations and traffic control shall be provided during the field measurements for Macrottexture Ratio. Table 7 shall be used with the Macrottexture Ratio to determine the degree of severity and the disposition of the disputed area of segregation. The Macrottexture Ratio results shall be binding on both the Owner and the Contractor.

313.08.01.05 Acceptance Criteria for Surface Smoothness

The acceptability of surface smoothness shall be as specified in the Contract Documents.

313.08.01.06 Lift Thickness for Square Metre Tender Items

313.08.01.06.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots for thickness before hot mix production for the tender item starts.

There shall be one lot consisting of all square metre tender items when the entire Contract has the same number of lifts and tender items throughout. There shall be a separate lot for areas with:

- a) Different number of lifts,
- b) Different tender items, or
- c) Both.

Each lot shall be divided into sublots, corresponding to the area of the upper most lift, which generally is the surface course. Sublots shall normally be 2,000 m² in size. A minimum of three sublots are required for each lot.

313.08.01.06.02 Acceptance Testing

The Owner shall conduct tests, carry out calculations, and provide values according to Table 4. A copy of each lift thickness measurement for each lift placed at each sample location upon completion of the subplot measurement shall be provided by the Contract Administrator.

313.08.01.06.03 Basis of Acceptance

The acceptance of lift thickness is based on subplot lift thickness measurements and lot mean lift thickness of the tender item. The Contract Administrator shall calculate the thickness payment adjustment for the lot once all measurements for the lot have been completed.

Sublot lift thickness shall be acceptable if they are equal to or greater than the minimum subplot lift thickness as specified in Table 8 for the tender item's T_D .

The subplot shall be deemed rejectable and shall be repaired if:

- a) The lift thickness measurement is less than the minimum subplot lift thickness as specified in Table 8, or
- b) For successive binder lifts of the same tender item, the combined lift thickness for these successive lifts is less than the minimum subplot lift thickness as specified in Table 8.

When a lift thickness lot contains any subplot that is deemed rejectable, the lot is rejectable until the subplot has been repaired and re-evaluated as acceptable. When the Contract Administrator allows a rejectable subplot to remain in place without repair, the subplot shall be subjected to a payment reduction according to the Payment Adjustment for Lift Thickness clause. A subplot lift thickness measurement for a rejectable subplot that receives a payment reduction shall not be used to assess the lot mean for the tender item.

The Contract Administrator shall calculate the lot mean lift thickness for each tender item to one decimal point and the lot thickness payment adjustment based on all the subplot lift thickness measurements in the lot, according to LS-100 and Table 9. If the lot mean lift thickness for the surface course tender item is less than 85% of the T_D the lot is rejectable.

The Owner shall determine if a rejectable lot may remain in the work without repairs. When the Owner has determined that a rejectable lot may remain in the work without repair, the lot shall be subjected to a payment reduction as determined by the Owner.

313.08.01.06.04 Referee Testing

An individual lift thickness measurement may be challenged by requesting referee testing in writing to the Contract Administrator within five Business Days after receiving the subplot lift thickness measurement. An opportunity shall be permitted to view the re-measurement of the QA designated pavement core for that subplot at an alternative Owner designated laboratory together with the Owner's representative. The re-measurement shall include the individual lift thickness that was challenged and shall also include any other lifts or combination of lifts in the core. The re-measured lift thickness measurements shall be considered binding and shall replace the original lift thickness measurements for assessment of all lifts measured for the core.

313.08.01.07 Geometrics and Longitudinal Joint Location

313.08.01.07.01 General

After final compaction, the HMA shall be smooth and true to the design profile and cross-section and constructed to the design width.

313.08.01.07.02 Pavement Width

The Contract Administrator shall conduct random spot checks of the width of each binder and surface course HMA lift for acceptance. Offset stakes shall be provided and maintained on both sides of the roadway, or other identifiers acceptable to the Contract Administrator, for use in checking the pavement width at 25 m maximum intervals until the Contract Administrator advises that the stakes or identifiers are no longer required.

The width of each lift shall be accepted provided:

- a) The outside edges of the lanes and the paved shoulders are parallel to the centreline and visually uniform.
- b) The width across all the adjacent lanes from the outside edge to outside edge is not less than the sum of the specified lane widths, and
- c) The width of the paved shoulders is not less than the paved shoulder width as specified in the Contract Documents.

If the width is not acceptable at any location, the Contract Administrator shall provide notification in writing that the pavement is rejectable. A written proposal for corrective action shall be submitted to the Contract Administrator within three Business Days of receiving the notification.

313.08.01.07.03 Longitudinal Joint Location

Longitudinal joints not meeting the Contract requirements shall be removed and replaced or assessed a payment reduction.

313.08.02 Repairs

313.08.02.01 General

All repairs shall be performed at no additional cost to the Owner. No repairs are permitted prior to completion of a lot.

All transverse joints in surface course repairs shall butt up to a full depth vertical surface. Repairs shall consist of the removal and replacement of the full thickness of the hot mix lift or the placement of an overlay when permitted by the Contract Administrator. A paver shall be used in carrying out the repair.

Repairs shall be full lane or full shoulder width except where localized repairs are allowed as specified in the Contract Documents.

The materials and the construction of repairs shall meet the acceptance criteria and other requirements as specified in the Contract Documents.

The limits and type of repairs shall be subject to the approval of the Contract Administrator and shall be approved prior to the repair being carried out.

Any damage to waterproofing system on bridge decks shall be repaired according to OPSS 914. The limits and type of waterproofing repair shall be subject to the approval of the Contract Administrator and shall be approved prior to the repair being carried out.

Repairs of an urgent nature, including moderate to very severe aggregate loss, moderate to very severe flushing, and wheel track rutting 16 mm in depth or greater shall be repaired within seven Days, unless extended by mutual agreement.

Except for urgent repairs, repairs shall be completed within 60 Days or prior to seasonal shutdown each year, whichever is the lesser, unless extended by mutual agreement.

313.08.02.02 Repairs for Mix Properties and Compaction

For a lot that is not rejected repairs may be chosen in lieu of accepting a payment adjustment, if the total payment factor for the lot is less than 0.940. When the Contract Administrator requires a rejectable lot to be repaired or repairs are chosen in lieu of accepting a payment adjustment, the areas of HMA in a lot that are to be repaired shall be determined subject to the minimum lengths and widths as specified in the Contract Documents. Each repair area shall include at least one of the loose mix or compaction core sample locations or both representing that subplot.

The minimum length of a single-repair to one lane shall be 250 m. The minimum length of a single-repair that extends over more than one lane shall be 250 lane-metres and no portion of the single-repair in a lane shall be less than 125 m in length.

The minimum limits of each repair shall be at least 125 lane-metres from the location of the loose mix or compaction core or both that represents the subplot; otherwise, a repair limit shall coincide with one end of the subplot when the sample location is less than 125 lane-metres from it. If the proposed limit of a single-repair falls within the proposed limit of another single-repair, the overlap shall count towards the 250 lane-metre minimum for both repairs. Repair areas within a single lane shall be separated by at least 100 m. If the delineation of repair areas results in patches less than 100 m apart, these repair areas shall be re-established to form a continuous repair.

A list and sketch identifying the proposed locations of the repairs shall be submitted to the Contract Administrator for review at least five Business Days prior to the intended start of the repair work. Each subplot and single-repair shall be uniquely labelled. Overlapping repair areas and discontinuous portions of a single-repair shall be labelled so that they are readily identified with their single-repair.

Prior to the repair, slab samples or cores shall be taken for testing of mix properties or compaction or both in the unrepaired area within 1 m of the limits of each end of the repair area. Additional samples or cores shall not be permitted to be taken beyond these locations until after QA or referee testing demonstrates that the remaining Material in the subplot proposed for repair is deemed to be rejectable. If the proposed repair limit coincides with the beginning of a subplot that is being left unrepaired, samples are not required at this location. Sufficient material shall be obtained for testing by the Owner's QA laboratory and for possible referee testing.

Testing shall demonstrate that the remaining Material in the subplot proposed for repair is not rejectable. To determine if the mix is rejectable, the mix properties and compaction shall comply with the basis of acceptance of a small quantity lot. If the Material is deemed to be rejectable, the proposed limit of the repair shall be extended by a minimum of 25 m, and the sampling and testing repeated. The repair area selected shall incorporate the location used for obtaining samples that shall be used to confirm that the remaining mix is not rejectable. If the repair proposal results in the removal of at least half the subplot tonnage, the Contract Administrator may waive testing demonstrating the suitability of the remainder of that subplot.

The unrepaired sublots combined with the unrepaired areas of any repaired sublots shall comprise one lot and shall be assessed based on the loose mix and core samples representing the unrepaired sublots. When a repaired subplot consists of two or more separate unrepaired areas, the Contract Administrator shall decide whether to combine these unrepaired areas as one subplot or to consider each unrepaired area as a separate subplot. If there are only one or two sublots in a lot that are not repaired, the Contract Administrator shall include those sublots as part of the previous or next lot.

The mix used for the repair shall comprise a separate lot or, prior to beginning any repair, the Contract Administrator in conjunction with the Contractor may decide to include it as part of the current lot being produced. The repaired area shall be tested for all criteria and re-evaluated for acceptance.

The two reconfigured lots shall be accepted at the full Contract price, subjected to a payment adjustment according to the Payment Adjustment for Mix Properties and Compaction clause, or rejected.

313.08.02.03 Repairs for Surface Tolerance

All areas not meeting the surface tolerance requirements shall be repaired by diamond grinding to a maximum of 5 mm or removed and replaced. Slurry produced from diamond grinding shall be removed from the site and managed as specified in the Contract Documents. The repaired areas shall be re-evaluated for surface tolerance acceptance by means of a 3 m straight edge as specified in Surface Tolerance clause.

313.08.02.04 Repairs for Segregation

Repairs for segregation shall meet the requirements of the General Repairs clause. In binder courses, localized repairs for mid-lane segregation less than 300 mm in width are permitted.

313.08.02.05 Repairs for Thickness

Any repairs solely to correct for excess lift thickness shall not be permitted.

The minimum length of a repair is the entire length of the subplot being repaired.

Acceptance for lift thickness of the repaired subplot shall be based on the individual subplot lift thickness measurement and the lot thickness payment adjustment shall be calculated based on the re-evaluated subplot measurement.

313.09	MEASUREMENT FOR PAYMENT
313.09.01	Actual Measurement
313.09.01.01	SMA 9.5 SMA 9.5 - ... mm Lift Thickness SMA 12.5 SMA 12.5 - ... mm Lift Thickness SMA 19.0 SMA 19.0 - ... mm Lift Thickness Superpave 4.75 Superpave 9.5 Superpave 9.5 - ... mm Lift Thickness Superpave 12.5 Superpave 12.5 - ... mm Lift Thickness Superpave 12.5 - Warm Mix Superpave 12.5 - Warm Mix - ... mm Lift Thickness Superpave 12.5FC 1 Superpave 12.5FC 1 - ... mm Lift Thickness Superpave 12.5FC 1 - Warm Mix Superpave 12.5FC 1 - Warm Mix - ... mm Lift Thickness Superpave 12.5FC 2 Superpave 12.5FC 2 - ... mm Lift Thickness Superpave 12.5FC 2 - Warm Mix Superpave 12.5FC 2 - Warm Mix - ... mm Lift Thickness Superpave 19.0 Superpave 19.0 - ... mm Lift Thickness Superpave 19.0 - Warm Mix Superpave 19.0 - Warm Mix - ... mm Lift Thickness Superpave 25.0 Superpave 25.0 - ... mm Lift Thickness Superpave 25.0 - Warm Mix Superpave 25.0 - Warm Mix - ... mm Lift Thickness Superpave 37.5 Hot Mix Asphalt Miscellaneous
313.09.01.01.01	By Area

Measurement of HMA by area shall be the horizontal area in square metres in place.

The quantities of HMA used for temporary ramp downs shall not be measured for payment. The removal of HMA used for temporary ramp downs shall not be measured for payment.

313.09.01.01.02 Tonne to Square Metre Conversion

When the unit of measure for a HMA tender item is square metres, and the Contract Documents refer to a quantity of mix for that tender item in tonnes and the Contract Documents do not already modify the quantity to relate to square metres, the Contract Administrator shall determine the theoretical HMA quantity in square metres (Q_A) that shall replace the non-payment tonnage quantity (Q_t) references as follows:

$$Q_A = Q_t / [0.975 \times BRD_{MD} \times (T_D/1000)] \quad (\text{Formula 1})$$

Where:

BRD_{MD} = the bulk relative density in t/m^3 , provided in the submitted HMA mix design, the Q_A is calculated for
 T_D = the design thickness, in millimetres, of the mix
 Q_t = non-payment tonnage quantity referred to elsewhere in the Contract Documents for the mix under the measurement by square metre tender item

313.09.01.01.03 By Mass

Measurement of HMA by mass shall be in tonnes according to the requirements of the Contract Documents.

The quantities of HMA used for temporary ramp downs shall not be measured for payment. The removal of HMA used for temporary ramp downs shall not be measured for payment.

313.09.01.02 Hot Mix Asphalt Miscellaneous

Measurement of HMA Miscellaneous shall be by area in square metres, regardless of the number of lifts placed.

313.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement. The Plan Quantity shall not be adjusted due to any of the exceptions specified in the Lift Thickness clause under the Sampling clause.

313.10 BASIS OF PAYMENT

313.10.01 Hot Mix

313.10.01.01 SMA 9.5 - Item
 SMA 9.5 - ... mm Lift Thickness - Item
 SMA 12.5 - Item
 SMA 12.5 - ... mm Lift Thickness - Item
 SMA 19.0 - Item
 SMA 19.0 - ... mm Lift Thickness - Item
 Superpave 4.75 - Item
 Superpave 9.5 - Item
 Superpave 9.5 - ... mm Lift Thickness - Item
 Superpave 12.5 - Item
 Superpave 12.5 - ... mm Lift Thickness - Item
 Superpave 12.5 - Warm Mix - Item
 Superpave 12.5 - Warm Mix - ... mm Lift Thickness - Item
 Superpave 12.5FC 1 - Item
 Superpave 12.5FC 1 - ... mm Lift Thickness - Item
 Superpave 12.5FC 1 - Warm Mix - Item
 Superpave 12.5FC 1 - Warm Mix - ... mm Lift Thickness - Item
 Superpave 12.5FC 2 - Item
 Superpave 12.5FC 2 - ... mm Lift Thickness - Item
 Superpave 12.5FC 2 - Warm Mix - Item
 Superpave 12.5FC 2 - Warm Mix - ... mm Lift Thickness - Item
 Superpave 19.0 - Item
 Superpave 19.0 - ... mm Lift Thickness - Item
 Superpave 19.0 - Warm Mix - Item

Superpave 19.0 - Warm Mix - ... mm Lift Thickness - Item
Superpave 25.0 - Item
Superpave 25.0 - ... mm Lift Thickness - Item
Superpave 25.0 - Warm Mix - Item
Superpave 25.0 - Warm Mix - ... mm Lift Thickness - Item
Superpave 37.5 - Item
Hot Mix Asphalt Miscellaneous - Item

Payment at the Contract price for the above tender items shall include full compensation for all labour, Equipment, and Materials required to do the work (including the HMA used for temporary ramp downs), the removal of HMA used for temporary ramp downs, and the applicable payment adjustments.

When repairing HMA, all associated work and replace or restore all associated damage and removals shall be carried out at no additional cost to the Owner.

When the Contract Administrator instructs to cease paving due to continued medium or severe segregation regardless of cause, shall be at no additional cost to the Owner.

The preparation and correction of existing surfaces and pavement beneath surface courses carried out in order to meet the requirements of the Contract Documents, including milling, padding, and diamond grinding, shall be at no additional cost to the Owner.

313.10.01.02 Payment Adjustment for Mix Properties and Compaction

For all mixes, when repair is not required or repair is not chosen for a lot, the payment adjustment for that lot due to mix properties and compaction requirements shall be:

$$PA_{MC} = \text{lot quantity} \times \text{price} \times [PF_{MC} - 1.000] \quad (\text{Formula 2})$$

Where:

PA_{MC} = payment adjustment for mix properties and compaction
 lot quantity = the quantity of the mix in the lot. For SMA 19.0, SMA 12.5, SMA 9.5, Superpave 12.5FC 1, and Superpave 12.5FC 2 tender items measured by tonnage, the lot quantity is the quantity of the mix in the lot multiplied by the applicable mass multiplier factor (MF) in the Payment Adjustment for Aggregate Density clause.
 price = the Contract price of the hot mix tender item
 PF_{MC} = payment factor for mix properties and compaction

For all mixes, when the PF_{MC} is:

- a) Less than 1.000, there shall be a reduction in payment, and
- b) Equal to 1.000 there shall be no adjustment.

313.10.01.02.01 Calculations

313.10.01.02.01.01 General

The PF_{MC} shall be based on the individual payment factors obtained from Table 6, based on PWL, determined for gradation, AC content, voids, and compaction using LS-101, Table 5, and the formulae in the Payment Factor for Gradation clause, the Payment Factor for Combined Gradation and Asphalt Cement Content clause, the Payment Factor for Voids clause, the Payment Factor for Combined Mix Properties clause, and the Payment Factor for Combined Mix Properties and Compaction clause. Rounding-off procedures for all calculations shall follow LS-100.

When there is no sampling or testing specified in the Contract Documents for an attribute or when the requirement for sampling or testing for an attribute is waived by the Owner, the payment factor for that attribute shall be equal to the payment factor it is added to in Formulae 5, 10, 11 or 12.

313.10.01.02.01.02 Payment Factor for Gradation

The payment factor for gradation shall be calculated using the following formulae:

For Superpave 37.5, Superpave 25.0, Superpave 19.0, Superpave 12.5, Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 19.0, and SMA12.5:

$$PF_G = (PF_{DLS} + PF_{4.75} + PF_{75}) / 3 \quad (\text{Formula 3})$$

For Superpave 9.5, Superpave 4.75, and SMA 9.5:

$$PF_G = (PF_{4.75} + PF_{75}) / 2 \quad (\text{Formula 4})$$

Where:

- PF_G = payment factor for gradation
- PF_{DLS} = payment factor for designated large sieve
- $PF_{4.75}$ = payment factor for the 4.75 mm sieve
- PF_{75} = payment factor for the 75 μ m sieve

313.10.01.02.01.03 Payment Factor for Combined Gradation and Asphalt Cement Content

The payment factor for combined gradation and AC content shall be calculated using the following formula:

$$PF_{GAC} = (PF_G + PF_{AC}) / 2 \quad (\text{Formula 5})$$

Where:

- PF_{AC} = payment factor for AC content
- PF_{GAC} = payment factor for combined gradation and AC content

313.10.01.02.01.04 Payment Factor for Voids

For Superpave mixes, if the lot mean VMA is not more than 0.50 per cent below the minimum VMA as specified in the Contract Documents for mix design purposes, the payment factor for VMA is 1.000. For lot mean VMA results more than 0.50 per cent lower than the minimum specified for mix design purposes, a payment factor for the subject lot shall be calculated in accordance with the following:

$$\text{If } (VMA_{min} - VMA_{mean}) \geq 2.5, \text{ then } PF_{VMA} = 0.0 \quad (\text{Formula 6})$$

$$\text{If } (VMA_{min} - VMA_{mean}) < 2.5 \text{ then, } PF_{VMA} = 0.8000 - 0.4 \times (VMA_{min} - 0.5 - VMA_{mean}) \quad (\text{Formula 7})$$

Where:

- PF_{VMA} = payment factor for VMA
- VMA_{mean} = lot mean VMA
- VMA_{min} = minimum VMA specified for mix design

For Superpave mixes, the payment factor for VMA shall be compared to the payment factor for air voids and the lesser of the two is the payment factor for voids (PF_{VOIDS}).

For SMA mixes, if the lot mean VMA is not more than 1.00 per cent below the minimum VMA as specified in the Contract Documents for mix design purposes, the payment factor for VMA is 1.000. For lot mean VMA results more than 1.00 per cent lower than the minimum specified for mix design purposes, a payment factor for the subject lot shall be calculated in accordance with the following:

If $(VMA_{min} - VMA_{mean}) \geq 3.0$, then $PF_{VMA} = 0.0$ (Formula 8)

If $(VMA_{min} - VMA_{mean}) < 3.0$ then, $PF_{VMA} = 0.8000 - 0.4 \times (VMA_{min} - 1.0 - VMA_{mean})$ (Formula 9)

Where:

PF_{VMA} = payment factor for VMA

VMA_{mean} = lot mean VMA

VMA_{min} = minimum VMA specified for mix design

For SMA mixes, the payment factor for VMA shall be compared to the payment factor for air voids and the lesser of the two is the payment factor for voids (PF_{VOIDS}).

313.10.01.02.01.05 Payment Factor for Combined Mix Properties

The payment factor for combined mix properties shall be calculated using the following formula:

$$PF_M = (PF_{GAC} + PF_{VOIDS}) / 2 \quad (\text{Formula 10})$$

Where:

PF_M = payment factor for combined mix properties

313.10.01.02.01.06 Payment Factor for Combined Mix Properties and Compaction

The payment factor for combined mix properties and compaction shall be calculated using Formula 11.

$$PF_{MC} = (PF_C + PF_M) / 2 \quad (\text{Formula 11})$$

Where:

PF_C = payment factor for compaction

The PF_{MC} shall be rounded and reported to four decimal places.

When the Contract Administrator decides that the unrepaired area of an original lot that has been partially repaired shall not be resampled, the PF_{MC} for the unrepaired area shall be 1.000.

313.10.01.02.01.07 Small Quantity Lots

For small quantity lots, each subplot shall be assigned a PF_{MC} of 1.000 if the subplot is not rejectable. If the subplot is determined to be rejectable, it shall be administered as described in the Repairs for Mix Properties and Compaction clause. When the Owner has determined that a rejectable subplot may remain in the work without repair, the lot shall be subjected to a payment adjustment reflecting the extent of the non-conformance as determined by the Owner.

313.10.01.03 Payment Adjustment for Surface Smoothness

Payment adjustment for surface smoothness shall be as specified in the Contract Documents.

313.10.01.04 Payment Adjustment for Segregated HMA

For all surface courses, where payment reduction for segregation is allowed in lieu of repairs, the payment reduction shall be calculated as follows:

- a) \$2,000 once for each applicable surface course tender item,
- b) An additional payment reduction of \$2.50/m for mid-lane segregation, and

- c) An additional payment reduction of \$5.00/m² for other segregation. The area of repair shall be computed by multiplying the full lane width by the length of the repair and rounded to the next whole square metre.

313.10.01.05 Payment Adjustment for Aggregate Density

For Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 19.0, SMA 12.5, and SMA 9.5 tender items measured in tonnes, the tender quantity is based on reference densities according to Table 10. A payment adjustment for aggregate density for each lot for these tender items shall be calculated by the following formulae:

$$MF = D_R / (BRD_{mix}) \quad (\text{Formula 12})$$

$$PA_{AD} = M_{mix} \times \text{Contract Price} \times [MF - 1.000] \quad (\text{Formula 13})$$

Where:

D_R	=	the reference bulk relative density of the mix in t/m ³ , as specified in Table 10
BRD_{mix}	=	the lot average bulk relative density in t/m ³ , calculated from values obtained in the testing of bulk samples obtained during production. The values shall be the same as those used in calculating the final air voids payment factor for the lot.
PA_{AD}	=	payment adjustment for aggregate density
M_{mix}	=	the weighed mass of the mix in the lot incorporated into the work
MF	=	the mass multiplier factor calculated to three decimal places
Contract Price	=	the Contract price of the tender item for the mix

For all mixes, when the mass multiplier factor is:

- Less than 1.000 there shall be a reduction in payment,
- Equal to 1.000 there shall be no adjustment, and
- Greater than 1.000 there shall be an increase in payment for the lot.

There shall be no payment adjustment for aggregate density for HMA tender items measured by square metres.

313.10.01.06 Payment Adjustment for Asphalt Cement Content and Changes in the Price Index

313.10.01.06.01 Hot Mix Asphalt Quantity Calculation

The quantity of HMA for use in the calculations (T_{mix}) shall be the tonnage of HMA accepted into the work.

When the unit of measure is square metres, T_{mix} shall be determined using the theoretical tonnage. The theoretical tonnage shall be calculated for each lot by the Contract Administrator as follows and rounded to one decimal according to LS-100:

$$T_{mix} = [0.975 \times BRD_{mix} \times (T_D / 1000) \times A_{mix}] \quad (\text{Formula 14})$$

Where:

BRD_{mix}	=	the lot average bulk relative density in t/m ³ , calculated from values obtained in the testing of bulk samples obtained during production. The values shall be the same as those used in calculating the final air voids payment factor for the lot.
T_D	=	the design thickness, in millimetres, of the HMA
A_{mix}	=	area of hot mix placed in square metres in the lot

313.10.01.06.02 Payment Adjustment for Asphalt Cement Content

The payment adjustment for AC content for each lot shall be calculated using the following formula:

$$PA_{AC} = T_{mix} \times [Price_{AC} \times (AC_{ERS} - AC_{BID})/100] \quad (\text{Formula 15})$$

Where:

- PA_{AC} = payment adjustment for asphalt cement content
- T_{mix} = the quantity of the HMA accepted into the lot according to the Hot Mix Asphalt Quantity Calculation clause
- $Price_{AC}$ = the purchase price per tonne of the AC used in the mix according to the invoice submitted as per the Submission Requirements subsection
- AC_{ERS} = the average percentage by mass of AC in the lot
- AC_{BID} = the percentage by mass of AC specified for bidding purposes elsewhere in the Contract Documents. For SMA mixes select a minimum AC Content from Table 5 of OPSS 1151 based on combined aggregate bulk relative density from first set of QA samples

For progress payment purposes, payment adjustments are made on the monthly progress payment certificate for the months in which hot mix paving occurs.

313.10.01.06.03 Payment Adjustment for Changes in the Asphalt Cement Price Index

A payment adjustment is applied based on changes to the Ministry's PGAC price index unless the Contract Administrator is notified in writing of the choice to opt out within five Business Days of receiving permission to start work. Once opted out of payment adjustments based on the price index, opt back in shall not be permitted. The price index is published monthly in the Contract Bulletin. The price index is used to calculate the amount of the payment adjustment per tonne of new AC accepted into the Work.

The price index is based on the price, excluding taxes, FOB the depots in the Toronto area, of AC grade PG 58-28 or equivalent. One index is used to establish and calculate the payment adjustment for all grades.

A payment adjustment per tonne of new AC is established for each month in which paving occurs when the price index for the month differs by more than 5% from the price index for the month prior to Tender Opening. When the price index differential is less than 5%, there is no payment adjustment established for that month. Payment adjustments due to changes in the price index are independent of any other payment adjustments made to the hot mix tender items.

The payment adjustment for the month is calculated from the formulae in Table 11.

The payment adjustment per tonne applies to the quantity of new AC in the HMA accepted into the Work during the month for which it is established. The quantity of new AC includes all grades of AC supplied with and without polymer modifiers.

For each month in which a payment adjustment has been established, the quantity is calculated using the HMA quantity accepted into the Work and its corresponding AC content as required by the JMF except for mixes which contain reclaimed asphalt pavement.

For mixes which contain reclaimed asphalt pavement the percentage of new AC is determined from the difference between the AC content required by the JMF and the AC content of the reclaimed asphalt pavement incorporated into the HMA, as calculated by the Contract Administrator.

For mixes containing an AST-AC, the percentage of AST-AC is deducted from the percentage of new AC. No other deductions are made for any other additives.

For progress payment purposes, payment adjustments are made on the monthly progress payment certificate for the months in which HMA paving occurs.

313.10.01.07**Payment Adjustment for Lift Thickness**

The payment adjustment for lift thickness shall apply to all placed and compacted HMA measured by square metre tender items using the horizontal area of the surface course in the lot. When the thickness payment adjustment is determined using a T_L calculated using a combination of tender items, the thickness payment adjustment shall apply to each binder course tender item included in T_L . The thickness payment adjustment shall be a reduction in payment. The formulae provided in Table 9 shall be used to calculate the thickness payment adjustment for each tender item. The lot payment adjustment shall be the sum of the payment adjustments calculated for each tender item.

When a rejectable subplot remains in the work without repair, the rejectable lifts in the subplot shall be subject to a payment reduction. The thickness payment adjustment for each rejectable lift shall be:

$$PA_T = 0.5 \times (\text{subplot quantity} \times \text{Contract price}) \quad (\text{Formula 16})$$

Where:

PA_T = subplot payment adjustment for each rejectable lift
subplot quantity = the area of the subplot
Contract price = the Contract price of the tender item for the lift

313.10.02**Anti-Stripping Treatments**

When aggregates have been processed from commercial sources for use in hot mix surface course paving, payment at the Contract price for the applicable HMA tender item shall be full compensation for all labour, Equipment, and Materials required to test, supply, and incorporate, the AST.

When aggregates have been processed from MTO/Crown, Wayside, and/or Letter of Approval quarries for use in hot mix surface course paving and the use of an AST was required, payment at the Contract price for the applicable HMA tender item shall be full compensation for all labour, Equipment, and Materials required to test, supply, and incorporate the AST. When hydrated lime is used as the AST, payment includes full compensation for the amount up to 1.0% by mass of total dry aggregate. When an alternate AST-AGG is used as the AST, payment includes full compensation for the amount up to the listed minimum dosage from the DSM listing for Anti-Stripping Treatments by mass of aggregate. When an AST-AC is used as the AST, payment includes full compensation for the amount up to the listed minimum dosage from the DSM listing for Anti-Stripping Treatments by mass of AC. Payment for additional AST above the listed minimum dosages shall be administered as a Change in the Work.

313.10.03**Hot Mix Asphalt Miscellaneous**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Materials to do the work except that the HMA Material shall be paid for under the appropriate HMA tender item.

313.10.04**Tack Coat**

Where there is no separate tender item for tack coat, payment at the Contract price for the applicable HMA tender item to be placed on the tack coat shall be full compensation for all labour, Equipment, and Materials for the tack coating.

313.10.05**Repair**

No payment shall be made for the:

- a) Quantity of HMA that is removed and replaced, overlaid, or otherwise repaired; or

- b) For additional shouldering, traffic control, and other work such as zone painting or bridge deck waterproofing.

When:

- a) In lieu of a reduction in payment, repairs to the lot, subplot, or visually defective HMA are completed; or
- b) The Contract Administrator has determined that a rejectable lot or subplot requires repair;

for all additional testing resulting from a repair to a lot a charge shall be applied at the rates established by the Owner for the year in which the testing was carried out.

No additional payment shall be made for the cost of tolerance measurements of the repaired areas that are required by the Contract Administrator.

313.10.06 Referee Testing and Segregation Challenge

313.10.06.01 Mix Properties and Compaction

If the referee test results show that the referee payment factor for compaction or mix properties is higher than the payment factor for compaction or mix properties based on the original QA test results by more than 0.025 and the referee results show that the lot is not rejectable, the Owner shall bear the cost of the referee testing for that attribute.

If the referee test results show that the lot is rejectable or the referee test results show that the referee payment factor for compaction or mix properties is not higher than the payment factor for compaction or mix properties based on the original QA test results by more than 0.025, the Contractor shall bear the cost of the referee testing for that attribute.

For density testing of aggregates, if referee testing is invoked, the cost of referee testing is assigned as follows:

- a) If the combined aggregate density as determined by the referee laboratory is within 0.010 of the result determined by the QA laboratory, the referee testing shall be at no additional cost to the Owner.
- b) If the referee result is between 0.011 and 0.020 of the QA result, the cost of referee testing shall be shared equally between the Contractor and Owner.
- c) If the difference in results is equal to or in excess of 0.020, the cost of referee testing shall be borne by the Owner.

When there is an outlier in the referee test results, the Owner shall charge 50% of the total cost for referee testing of all sublots in the original lot.

The cost of the referee testing shall be based on the referee testing rates as specified elsewhere in the Contract Documents.

313.10.06.02 Lift Thickness

If the referee test result is at least 3 mm greater than the original QA test result, the Owner shall bear the cost of the thickness measurement referee testing. Otherwise, the Contractor shall bear the cost of the thickness measurement referee testing.

313.10.06.03**Segregation Challenge**

When a challenge is successful as described in the Challenging Severity of Segregation clause, the Owner shall pay for the cost of the traffic control, if the traffic control was not necessary for any other reason. The Owner shall not be responsible for any other costs associated with the second visual assessment including the cost of delays.

When a challenge is not successful as described in the Challenging Severity of Segregation clause, all costs associated with the second visual assessment, including the cost of traffic control and delays, shall be at no additional cost to the Owner.

TABLE 1
Maximum Field Adjustments for JMF

JMF Properties	Maximum Field Adjustment % (Notes 1 and 2)
AC content (all mixes except SMA mixes)	± 0.2
AC content (SMA mixes only)	± 0.4
Per cent Binder Replacement	- 5.0
Per cent passing 26.5 mm, 25.0 mm, 19.0 mm, and 16.0 mm sieves	± 5.0
Per cent passing 13.2 mm, 12.5 mm, and 9.5 mm sieves	± 4.0
Per cent passing 4.75 mm, 2.36 mm, and 1.18 mm sieves	± 3.0
Per cent passing 300, and 150 µm sieves	No limits
Per cent passing 75 µm sieve (all mixes except SMA mixes)	± 1.0
Per cent passing 75 µm sieve (SMA mixes only)	± 2.0
Notes: 1. The maximum field adjustment is applied against the original JMF submitted with the mix design. 2. The adjusted JMF shall meet the requirements of the Contract, including AC content and gradation on all sieves.	

TABLE 2
Sample Size and Frequency

Material	Sample Size	Frequency of Sampling
SMA mixes, Superpave 9.5, 12.5, 12.5FC 1, 12.5FC 2, and 19.0 (Note 1)	20 to 30 kg or 30 to 40 kg (Note 2)	Every subplot
Superpave 25.0 and 37.5 (Note 1)	25 to 35 kg or 35 to 45 kg (Note 2)	Every subplot
HMA Compaction Cores	150 to 200 mm diameter	Every mix properties subplot
HMA Thickness Cores	50 mm diameter	Every thickness subplot
HMA Aggregates for Density Testing	Coarse aggregate 10 kg Fine aggregate 5 kg RAP 5 kg	First sample to be taken at least 10 Days prior to producing first HMA lot; second sample at 15,000 tonnes; thereafter every 20,000 tonnes or when new samples requested
SMA mixes for draindown testing	3 to 5 kg	Once per lot
WMA for moisture sensitivity testing (Note 1)	50 kg	3 sublots per mix type
Notes: 1. Each material sample receptacle shall have a maximum mass of 30 kg. For ease of handling, especially when the larger sample size is required, splitting of material at the paving site is permitted such that a sample is contained in a maximum of two receptacles whose total mass does not exceed the maximum specified above. Once delivered to testing laboratories, combining of the material from the two receptacles is only mandatory if a single receptacle contains insufficient material to carry out the full suite of tests required. 2. The larger sample size shall be applicable when samples are designated for testing to the maximum number of gyrations. The frequency of the larger samples shall be one per lot, as designated by the Contract Administrator.		

TABLE 3
Breakdown of the Tender Item Quantity into Lots for Mix Properties and Compaction

Number of Tonnes	Quantity of Square Metres		Number of Lots
	40 to 55 mm Lift Thickness	60 to 100 mm Lift Thickness	
< 5,000	40,000	25,000	1
5,000 to 10,000	40,000 to 80,000	25,000 to 50,000	2
10,000 to 12,000	80,000 to 100,000	50,000 to 60,000	2 or 3 (Note 1)
> 12,000	> 100,000	> 60,000	3 +
Notes: 1. As determined by the Contract Administrator in consultation with the Contractor.			

TABLE 4
Testing Requirements

Properties and Attributes	Testing Method	Calculations, Values, and Results Required
Mix Properties		
AC Content and Aggregate Gradation for mix samples	LS-282 or LS-292	% AC, % passing DLS sieve, 4.75 mm sieve, 75 µm sieve
Volumetric Properties		
Laboratory Compaction to: i. Design number of gyrations (N_{des}) ii. Maximum number of gyrations (N_{max}) Maximum Theoretical Specific Gravity (G_{mm})	AASHTO T 166 using the same laboratory compaction protocol as was used in mix design. (Note 1) AASHTO T 312, LS-264 Superpave Mixes only: in addition to compacting all samples to the design number of gyrations, one sample from each lot of HMA shall be compacted to the maximum number of gyrations. Bulk Relative Density for mix samples, BRD_m	BRD_m BRD at N_{des} BRD at N_{ini} BRD at N_{max} G_{mm} $\%G_{mm}$ @ N_{ini} $\%G_{mm}$ @ N_{des} $\%G_{mm}$ @ N_{max}
Voids in Mineral Aggregate (VMA)	LS-604, LS-605, LS-266 (Note 2) G_{sb} = combined bulk relative density of blended coarse and blended fine aggregates	G_{sb} VMA
Voids Filled with Asphalt (VFA)	AASHTO R 35	VFA
Air voids for mix (V_a)	LS-265	V_a
Dust to Binder Ratio (D_P) for Superpave mixes	AASHTO R 35	D_P
Compaction		
Compaction and Thickness of Cores	BRD_c = Bulk Relative Density for core samples, LS-262 (Note 1) $MRD_m = G_{mm}$ (Maximum Relative Density for loose mix samples, LS-264) $\% \text{ Compaction} = (100 \times BRD_c / MRD_m)$	Thickness of Core $\% \text{ Compaction}$
Lift Thickness		
Thickness of Cores	LS-294	Lift Thickness
SMA Mix Properties		
Draindown for mix	LS 310	$\% \text{ Draindown}$
WMA Moisture Sensitivity		
WMA Moisture Sensitivity	AASHTO T 283 including Table 1	TSR Visual Stripping Rating
Notes: 1. For all gyratory-compacted specimens and cores of SMA mixes and Superpave mixes, if the per cent water absorbed by the specimen is found to exceed 2% by volume, as described in AASHTO T 166, then the bulk relative density shall be determined using either LS-306 or ASTM D 6752 2. Calculate to two decimal places for each subplot using the BRD_m for the subplot, and the G_{sb} of the most recent QA samples, as specified in the Contract Documents, to provide a lot mean VMA to two decimal places. 3. The rounding-off procedure, for all values, shall be according to LS-100.		

TABLE 5
Specification Limits for HMA Acceptance Attributes

Attributes	HMA Type	Lower Limit (LL) %	Upper Limit (UL) %
AC Content	All HMA types	JMF - 0.40 (Note 1)	JMF + 0.50
Designated Large Sieve	All HMA types	JMF - 5.0	JMF + 5.0
4.75 mm Sieve	All HMA types	JMF - 5.0	JMF + 5.0
75 µm Sieve	All HMA types	JMF - 2.0	JMF + 2.0
Air Voids	All HMA types	2.5	5.5
Pavement Compaction	Superpave 37.5, 25.0, 19.0, 12.5, 9.5 and 12.5FC 1	92.0	97.0
	Superpave 12.5FC 2	92.0	98.0
	SMA	93.0	98.0
Notes:			
1. When a JMF change results in a decrease in the design AC content, the lower limit (LL) shall be set at the revised JMF minus 0.3% for all lots to which the JMF change applies.			

TABLE 6
Payment Factors Based on Per Cent Within Limits

PWL	Designated Large Sieve	4.75 mm Sieve	75 µm Sieve	AC Content	Air Voids	Compaction
100	1.000	1.000	1.000	1.000	1.000	1.000
99	1.000	1.000	1.000	1.000	1.000	1.000
98	1.000	1.000	1.000	1.000	1.000	1.000
97	1.000	1.000	1.000	1.000	1.000	1.000
96	1.000	1.000	1.000	1.000	1.000	1.000
95	1.000	1.000	1.000	1.000	1.000	1.000
94	1.000	1.000	1.000	1.000	1.000	1.000
93	1.000	1.000	1.000	1.000	1.000	1.000
92	1.000	1.000	1.000	1.000	1.000	1.000
91	1.000	1.000	1.000	1.000	1.000	1.000
90	1.000	1.000	1.000	1.000	1.000	1.000
89	1.000	1.000	1.000	1.000	1.000	0.991
88	1.000	1.000	1.000	1.000	1.000	0.983
87	1.000	1.000	1.000	1.000	1.000	0.974
86	1.000	1.000	1.000	1.000	1.000	0.965
85	1.000	1.000	1.000	1.000	1.000	0.956
84	0.997	0.997	0.997	0.992	1.000	0.948
83	0.994	0.994	0.994	0.984	1.000	0.939
82	0.992	0.992	0.992	0.976	1.000	0.930
81	0.989	0.989	0.989	0.968	1.000	0.921
80	0.986	0.986	0.986	0.960	1.000	0.913
79	0.983	0.983	0.983	0.952	0.999	0.904
78	0.980	0.980	0.980	0.944	0.998	0.895
77	0.977	0.977	0.977	0.936	0.995	0.886
76	0.974	0.974	0.974	0.928	0.991	0.878
75	0.972	0.972	0.972	0.920	0.986	0.869
74	0.969	0.969	0.969	0.912	0.980	0.860
73	0.966	0.966	0.966	0.904	0.973	0.851
72	0.963	0.963	0.963	0.896	0.964	0.843
71	0.960	0.960	0.960	0.888	0.955	0.834
70	0.957	0.957	0.957	0.880	0.944	0.825
69	0.954	0.954	0.954	0.872	0.933	0.816
68	0.951	0.951	0.951	0.864	0.920	0.808
67	0.949	0.949	0.949	0.856	0.906	0.799
66	0.946	0.946	0.946	0.848	0.891	0.790
65	0.943	0.943	0.943	0.840	0.875	0.781
64	0.940	0.940	0.940	0.832	0.858	0.773
63	0.937	0.937	0.937	0.824	0.839	0.764
62	0.934	0.934	0.934	0.816	0.820	0.755
61	0.931	0.931	0.931	0.808	0.799	0.746

PWL	Designated Large Sieve	4.75 mm Sieve	75 µm Sieve	AC Content	Air Voids	Compaction
60	0.929	0.929	0.929	0.800	0.778	0.738
59	0.926	0.926	0.926	0.790	0.755	0.729
58	0.923	0.923	0.923	0.780	0.731	0.720
57	0.920	0.920	0.920	0.770	0.706	0.711
56	0.917	0.917	0.917	0.760	0.680	0.703
55	0.914	0.914	0.914	0.750	0.653	0.694
54	0.911	0.911	0.911	0.740	0.624	0.685
53	0.909	0.909	0.909	0.730	0.595	0.676
52	0.906	0.906	0.906	0.720	0.564	0.668
51	0.903	0.903	0.903	0.710	0.533	0.659
50	0.900	0.900	0.900	0.700	0.500	0.650
49	0.882	0.882	0.882	0.686	0.490	0.637
48	0.864	0.864	0.864	0.672	0.480	0.624
47	0.846	0.846	0.846	0.658	0.470	0.611
46	0.828	0.828	0.828	0.644	0.460	0.598
45	0.810	0.810	0.810	0.630	0.450	0.585
44	0.792	0.792	0.792	0.616	0.440	0.572
43	0.774	0.774	0.774	0.602	0.430	0.559
42	0.756	0.756	0.756	0.588	0.420	0.546
41	0.738	0.738	0.738	0.574	0.410	0.533
40	0.720	0.720	0.720	0.560	0.400	0.520
39	0.702	0.702	0.702	0.546	0.390	0.507
38	0.684	0.684	0.684	0.532	0.380	0.494
37	0.666	0.666	0.666	0.518	0.370	0.481
36	0.648	0.648	0.648	0.504	0.360	0.468
35	0.630	0.630	0.630	0.490	0.350	0.455
34	0.612	0.612	0.612	0.476	0.340	0.442
33	0.594	0.594	0.594	0.462	0.330	0.429
32	0.576	0.576	0.576	0.448	0.320	0.416
31	0.558	0.558	0.558	0.434	0.310	0.403
30	0.540	0.540	0.540	0.420	0.300	0.390
29	0.522	0.522	0.522	0.406	0.290	0.377
28	0.504	0.504	0.504	0.392	0.280	0.364
27	0.486	0.486	0.486	0.378	0.270	0.351
26	0.468	0.468	0.468	0.364	0.260	0.338
25	0.450	0.450	0.450	0.350	0.250	0.325
24	0.432	0.432	0.432	0.336	0.240	0.312
23	0.414	0.414	0.414	0.322	0.230	0.299
22	0.396	0.396	0.396	0.308	0.220	0.286
21	0.378	0.378	0.378	0.294	0.210	0.273
20	0.360	0.360	0.360	0.280	0.200	0.260

PWL	Designated Large Sieve	4.75 mm Sieve	75 µm Sieve	AC Content	Air Voids	Compaction
19	0.342	0.342	0.342	0.266	0.190	0.247
18	0.324	0.324	0.324	0.252	0.180	0.234
17	0.306	0.306	0.306	0.238	0.170	0.221
16	0.288	0.288	0.288	0.224	0.160	0.208
15	0.270	0.270	0.270	0.210	0.150	0.195
14	0.252	0.252	0.252	0.196	0.140	0.182
13	0.234	0.234	0.234	0.182	0.130	0.169
12	0.216	0.216	0.216	0.168	0.120	0.156
11	0.198	0.198	0.198	0.154	0.110	0.143
10	0.180	0.180	0.180	0.140	0.100	0.130
9	0.162	0.162	0.162	0.126	0.090	0.117
8	0.144	0.144	0.144	0.112	0.080	0.104
7	0.126	0.126	0.126	0.098	0.070	0.091
6	0.108	0.108	0.108	0.084	0.060	0.078
5	0.090	0.090	0.090	0.070	0.050	0.065
4	0.072	0.072	0.072	0.056	0.040	0.052
3	0.054	0.054	0.054	0.042	0.030	0.039
2	0.036	0.036	0.036	0.028	0.020	0.026
1	0.018	0.018	0.018	0.014	0.010	0.013
0	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 7
Allowable Macrotexture Ratios for Various Mixes

Mix Type	Macrotexture Ratio (M_R)		
	Degree of Segregation		
	Slight	Medium	Severe
Superpave 9.5	< 1.5	1.5 to 2.0	> 2.0
Superpave 12.5, 12.5FC 1, 12.5FC 2	< 1.6	1.6 to 2.2	> 2.2
Superpave 19.0	< 1.8	1.8 to 2.6	> 2.6
Superpave 25.0	< 2.0	2.0 to 3.5	> 3.5

TABLE 8
Minimum Sublot Lift Thickness

Mix Course	Design Lift Thickness (T_D) mm	Minimum Sublot Lift Thickness mm
All Courses	25 to 39	$T_D - 7$
	40 to 59	$T_D - 10$
Surface Course	60 and greater	$T_D - 15$
Binder Courses	60 and greater	$0.70 \times T_D$

TABLE 9
Lot Thickness Payment Adjustment

Course	T_L	Thickness Payment Adjustment, PA_T
Surface Course (Note 1)	$T_L \geq [0.85 \times T_D]$	$PA_T = \text{lot quantity} \times \text{price} \times \{[1.000 - (T_L / T_D)] \times 2.0\}$
Binder Course	$T_L \geq [0.95 \times T_D]$	$PA_T = \text{lot quantity} \times \text{price} \times \{[1.000 - (T_L / T_D)]\}$
	$[0.95 \times T_D] > T_L \geq [0.85 \times T_D]$	$PA_T = \text{lot quantity} \times \text{price} \times \{[1.000 - (T_L / T_D)] \times 2.0\}$
	$T_L < [0.85 \times T_D]$	$PA_T = \text{lot quantity} \times \text{price} \times \{[1.000 - (T_L / T_D)] \times 3.0\}$
Where: T_L = lot mean lift thickness for the tender item, if lot mean lift thickness is less than or equal to T_D (see definition), or $T_L = T_D$, if lot mean lift thickness is greater than T_D lot quantity = the horizontal area of the upper most lift of hot mix in the lot (normally surface course) price = the Contract price of the hot mix tender item Notes: 1. A lot is rejectable when the surface course $T_L < [0.85 \times T_D]$.		

TABLE 10
Reference Densities, D_R

Region	Reference Densities, D_R tonnes/m ³
West Region	2.530
Central Region Northeastern Region Northwestern Region	2.520
Eastern Region	2.390

TABLE 11
AC Price Adjustment

I_P	AC Price Adjustment, PA
$I_P > 1.05 I_{TO}$	$PA = (I_P - 1.05 I_{TO}) \times T_{AC}$
$I_P < 0.95 I_{TO}$	$PA = (0.95 I_{TO} - I_P) \times T_{AC}$
Note: If $I_P > 1.05 I_{TO}$ the Contractor receives compensation; however, if $I_P < 0.95 I_{TO}$ the Owner receives a rebate. Where: PA = payment adjustment for new AC, in dollars I_{TO} = PGAC price index for the month prior to Tender Opening I_P = PGAC price index for the month in which paving occurs T_{AC} = quantity of new AC in tonnes T_{AC}, shall be calculated as follows: $T_{AC} = [AC_{new} / 100] \times T_{mix\_mnth}$ Where: AC_{new} = the percentage of new AC in the mix as required by the JMF. T_{mix_mnth} = the tonnage of HMA, as calculated in the Hot Mix Asphalt Quantity Calculation clause, accepted into the work during the month for which the payment adjustment was calculated.	



**CONSTRUCTION SPECIFICATION FOR UNTREATED SUBBASE,
BASE, SURFACE, SHOULDER, SELECTED SUBGRADE,
AND STOCKPILING**

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314-A	Commentary

314.01 SCOPE

This specification covers the requirements for the construction of Subbase, Base, roadway surface, Shoulder, and edge ramping for bituminous pavements, selected subgrade and stockpiling at specified sites.

314.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

314.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

314.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 350	Concrete Pavement and Concrete Base
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

314.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Selected Subgrade means a granular material meeting the requirements of Select Subgrade Material (SSM), as specified in OPSS 1010, which is used to replace unsuitable native soils or raise the existing grade or both, in order to meet the final subgrade grading requirements, specified in the Contract Documents.

Tolerance means a construction working tolerance only that is considered to be:

a) Minus when it is:

- i. narrower than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
- ii. lower in elevation than the Contract standard when pertaining to vertical dimensions.

b) Plus when it is:

- i. wider than the Contract standard when pertaining to horizontal dimensions as measured from centreline, or
- ii. higher in elevation than the Contract standard when pertaining to vertical dimensions.

314.05 MATERIALS

314.05.01 Aggregates

Aggregates used for Base, Subbase and selected subgrade applications shall be according to OPSS 1010.

314.05.02 Water

Water shall be free of any contaminants that could adversely affect the environment or the placement and compaction of materials for Base, Subbase and selected subgrade applications.

314.06 EQUIPMENT

314.06.01 Water

Equipment used for applying water to granular materials in order to meet compaction requirements for Base, Subbase and selected subgrade applications shall be equipped with variable flow control to uniformly and completely wet the material without causing the material to be eroded away. The equipment operator shall also have the capability to monitor and change the flow while the equipment is moving.

314.07 CONSTRUCTION

314.07.01 Subbase, Base, Surface, and Selected Subgrade

All materials shall be kept free from clay and other types of deleterious material. Construction operations shall not disturb underlying work.

All materials shall be placed in uniform lifts without segregation.

Except as provided under the Modified Layer Compaction Method clause:

- a) Granular B, Type II shall be placed in accordance with the compaction methods specified in the Granular B, Type II clause such that the thickness of the compacted layer is not greater than 150 mm.
- b) All other materials shall be placed such that the thickness of the compacted layer is not greater than 150 mm.

In all cases, each lift shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent lift, when applicable.

Prior to closing down operations for each Day, the Subbase material shall be bladed and compacted and, if necessary, covered with sufficient Base material to carry traffic.

The Base shall be maintained to the tolerances in grade and cross-section and to the specified density until Contract Completion or, if the Contract includes paving, until the Base surface is paved.

314.07.02 Winter Grading

Any areas where materials used for Subbase, Base, selected subgrade or other fill applications are being placed shall be free of ice and snow. Frozen material shall not be incorporated into the Work. Materials used for Subbase, Base, selected subgrade or other fill applications shall not be placed over frozen ground. However, one lift of material may be placed over frozen ground, as long as the final grading and compaction of that lift is done after the underlying material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified material shall be built along the outside edges of each bituminous pavement construction course. Such ramps shall be at a height level with the pavement course and fall away from its edge at a slope not steeper than 4H:1V. Care shall be taken to prevent any ramping material from being spilled or pushed onto the pavement. Any material that is spilled shall be removed immediately without damage to the pavement and the surface thoroughly cleaned with the use of a power broom or other suitable means.

Prior to paving any section, only sufficient material to construct the ramps shall be placed on the Shoulders. No other Shoulder material shall be placed until the conditions, as detailed in the Shoulders subsection, have been attained.

Edge ramps shall be completed prior to opening adjacent pavement to traffic.

314.07.04 Shoulders

Material used for shouldering shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Prior to commencing Shoulder construction, all debris and deleterious material shall be removed from the Shoulder area.

Shouldering operations shall commence as soon as, but not before, the following pavement conditions are met:

a) Bituminous Pavements

Placement of material for shouldering operations shall not commence along any section of pavement, until at least 6 hours have elapsed from the time of completion of the final bituminous pavement course in that section. In addition, for pavement sections that are already open to traffic, all shouldering operations shall be completed within 24 hours of their commencement. In all cases where a pavement section is not yet open to traffic, the shouldering shall be completed prior to opening that pavement section to traffic.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed prior to opening the concrete base or concrete pavement to traffic.

All Shoulder construction material shall be conveyed from the transport vehicle onto the Shoulder area. End dumping of Shoulder construction material directly on to the adjacent pavement surface or directly on to the Shoulder shall not be permitted. The material shall be uniformly distributed within the specified Shoulder limits without segregation. Grading and shaping operations shall confine all material to within the specified Shoulder limits without overspill.

Any Shoulder construction material deposited, dragged, or inadvertently placed on the pavement surface shall be removed immediately and the pavement surface shall be thoroughly cleaned with the use of a power broom or other suitable means.

314.07.05 Compaction

314.07.05.01 General

Each lift of material shall be compacted as specified below prior to the placement of the next lift.

The rate of placing material shall be controlled by the adequacy of the compaction obtained.

314.07.05.02 Compaction Requirements

314.07.05.02.01 Granular B, Type II

Material shall not be dumped into position, but shall be deposited on and pushed over the end of the lift being constructed by means of bulldozers or other approved equipment.

The placement of the first lift of material over wet or weak subgrade shall be monitored and the placement and compaction procedure modified as required, with the approval of the Contract Administrator, to minimize subgrade disturbance. Localized, unusually wet or weak subgrade areas shall be identified to the Contract Administrator for possible treatment.

In restricted zones, as specified in OPSS 501, Granular B, Type II shall be compacted using hand-operated vibratory equipment with a minimum operating mass of 400 kg and a maximum power output between 5.0 and 9.9 kW. Where confined areas are less than the minimum width and where such equipment can be used safely, then smaller vibratory hand-operated tampers shall be used. One hundred percent compaction coverage with a minimum of four passes shall be provided in all cases.

In non-restricted zones, Granular B, Type II shall be compacted using single drum, vibratory, smooth steel drum rollers, with a minimum operating mass of 5,000 kilograms and minimum operating dynamic force of 75 kN. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.

314.07.05.02.02 All Other Granular Materials

The compaction requirements shall be according to OPSS 501.

314.07.05.03**Modified Layer Compaction Method**

Material may be placed in layers thicker than permitted under the Subbase, Base, Surface, and selected subgrade subsection, subject to the following provisions:

- a) All materials, with the exception of Granular B, Type II shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.
- b) Granular B, Type II shall be placed in uniform layers with a compacted depth not to exceed the values shown in Table 1 for various sizes of single drum, vibratory, smooth wheel drum rollers. Both the minimum operating mass and the minimum operating dynamic force requirements shown in Table 1 shall be met for the roller used. One hundred percent roller pass coverage with a minimum number of four passes shall be provided. Each roller pass shall overlap the coverage of the preceding pass by a minimum of 0.5 m.
- c) Prior to placing material in layers as described in a) or b) above depending on the type of granular material used, the ability of the proposed method to achieve satisfactory compaction shall be demonstrated to the satisfaction of the Contract Administrator by means of a two-lane trial area. The trial area location shall be approved by the Contract Administrator. At least 48 hours prior to any work commencing on the trial area, full details of the proposed placing and compacting system or systems, including the rate of placing, depth of layer, number and type of compaction units, and number of passes shall be submitted to the Contract Administrator. The areas designated to evaluate each system shall be of sufficient length to be representative of the proposed method and shall normally be approximately 150 m in length. Approval will follow within one Business Day after satisfactory completion of the compaction trial area.
- d) When the Contract Administrator, approves a system of placing and compacting, the system shall be used for the remainder of the work to which it is applicable, except that:
 - i. Should it be necessary at any time to change the system or any part of it, including the source of material or the rate of placing the material, approval to change the system shall be obtained from the Contract Administrator, who may require a further trial area.
 - ii. If, at any time, tests show that a previously-approved system is no longer producing the required degree of compaction, changes shall be made as necessary to satisfy the requirements of this specification.

314.07.06**Tolerances**

The surface of the uppermost layer of granular material and each granular course shall be bladed, shaped, and compacted to produce the grade and cross-section specified in the Contract Documents, within the tolerances shown in Table 2.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerances shall take precedence.

314.07.07**Stockpiling of Granular Material**

Sites for stockpile construction, specified in the Contract Documents, shall be cleared and grubbed, regardless of stockpile height, according to OPSS 201. Organic soil underlying the stockpile location shall be removed and the site cleaned up prior to stockpile construction. Stockpiles shall be constructed, including the supply and placement of a pad upon which the materials are to be stockpiled, according to OPSS 1001.

314.07.08 Grade Checks

The Contract Administrator shall be notified within 12 hours when each Subbase or Base course has been completed, including Shoulders, and prior to the next course being placed.

The Contractor shall be responsible for carrying out all grade checks to ensure that horizontal and vertical grading tolerances are met.

Grade checks shall be carried out on all finished granular surfaces. Grade checks of granular grading surfaces shall be based on horizontal and vertical grading tolerances, as specified in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the grading templates, or when grading templates are not available, at the frequency requirements shown for the layout specified elsewhere in the Contract Documents.

314.07.09 Submission of Grade Checks

All grade checks concerning horizontal and vertical grading tolerances, including all non-compliances, shall be submitted to the Contract Administrator within 2 Business Days following completion of the grade.

When grading templates are available, the Contractor shall sign and certify on the grading template that the components of the work indicated on that template have been correctly constructed to the specified line and grade tolerances. If a template is not available, then the Contractor shall complete, sign, and submit MTO form PH-CC-820 to the Contract Administrator.

314.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

314.08 QUALITY ASSURANCE

314.08.01 General

The Owner may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Acceptance

If the Contract Administrator chooses not to take QA grade checks or if the QA grade checks conform to those determined by the Contractor, the work shall then be accepted.

However, if any discrepancies between the QA and the Contractor's grade checks are found, then, at the discretion of the Owner, additional QA grade checks may be carried out in any other location.

If the finished grade or cross-section or both are not within the tolerances specified in the Tolerances subsection, then:

- a) The Contract Administrator shall notify the Contractor and advise where the tolerances have not been met, including overbuilding of the width of a granular course.
- b) The Contractor shall be charged for each station where the tolerances have not been met, at the rate specified in the Basis of Payment section.
- c) The Contractor shall bring the granular surface to within the specified tolerances for grade, at no additional cost to the Owner.

314.09 MEASUREMENT FOR PAYMENT

314.09.01 Actual Measurement

**314.09.01.01 Granular A, B Type I, B Type II, B Type III, M and O
Granular A, B Type I, B Type II, B Type III, M, and O Stockpiled
Granular A, B Type I, B Type II, B Type III, M, and O from Stockpile
Select Subgrade Material, Compacted**

314.09.01.01.01 Tonne

When payment is by the tonne:

- a) When the Contractor supplies Granular A and M composed of air-cooled iron blast-furnace slag or nickel slag, the payment quantities shall be determined by applying the following factors:
 - i. The total measured mass of air-cooled iron blast-furnace slag incorporated into the work shall be multiplied by a factor of 1.116.
 - ii. The total measured mass of nickel slag incorporated into the work shall be multiplied by a factor of 0.85.
- b) When Granular B is composed of slag, the payment quantities shall be determined by comparing the density of the material to the average density of granular material as set by the Owner for that specific area and applying the conversion factors that have been determined to the weighed tonnes.
- c) When granular material is composed of slag, it is necessary to determine the amount of overrun or underrun. Such overrun and underrun shall be the difference between the tender quantity and the payment quantity as determined by applying the foregoing factors to the weighed tonnes.

314.09.01.01.02 Cubic Metre

When payment is by cubic metre, one of the following methods shall be used as determined by the Contract Administrator:

a) End Area Method

i. At Source

The volume of material shall be measured at the source in its original location and computed in cubic metres by the method of average end areas.

Cross-sections shall be taken after the source has been cleared, grubbed, and stripped of all unsuitable surface material.

The volume of boulders removed from borrow pits that cannot be accommodated in embankments or any other areas acceptable to the Owner, shall be deducted.

ii. In Place

When the measurement for payment of material in its original location is impractical, the measurement for payment shall be made of material measured in place with no allowance for shrinkage and computed in cubic metres by the method of average end areas.

b) Truck Box Method

The truck box method shall only be used when the Contract Administrator deems that the quantities are too small or the end area method is impractical for other reasons.

In this case, measurement for payment shall be based on the total volume in cubic metres of loose granular material, calculated by the Contract Administrator, from estimated percentages of the pre-determined capacity of each truck box determined from measurements of its dimensions.

Each truck that the Contractor intends to use shall be uniquely and readily identifiable to the satisfaction of the Contract Administrator.

314.09.01.01.03 Square Metre

When payment is by square metre, the area shall be based on that shown in the Contract Documents.

314.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

314.10 BASIS OF PAYMENT

- 314.10.01 Granular A - Item**
Granular A, Stockpiled - Item
Granular A, from Stockpile - Item
- Granular B Type I - Item**
Granular B Type I, Stockpiled - Item
Granular B Type I, from Stockpile - Item
- Granular B Type II - Item**
Granular B Type II, Stockpiled - Item
Granular B Type II, from Stockpile - Item
- Granular B Type III - Item**
Granular B Type III, Stockpiled - Item
Granular B Type III, from Stockpile - Item
- Granular M - Item**
Granular M, Stockpiled - Item
Granular M, from Stockpile - Item
- Granular O - Item**
Granular O, Stockpiled - Item
Granular O, from Stockpile - Item
- Select Subgrade Material, Compacted - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

As specified in the Acceptance subsection, \$250.00 shall be deducted from payment for each station where the QA grade check of the finished grade is found to be outside of the specification limit.

Any additional grading carried out to correct grades that are not within the tolerances specified in the Tolerances subsection shall be carried out at no additional cost to the Owner.

Where a finished granular course exceeds the horizontal tolerances specified in the Tolerances subsection and the material outside that tolerance has been left in place, the Owner shall deduct from payment the theoretical quantity of material placed outside of that tolerance, based on a conversion factor of 2.0 t/m³, regardless of the type of granular material used.

TABLE 1
Modified Layer Compaction Thickness for Granular B, Type II
Single Drum, Vibratory, Smooth Wheel Drum Roller

Minimum Operating Mass kg	Minimum Operating Dynamic Force kN	Maximum Layer Depth After Compaction mm
5,000	75	300
8,000	150	450
12,000	250	600
15,000	350	750

TABLE 2
Allowable Tolerances for Finished Granular Surfaces

Tolerances From Specified Grade and Cross - Section	Finished Granular Courses mm	Finished Granular Surfaces Immediately Beneath Bituminous Courses, Sidewalks, and Curb and Gutter mm		Finished Granular Surfaces Immediately Beneath Concrete Courses, Sidewalks, and Curb and Gutter mm
		When the Finished Grade is Controlled by Fixed Components Such as Existing Pavements and Curbs	All Others	
Vertical	+ 30 - 30	+ 10 - 10	+ 30 - 30	+ 10 - 10
Horizontal	+ 30 - 0	+ 10 - 0	+ 30 - 0	+ 10 - 0
Surface Deviation (Note 1)	15	10		10
Notes:				
1. The maximum gap between a granular surface and the underside of a 3 m rigid metal straightedge, placed anywhere and in any direction on that surface.				

Appendix 314-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR EXTRUDED EXPANDED POLYSTYRENE FROST HEAVE TREATMENT

TABLE OF CONTENTS

316.01	SCOPE
316.02	REFERENCES
316.03	DEFINITIONS - Not Used
316.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
316.05	MATERIALS
316.06	EQUIPMENT - Not Used
316.07	CONSTRUCTION
316.08	QUALITY ASSURANCE - Not Used
316.09	MEASUREMENT FOR PAYMENT
316.10	BASIS OF PAYMENT

316.01 SCOPE

This specification covers the requirements for the installation of extruded expanded polystyrene insulation for frost heave treatment of pavements.

316.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 308	Tack Coating and Joint Painting
OPSS 314	Untreated Granular Subbase, Base, Surface, Shoulder, and Stockpiling
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1605 Extruded Expanded Polystyrene Pavement Insulation

316.05 MATERIALS

316.05.01 Extruded Expanded Polystyrene

Extruded expanded polystyrene insulation shall be according to OPSS 1605 and supplied in sheets 600 x 2400 mm.

Grade and compressive strength of the extruded expanded polystyrene insulation shall be as specified in the Contract Documents.

316.05.02 Tack Coat

Tack coat shall be according to OPSS 308.

316.05.03 Granular

Granular base and subbase shall be according to OPSS 1010.

When Granular B is used as backfill, 100% of the material shall pass the 75 mm sieve.

316.07 CONSTRUCTION

316.07.01 General

The site shall be prepared and extruded expanded polystyrene insulation placed and covered with compacted granular material.

316.07.02 Site Preparation

316.07.02.01 Excavation

The excavation shall be carried out to the dimensions specified in the Contract Documents. The tolerance of the earth grade on which the extruded expanded polystyrene is to be placed shall be according to OPSS 206 and the surface shall not deviate by more than 10 mm at any place on a 3 m straight edge.

All protruding material such as cobbles, boulders, and roots exceeding 50 mm in any dimension shall be removed from the surface.

316.07.02.02 Pavement Surface

The pavement surface shall be cleaned of all earth, granular, and any other debris before tack coat is placed.

316.07.03 Placing Extruded Expanded Polystyrene

316.07.03.01 General

Extruded expanded polystyrene sheet treatment shall be placed and secured. The sheets shall be placed lengthwise and parallel to the centreline of the roadway to obtain butt joints and staggered transverse joints. The area to be treated and the insulation thickness shall be as specified in the Contract Documents.

316.07.03.02 Securing

Each sheet of extruded expanded polystyrene may be secured by placing sufficient granular material to ensure that no movement takes place during subsequent operations.

Alternatively, hardwood skewers 10 mm in diameter and 150 mm in length shall be used to secure the extruded expanded polystyrene to the prepared surfaces.

When extruded expanded polystyrene is placed directly on a pavement surface, tack coat shall be applied according to OPSS 308 to the existing pavement surfaces to provide a secure bond between the extruded expanded polystyrene and the pavement surface. The tack coat shall be applied at a rate of 0.35 kg/m². The extruded expanded polystyrene shall be placed while the tack coat is still tacky.

316.07.04 Granular Material

Granular base or subbase material shall be placed according to OPSS 314; except, the initial lift of granular material for protection of extruded expanded polystyrene from construction traffic shall be the depth specified in the Contract Documents placed in one lift by end dumping and spreading.

Vehicular traffic shall not be permitted on the extruded expanded polystyrene sections until the full depth of the entire granular base and subbase courses have been placed and compacted according to OPSS 501.

316.07.05 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

316.09 MEASUREMENT FOR PAYMENT

316.09.01 Actual Measurement

316.09.01.01 Extruded Expanded Polystyrene Treatment

Measurement of extruded expanded polystyrene shall be by area in square metres.

316.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

316.10 BASIS OF PAYMENT

316.10.01 Extruded Expanded Polystyrene Treatment - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

316.10.02 Excavation

Payment for earth and rock excavation shall be according to OPSS 206.

316.10.03 Granular Base and Subbase

Payment for granular base and subbase material placed over the polystyrene shall be according to OPSS 314.

316.10.04 Tack Coat

Payment for tack coat shall be according to OPSS 308.



CONSTRUCTION SPECIFICATION FOR TEMPORARY HOT MIX PAVEMENT

TABLE OF CONTENTS

317.01	SCOPE
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317.05	MATERIALS
317.06	EQUIPMENT - Not Used
317.07	CONSTRUCTION
317.08	QUALITY ASSURANCE - Not Used
317.09	MEASUREMENT FOR PAYMENT
317.10	BASIS FOR PAYMENT

317.01 SCOPE

This specification covers the requirements for construction of temporary hot mix asphalt.

317.02 REFERENCES

This Special Provision refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

317.03 DEFINITIONS

For this Special Provision, the definitions in OPSS 313 and the following definition apply:

Temporary Hot Mix Pavement means hot mix that is not intended to form part of the permanent work.

317.05 MATERIALS

317.05.01 Hot Mix Asphalt

Temporary hot mix pavement mix shall be suitable for its intended use.

317.05.02 Release Agents

Release agents shall be according to the Release Agents clause as specified in OPSS 313.

317.07 CONSTRUCTION

317.07.01 Preparation of Foundation and Existing Pavement

Preparation of foundation and existing pavement shall be according to the Preparation of Foundation and Existing Pavement clause as specified in OPSS 313.

317.07.02 Placing Hot Mix Asphalt

317.07.02.01 Paving

Levelling, binder and surface courses shall be laid to the specified depths by means of mechanical self-propelled pavers and uniformly compacted with rollers. A shoulder spreader may be used if the lane widening is equal to or less than 1.5 m in width and adjacent to an existing lane.

Excess HMA shall not be cast onto the surface of the freshly laid mat. After final compaction of each course the surface shall be smooth and true to the established crown and grade, uniform in texture and shall be free of any defects including, but not limited to, segregation, fat spots, oil spills, chatter, and roller marks.

All through lane paving courses shall be completed prior to the placement of adjacent sideroads, speed change lanes, and other paved areas.

The temporary HMA shall be placed and compacted to the total thickness specified in the Contract Documents.

At the end of each completed portion of the lanes and prior to opening them to traffic, the ends of completed sections of HMA course shall be temporarily ramped down to the existing pavement according to the Temporary Ramp Downs clause.

If paving is being carried out under lane closures, paving shall be completed to the same station for the full pavement width, including paved shoulders, prior to the roadway being reopened to traffic except as noted in the Partial Paving of Full Pavement Width clause.

317.07.02.02 Partial Paving of Full Pavement Width

Partial paving of the full pavement width is not permitted when one or more of the following conditions exist:

- a) When the ramping height would be greater than 50 mm, or
- b) The pavement slope would cause water to accumulate at the edge of the ramping and extend onto an adjacent lane or shoulder that will be open to traffic.

When partial paving of the full pavement width is permitted, temporary longitudinal and transverse ramp downs shall be placed regardless of the difference in height elevations between adjacent pavement surfaces.

317.07.02.03 Temporary Ramp Downs

Temporary ramp downs shall be according to the Temporary Ramp Downs clause as specified in OPSS 313.

317.07.03 Winter Carry-over of Temporary Hot Mix Pavement

If temporary hot mix pavement is specified to be removed prior to seasonal shutdown but due to delays cannot be removed:

- a) The Contract Administrator shall be notified at least 20 Business Days prior to the seasonal shutdown, and;
- b) The responsibility for preparing the temporary hot mix pavement for, and making repairs during, the shutdown period will depend upon the reasons for the carry-over to the next construction season.

Preparation requirements for the shutdown period will be subject to prior approval by the Owner and may include, but are not limited to, drainage improvements, erosion control measures, resurfacing with a lift of HMA, placing shoulder materials, temporary pavement markings, and traffic control.

317.07.04 Quality Control

317.07.04.01 General

The QC procedures shall be conducted to ensure HMA meets the requirements of the selected HMA type for the intended purpose.

317.07.04.02 Repairs

All defects in the materials and workmanship of the temporary hot mix pavement shall be repaired to ensure a safe and smooth riding surface. Repairs shall be made with the same HMA type as the original work unless the Owner accepts a proposal to do otherwise. The Contractor shall not be responsible for repairing defects caused by granular base, sub-base or sub-grade problems provided these have been constructed according to the Contract Documents.

Timing for repairing defects shall be according to Table 1.

In emergency situations, or if the Contractor has not started repairs within 24 hours of receiving written notification the Owner may, without obligation to do so, make such repairs. The Owner will keep records of lane closure times and repair costs. The Contractor shall not conduct any operations in the same area during the Owner's repair operation.

317.07.05 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

317.09 MEASUREMENT FOR PAYMENT

317.09.01 Actual Measurement

317.09.01.01 Temporary Hot Mix Pavement

317.09.01.01.01 By Mass

Measurement of temporary hot mix pavement shall be by mass in tonnes.

The quantities of HMA used for temporary ramping shall not be measured for payment. The removal of HMA used for temporary ramping shall not be measured for payment.

317.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement.

317.10 BASIS OF PAYMENT

317.10.01 Temporary Hot Mix Pavement – Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Materials to do the work.

317.10.02 Repair Delay Charges

The Contractor will be assessed \$30 per hour for each hour, or part thereof, that expires between:

- a) 24 hours after the time that the Contractor is given written notification by the Contract Administrator that a deficiency has been observed in the temporary hot mix pavement and the time that the repair begins, and
- b) each time that uncompleted repair work stops and the time that it resumes.

317.10.03 Removal of Temporary Hot Mix Pavement

Payment for removal of the temporary hot mix pavement, excluding defective temporary hot mix pavement, shall be made under the applicable tender item for HMA pavement removal.

TABLE 1
Repair Criteria and Maximum Repair Period for Defects in Temporary HMA Pavement Surface

Defect	Repair Criteria	Freeway	Non-Freeway
Potholes	Any pothole that is deeper than 50 mm and greater than 0.04 m ² (e.g., 20 cm X 20 cm or 10 cm X 40 cm) on asphalt pavement shall be repaired upon detection.	3 Days	7 Days
	Any pothole exceeding 20 mm in depth on a bridge surface shall be repaired upon detection.	3 Days	3 Days
Pavement Edge Surface Loss	Paved surface edge surface loss which extends more than 100 mm inward from the outer edge shall be repaired upon detection.	7 Days	7 Days
Water Ponding	Water Ponding on paved surfaces resulting from high gravel shoulders repaired upon detection.	7 Days	14 Days
Distortion	Distortions such as rippling, shoving, rutting, bumps, and dips are marked with warning signage upon detection.	1 Day	1 Day
Cracking	Cracks in asphalt pavement surfaces wider than 25 mm shall be repaired upon detection.	14 Days	14 Days
Sink Holes	Sink Holes shall be repaired upon detection.	1 Day	1 Day
Hazards	Deficiencies or defects that pose an imminent hazard shall be addressed upon detection.	2 hours	2 hours



CONSTRUCTION SPECIFICATION FOR OPEN GRADED DRAINAGE LAYER

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320.06	EQUIPMENT
320.07	CONSTRUCTION
320.08	QUALITY ASSURANCE
320.09	MEASUREMENT FOR PAYMENT
320.10	BASIS OF PAYMENT

320.01 SCOPE

This specification covers the requirements for materials, construction, and testing of asphalt cement and Portland cement treated open graded drainage layer.

320.02 REFERENCES

This specification refers to the following standards, specifications, and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 313	Hot Mix Asphalt - End Result
OPSS 350	Concrete Pavement and Concrete Base

Ontario Provincial Standard Specifications, Material

OPSS 1103	Emulsified Asphalt
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-100	Rounding-Off of Test Data and Other Numbers
LS-601	Material Finer Than 75 μ m Sieve in Mineral Aggregates by Washing

LS-602	Sieve Analysis of Aggregates
LS-604	Relative Density and Absorption of Coarse Aggregate
LS-606	Soundness of Aggregates by Use of Magnesium Sulphate
LS-608	Percent Flat and Elongated Particles in Coarse Aggregate
LS-614	Freezing and Thawing of Coarse Aggregates
LS-618	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-625	Guidelines for Sampling of Granular Materials
LS-627	Open-Graded Drainage Layer (OGDL) Core Porosity Test
LS-630	Determination of Amount of Contamination of Coarse Aggregate
LS-631	Qualitative Determination of Presence of Plastic Fines in Aggregates

ASTM International

C174 / C174M - 17 Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores

320.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 313 and OPSS 350 and the following definitions apply:

Delineator means the material used to delineate boundary between Portland cement treated open graded drainage layer and the overlying concrete slab to facilitate measurement of the slab thickness.

Design Lift Thickness means the thickness in millimetres of the OGDL lift as specified in the Contract Documents.

Drainage System means the OGDL, subdrains, and the lateral outlets.

Duplicate Samples means two samples taken at the same time and location - one to be used for quality assurance testing and the other for referee testing.

Mixture or Mix means open graded drainage layer material treated with either asphalt cement or Portland cement.

Open Graded Drainage Layer (OGDL) means a rapid draining layer located within the pavement structure that is covered either by concrete pavement, concrete base, or hot mix asphalt pavement and overlies the granular base course. The OGDL can be either Portland cement treated or asphalt cement treated.

Porosity of OGDL means the ratio of the volume of voids to total volume of OGDL as measured by LS-627.

320.04 DESIGN AND SUBMISSION REQUIREMENTS

320.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator at least three Days prior to placement of the OGDL:

- a) Source(s) for the OGDL aggregate material.
- b) Volumetric proportions for the OGDL mixture.
- c) The type of plant to be used for OGDL mixture production and the plant location.

320.05 MATERIALS

320.05.01 General

Proportioning and mixing of OGDL materials shall produce a uniform homogenous mixture in which all particles of the aggregates are thoroughly and uniformly coated.

The porosity of the placed OGDL lift shall be 0.25 to 0.40, determined according to LS-627.

320.05.02 Aggregates

Aggregates for OGDL shall consist of 100% crushed particles produced by crushing bedrock material. Reclaimed materials or crushed reclaimed materials shall not be permitted.

The aggregates shall meet all of the requirements for gradation and physical properties shown in Tables 1 and 2.

320.05.03 Asphalt Cement Treated OGDL

Asphalt cement shall be according to the requirements for performance graded asphalt cement specified in the Contract Documents. The percentage by mass of asphalt cement in the mixture shall be $1.8 \pm 0.2\%$.

320.05.04 Portland Cement Treated OGDL

Cementing materials and water used in production of OGDL shall be according to OPSS 1350.

The mix shall contain $120 \pm 10 \text{ kg/m}^3$ of Type GU Portland cement or Portland limestone cement (PLC) Type GUL. A portion of Portland or Portland limestone cement may be replaced by supplementary cementing materials as specified in OPSS 1350.

320.05.05 Delineator

The delineator shall consist of SS-1 emulsified asphalt according to OPSS 1103 diluted with an equal volume of water.

320.06 EQUIPMENT

320.06.01 Production Equipment

Portland cement treated OGDL mix shall be produced, mixed and delivered from a batching plant according to OPSS 1350.

320.06.02 Paving Equipment

Paving equipment shall not cause segregation of the material and shall place a uniform, homogeneous OGDL across the lane to the required grade and design lift thickness specified in the Contract Documents.

Paving equipment shall be self-propelled and capable of laying a consistent satisfactory mat that is true to the crossfall, profile, cross-section, and alignment specified in the Contract Documents.

320.06.03 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

320.07 CONSTRUCTION

320.07.01 Operational Constraints

OGDL mixture shall not be placed in the rain and the ambient temperature at the time of mixture placement shall be above 2°C. Precautions shall be taken to protect placed plastic Portland cement treated OGD L from rain.

Traffic shall not be permitted on the OGD L with the exception of sampling equipment, equipment for the application of delineator, and the paving train during the placement of the overlying pavement.

Contamination of the OGD L by mud or other contaminants shall not be permitted.

All OGD L shall be covered with the overlying pavement within 30 Days following placement.

The subdrains and lateral outlets of the drainage system shall be operational prior to the placement of the OGD L.

320.07.02 Longitudinal and Transverse Joints

All joints shall be made to obtain a complete bond between the two OGD L edges and a smooth riding surface. Longitudinal and transverse joints shall be butt joints. The existing or previously placed OGD L edge shall be a straight clean vertical surface for the full depth of the OGD L. Where ramping or damage has occurred, trimming shall be required.

All dirt or other foreign material and all loose material shall be removed from all vertical surfaces. When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction.

320.07.03 Rolling

Rollers for compaction shall not be in vibration mode. Aggregate pick-up by the rollers shall be avoided. When water is used on the roller drums to prevent aggregate pick-up, free water shall not be allowed to fall onto the Portland cement treated OGD L surface.

320.07.04 Surface Tolerances

The surface shall be shaped and compacted so the finished surface does not deviate more than 10 mm from the grade and cross-section specified in the Contract Documents.

The surface tolerance shall be such that when tested with a 3 m straight edge placed in any direction on the surface except across the crown, there shall not be a gap greater than 5 mm between the bottom of the straight edge and the surface of the OGD L. Correction of the finished surface by grading or milling, or both, shall not be permitted.

320.07.05 Delineation

A delineator shall be placed on the Portland cement treated OGD L prior to placement of the overlying concrete pavement or concrete base.

The delineator shall be applied using self-propelled or towed pressure distributors capable of applying the product in a continuous and uniform manner over all of the OGD L to be overlaid.

320.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

320.08 QUALITY ASSURANCE

320.08.01 General

A laboratory designated by the Owner shall carry out acceptance testing.

The Owner shall be responsible for all costs associated with testing for Quality Assurance (QA) purposes, unless otherwise specified in this specification.

All test results shall be forwarded to the Contractor as they become available.

320.08.02 Sampling

The Contract Administrator shall be allowed access to all sampling locations and reserves the right to request a sample at any time.

All samples shall be placed in clean sample bags, then sealed and labelled, as specified in the Contract Documents.

All samples shall be accompanied by MTO Form PH-D-10.

320.08.02.01 Sampling of Aggregate for Gradation and Physical Properties

All aggregates samples shall be duplicate samples.

At least one duplicate 25 kg sample of aggregate from every lot of 50,000 m² or part thereof of OGDL being produced shall be obtained.

Additional samples shall also be taken whenever the aggregate changes to a new source or a new bench in a quarry. In this case, the existing lot shall be terminated and a new lot commenced.

Unless otherwise specified, all samples of aggregate shall be taken at the plant producing OGDL from individual stockpiles with a minimum quantity of 500 tonnes of aggregate, or at least 10% of the total quantity of aggregate requirement for the OGDL mix, unless otherwise directed by the Contract Administrator.

Sampling from stockpiles shall be according to LS-625. Each sample shall be treated as discrete sample and not combined or blended with any other sample.

320.08.02.02 Sampling of OGDL for Thickness and Porosity

The Contract Administrator shall establish the lot size as well as the number of sublots for thickness and porosity sampling, after discussions with the Contractor and prior to placement of the OGDL.

Lot size is generally 40,000 m² with the subplot size of 4,000 m². In all cases, a maximum allowable subplot numbers is 10 sublots per lot.

Within five Business Days of placement and prior to the placement of the overlying pavement layer, one intact 150 mm nominal diameter core shall be taken of the full depth of the OGDL for each subplot at a random location selected by the Contract Administrator.

Metal or cardboard containers that protect the integrity and shape of cores during transportation and until testing shall be used. When cores are taken the cores shall be intact and undamaged. If an intact and undamaged core cannot be obtained, then the sample shall be taken by saw cutting an intact sample with minimum dimensions of 140 by 140 mm square and maximum dimensions of 145 by 145 mm square. The sample shall be delivered intact and undamaged.

Immediately after sampling, each sample hole shall be filled with OGDL aggregate, treated with asphalt cement or Portland cement, up to the top of the surrounding OGDL.

320.08.03 Testing

320.08.03.01 Gradation and Physical Properties

Aggregates shall be tested according to Tables 1 and 2.

Aggregate shall be tested according to LS-614, unless written notification to the Contract Administrator to test according to LS-606 is received prior to sampling of the applicable materials for QA purposes. Unless the Contract Administrator has received such a request to replace LS-614 with LS-606, conformance to LS-614 shall be required.

When notification to replace LS-614 is received after QA testing using LS-614 has been initiated, the Owner shall charge \$750.00 for each test initiated, which includes the cost of the testing using LS-614, administrative charges, and additional sampling, if required.

320.08.03.02 Thickness

One sample from each subplot shall be tested to determine the thickness of the OGDL according to ASTM C174. The test result for each subplot shall be used to compute the lot mean thickness calculated to one decimal place according to LS-100.

320.08.03.03 Porosity

The same sample used for the thickness determination from each subplot shall be tested to determine the porosity of the OGDL according to LS-627. The test result for each subplot shall be used to compute the lot mean porosity calculated to two decimal places according to LS-100.

320.08.04 Acceptance

Acceptance of OGDL shall be based on the gradation and physical properties of the aggregates used as well as the thickness, porosity, surface appearance and surface tolerance of the OGDL after placement.

320.08.04.01 Acceptance of Gradation and Physical Properties

The aggregates within a lot of OGDL shall be deemed to be acceptable, if the test results for the aggregate sample representing that lot meet all of the acceptance limit requirements specified in Tables 1 and 2.

If one or more test results for an aggregate sample representing a lot of OGDL do not meet all of those acceptance limit requirements, then the OGDL aggregates shall be removed from the Work and replaced according to the Repairing and Re-Decisioning subsection, or a price reduction applied at the discretion of the Contract Administrator. A price reduction may only be applied for each m² of OGDL left in the Work as long as the aggregate sample representing that lot are all within the price reduction range(s) specified in Tables 1 and 2.

If the QA test results of an aggregate sample representing a lot of OGDL for gradation and physical properties do not meet all the specified requirements and are not price adjusted, then all of the aggregates within that lot shall be rejected and any OGDL that includes those aggregates shall be removed from the Work and replaced at no additional cost to the Owner.

320.08.04.02 Acceptance of Surface Appearance

The surface appearance of the OGDL shall be assessed by the Contract Administrator based on visual surveys. The finished OGDL surface shall have a uniformly open texture and be free of loose aggregate. The OGDL shall be rejected if:

- a) A single appearance of irregularity exceeds 5 m².
- b) The combined area of multiple irregularities exceeds 10 m² over a 100 m² section.

c) Any OGDL identified by the Contract Administrator as being contaminated.

OGDL that is rejected for its appearance shall be repaired. OGDL that is repaired shall be re-decided according to the Repairing and Re-Deciding subsection.

320.08.04.03 Acceptance of Surface Tolerance

All areas not meeting the surface tolerance requirements as specified in the Surface Tolerances subsection shall be rejected, repaired and re-decided according to the Repairing and Re-Deciding subsection.

320.08.04.04 Acceptance of Thickness

Thickness acceptance shall be based on the mean of the lot, provided that no single subplot is deemed rejectable. A subplot shall be rejected, if the subplot thickness is less than 0.60 of the design lift thickness. Rejected sublots shall not be included in the lot mean thickness calculation.

If the lot mean thickness is greater than or equal to the design lift thickness, the item shall be accepted without any price reduction for thickness.

If the lot mean thickness is less than the design lift thickness, but greater than or equal to 0.75 of the design lift thickness, the lot shall be subject to a price reduction calculated using the pay factors given in Table 3.

The lot shall be rejected, if the lot mean thickness is less than 0.75 of the design lift thickness.

If repair to the lot is chosen in lieu of a price reduction or if a rejected lot requires repair, the lot shall be repaired and decided according to the Repairing and Re-Deciding subsection.

320.08.04.05 Acceptance of Porosity

Acceptance for the porosity of OGDL shall be based on the lot mean for the porosity of OGDL, and the porosity of individual sublots.

A subplot shall be rejected if the porosity of OGDL is less than 0.20 or greater than 0.50. Rejected sublots shall not be included in the lot mean porosity calculation and shall be repaired according to the Repairing and Re-Deciding subsection.

The lot shall be accepted if the lot mean porosity of OGDL is greater than or equal to 0.25, and less than or equal to 0.40, and with less than 30% of sublots with porosity outside the range of 0.25 to 0.40.

If the lot mean porosity of OGDL is greater than or equal to 0.25, and less than or equal to 0.40, and with more than 30% of sublots with porosity outside the range of 0.25 to 0.40, those sublots outside the range shall require repair until more than 30% of sublots are within the range of 0.25 to 0.40 for the porosity.

If the lot mean porosity of OGDL is greater than or equal to 0.20 and less than 0.25, or greater than 0.40 and less than or equal to 0.50, the lot shall be subjected to a price reduction calculated using the pay factors in Table 4. If repair to the sublots is chosen in lieu of a payment adjustment, the sublots shall be repaired and re-decided according to the Repairing and Re-Deciding subsection.

If the lot mean porosity of OGDL is less than 0.20 or greater than 0.50, the lot shall be rejected, repaired and re-decided according to the Repairing and Re-Deciding subsection.

320.08.04.06 Referee Testing for Gradation and Physical Properties

Referee testing may be invoked for one or more attributes by submitting a written request to the Contract Administrator, within five Business Days following notification that a sample representing a lot of OGDL does not meet the requirements of this specification.

Referee testing shall be carried out, as specified herein and as specified in the Contract Documents.

The retained duplicate QA aggregates samples shall be used for referee testing.

All referee test results for a lot shall replace the respective QA tests for acceptance of the applicable lot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the referee test results, the cost of the referee testing of that lot, including the cost of transporting the samples to the referee laboratory, at the rates as specified in the Contract Documents shall be at no additional cost to the Owner. In all other cases, the Owner shall bear the cost of the referee testing and the cost of transporting the samples of that lot.

320.08.04.07 Re-test for Thickness and Porosity

Re-testing for thickness or porosity or both may be invoked by submitting a written request to the Contract Administrator, within five Business Days following notification that any QA samples representing a lot or subplot of OGDL fails to meet the requirements of this specification.

The re-test shall be carried out on the same QA sample, as specified herein and as specified in the Contract Documents. Witnessing of the re-test of the same QA samples for thickness or porosity or both is permitted.

All re-test results for a lot or subplot shall replace the respective QA tests for acceptance of the applicable lot or subplot and shall be binding on both the Owner and the Contractor.

If a lot is not accepted at full payment based on the re-test results, the cost of the re-testing of that lot shall be at no additional cost to the Owner. In all other cases, the Owner shall bear the cost of the re-testing.

320.08.05 Repairing and Re-Decisioning

320.08.05.01 General

All repairs including removals and replacements to OGDL shall be full lane or shoulder width and a sufficient length for the repair to be carried out employing the same equipment used during initial placement of the OGDL with the exception of repairs for surface deficiencies in surface tolerance. OGDL used for repairs shall meet the requirements of this specification.

All repairs shall be carried out at no additional cost to the Owner.

320.08.05.02 Gradation and Physical Properties

Any OGDL that includes rejected aggregates, as specified in the Acceptance of Gradation and Physical Properties clause, shall be removed and replaced.

320.08.05.03 Surface Appearance

Rejected OGDL due to surface irregularities or contamination shall be removed and replaced.

320.08.05.04 Surface Tolerance

Where the finish grade of OGDL is below the design grade, the final grade of the pavement shall be corrected with an additional thickness of overlying surface material. Patching on the surface of OGDL shall not be permitted. If the finish grade of OGDL is above the design grade, the overlying surface material shall follow the design thickness. Milling on the surface of OGDL shall not be permitted.

320.08.05.05 Thickness and Porosity

For each subplot or lot that is rejected due to thickness or porosity or both, or chosen for repair, the entire subplot of OGDL shall be removed and replaced.

When repairs are made to rejected sublots or lot or those sublots that are chosen for repair due to non-conformance, the original lot and replaced sublots shall be re-evaluated and re-decided for acceptance.

The original lot shall be divided into two reconfigured lots in the following way: All non-replaced sublots shall be grouped as one lot; The remaining sublots (i.e., replaced sublots) shall be grouped as another lot. Lot mean thickness and lot mean porosity shall be re-calculated for both reconfigured lots and shall be re-decided for either in payment at the full Contract price, subjected to a payment reduction, or deemed rejectable.

320.09 MEASUREMENT FOR PAYMENT

320.09.01 Actual Measurement

320.09.01.01 Open Graded Drainage Layer

Measurement of OGD L shall be by area in square metres.

320.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

320.10 BASIS OF PAYMENT

320.10.01 Open Graded Drainage Layer - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, except as otherwise specified herein.

When test results show that either the thickness payment factor or porosity of OGD L payment factor for the lot is less than 1.000, the payment reduction for the lot shall be as follows.

$$(2.000 - PF_T - PF_P) \times \text{item price} \times \text{lot quantity}$$

Where: PF_T and PF_P are calculated according to Table 3 and 4, respectively.

In addition, any OGD L that contains aggregates that do not meet any of the requirements for gradation or physical properties as specified in the Acceptance of Gradation and Physical Properties clause shall be subject to a 10% payment reduction.

For purposes of payment reduction, the term item price means the Contract price of the Open Graded Drainage Layer item.

TABLE 1
Gradation Requirements (LS-602)

Percentage Passing By Mass of Aggregate (Note 1)		
Sieve Designation	Acceptance Limit	Price Reduction Range(s)
37.5 mm	100	90.1 – 100
26.5 mm	95.0 – 100	85.5 – 94.9
19.0 mm	90.0 – 100	81.1 – 89.9
16.0 mm	65.0 – 100	58.5 – 64.9
13.2 mm	40.0 – 86.0	36.1 – 39.9 or 86.1 – 94.6
9.5 mm	20.0 – 55.0	18.1 – 19.9 or 55.1 – 60.5
4.75 mm	0 – 10.0	10.1 – 12.0
2.36 mm	0 – 5.0	5.1 – 6.0
75 µm	0 – 2.0	2.1 – 2.4
Notes: 1. All results are rounded to one decimal place according to LS-100.		

TABLE 2
Physical Property Requirements

MTO Test Number	Laboratory Test	Acceptance Limit	Price Reduction Range
LS-601	Wash Pass 75µm sieve, Guideline B, % maximum	2.0	2.1 - 2.2
LS-604	Absorption, % maximum	2.0	2.1 - 2.2
LS-608	Flat and Elongated Particles, % maximum (4:1)	20.0	20.1 - 22.0
LS-614	Unconfined Freeze-Thaw, % maximum loss (Note 1)	15.0	15.1 - 18.8
LS-618	Micro-Deval Abrasion, % maximum loss	21.0	21.1 - 23.1
LS-630	Amount of Contamination, % maximum	1.0 (Note 2)	≤1.1 (Note 2)
LS-631	Plastic Fines	NP (Non-Plastic)	NP (Non-Plastic)
Alternative Requirement for LS-614			
LS-606	Magnesium Sulphate Soundness, % maximum loss (Note 1)	15.0	15.1 - 18.8

Notes:

1. The Owner shall waive the requirements for LS-614, Unconfined Freeze-Thaw, provided the Contractor has submitted a written request that the aggregate meet the alternative requirements for LS-606, Magnesium Sulphate Soundness.
2. Combined amount of wood, clay brick and/or gypsum and/or gypsum wall board or plaster, etc. shall not exceed the maximum percentages by mass shown above.
3. All results are rounded to one decimal place according to LS-100.

TABLE 3
Thickness Payment Factors

Acceptance Criteria	Classification	Payment Factor, PF_T
$T_C \geq T_D$	Acceptable	1.000
$0.9T_D \leq T_C < 1.0T_D$	Payment Reduction	T_C/T_D
$0.75T_D \leq T_C < 0.9T_D$	Payment Reduction	$(T_C/T_D)^{1.5}$

Where:

T_D is the OGDL design lift thickness specified in the Contract Documents in millimetres.

T_C is the mean thickness of OGDL of the lot in millimetres calculated to one decimal place according to LS-100.

PF_T is the payment factor for thickness of the OGDL of the lot calculated to three decimal places according to LS-100.

TABLE 4
Porosity of OGDL Payment Factors

Acceptance Criteria	Classification	Payment Factor, PF_P
$0.25 \leq n_c \leq 0.40$ with less than 30% of sublots with porosity outside the range of 0.25 to 0.40	Acceptable	1.000
$0.20 \leq n_c < 0.25$	Payment Reduction	$1 - 4(0.25 - n_c)$
$0.40 < n_c \leq 0.50$	Payment Reduction	$1 - 2(n_c - 0.4)$

Where:

PF_P is the payment factor for porosity of OGDL of the lot calculated to three decimal places according to LS-100.

n_c is the mean porosity of OGDL of the lot calculated to two decimal places according to LS-100.



**CONSTRUCTION SPECIFICATION FOR
IN-PLACE FULL DEPTH RECLAMATION OF
BITUMINOUS PAVEMENT AND UNDERLYING GRANULAR**

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330-A	Commentary

330.01	SCOPE

This specification covers the requirements for in-place full depth reclamation of bituminous pavement and mixing with a portion of the underlying granular, and shaping and compacting the processed materials as granular base.

330.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

330.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

330.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 501	Compacting

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:	
LS-621	Determination of Amount of Asphalt-Coated Particles in Coarse Aggregate

330.07 CONSTRUCTION

330.07.01 General

The work of in-place full depth reclamation shall consist of pulverizing the existing bituminous pavement, mixing the processed material with the underlying granular material, and shaping and compacting the blended material and the existing shoulders.

330.07.02 Operational Constraints

The in-place full depth reclamation including pulverizing, mixing, shaping, and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall also be shaped and compacted to grade prior to closing down operations each day.

330.07.03 Reclamation of Bituminous Pavement and Underlying Granular

The bituminous pavement and underlying granular shall be reclaimed to the depths specified in the Contract Documents. The tolerance for the average depth of processing shall be ± 15 mm from the depth specified.

The processed depth shall be such that the blended material shall contain a maximum of 50% by mass of asphalt coated aggregate in the final blend as determined by LS-621.

The operation of full depth reclamation shall ensure that 100% of the mixed material passes the 26.5 mm sieve and not more than 75% passes the 4.75 mm sieve.

330.07.04 Surface Shaping and Compacting

The graded surface of the processed material, including existing shoulder, shall be according to the requirements of OPSS 301. The material shall be compacted as specified in OPSS 501. Scarifying and fine grading to the specified lines and grades shall be carried out immediately prior to paving.

Surfaces of processed material that have been exposed to traffic and are to receive granular base material to depths of up to 100 mm as required in the Contract shall be scarified immediately prior to placement of the base course material.

330.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

330.08 QUALITY ASSURANCE

330.08.01 Samples for Testing

Samples for testing may be taken by the Contract Administrator to ensure that the mix is according to LS-621.

330.09 MEASUREMENT FOR PAYMENT

330.09.01 Actual Measurement

330.09.01.01 In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular

Measurement of in-place full depth reclamation of bituminous pavement and underlying granular shall be by horizontal area processed in square metres.

330.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

330.10**BASIS OF PAYMENT****330.10.01****In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for granular base shall be made under the appropriate roadway granular item.

For the purposes of the Changes in the Work clause of the MTO General Conditions of Contract, the depths of pavement to be processed shown in the Contract Documents shall be deemed to be incorrect only when the average depth of all processing differs by more than 15 mm from the equivalent average depth derived from measurements taken by the Contract Administrator during the processing operation.

Appendix 330-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

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331-A	Commentary

331.01 SCOPE

This specification covers the requirements for in-place full-depth reclamation of the existing hot mix asphalt (HMA) pavement and underlying granular base; shaping and compacting the unstabilized material; if required, adding and blending corrective aggregates or active filler or both; adding and mixing expanded asphalt; and shaping and compacting the expanded asphalt mix.

331.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

331.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

331.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 313	Hot Mix Asphalt - End Result
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1101	Performance Graded Asphalt Cement
OPSS 1301	Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200	Penetration of Bituminous Materials
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-602	Sieve Analysis of Aggregates
LS-625	Sampling of Granular Materials
SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

American Association of State Highway and Transportation Officials (AASHTO)

T40-02 Sampling Bituminous Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

331.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Filler means substances that chemically alter the mix properties.

Corrective Aggregate means virgin aggregate or reclaimed asphalt pavement (RAP) or both added to the reclaimed materials to meet the expanded asphalt mix requirements.

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Expanded Asphalt Mix (EAM) means the mixture of reclaimed materials; corrective aggregate or active filler or both, if required; and expanded asphalt.

Expanded Asphalt Mix (EAM) Mat means a pavement course which comprises Expanded Asphalt Mix.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Reclaimed Material means the mixture of reclaimed existing asphalt pavement and granular base.

Unstabilized Material means the mixture of reclaimed existing asphalt pavement and granular base; and corrective aggregate or active filler or both, if required.

331.04 DESIGN AND SUBMISSION REQUIREMENTS

331.04.01 Design Requirements

For mix design purposes, prior to commencing the work the Contractor shall obtain samples representative of the material that is produced during in-place full-depth reclamation. These samples shall be used to establish the design rate of expanded asphalt as a per cent by mass of the unstabilized material and to establish the necessity for corrective aggregate and/or active filler. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

For bidding purpose only, the design rate of the expanded asphalt shall be as specified in the Contract Documents.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the grade, manufacturer, and supplier of the PGAC.
- b) The percent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse effects to mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source, gradation and quantity of corrective aggregate, if required.
- j) Type, source and quantity of active filler, if required.

331.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of EAM operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by 0.3% or greater. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

331.05 MATERIALS

331.05.01 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The Additional Testing Requirements and Acceptance Criteria for PG Grades table shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

331.05.02 Corrective Aggregates

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed material at the application rate determined in the mix design. Corrective aggregate shall meet the physical property requirements of OPSS 1010 for Granular A.

331.05.03 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed material at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

331.05.04 Water

Water shall be clean and free from oil, acid, alkali, organic matter or other deleterious substances.

331.05.05 Expanded Asphalt Mix

The EAM shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve, and shall be measured based on air dried gradation according to coarse sieving operation of LS-602.

331.06 EQUIPMENT

331.06.01 Full-Depth Reclamation and Stabilization Equipment

The reclaimer-stabilizer shall be capable of reclaiming the existing asphalt pavement and underlying granular base to the depths specified in the Contract Documents, incorporating corrective aggregate or active filler or both into the mix, adding expanded asphalt in a controlled manner, and producing a uniform mix.

The reclaimer-stabilizer shall be fitted with an automatic sensor system to accurately maintain a preset depth of cut within a tolerance of 10 mm and shall have a minimum 2.0 m wide cutting drum.

The reclaimer-stabilizer shall have an asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the unstabilized material. In order to mix the unstabilized material with the expanded asphalt, the reclaimer-stabilizer shall include the following features:

- a) A system to control and regulate the application of expanded asphalt in relation to travel speed and mass of material within a tolerance of $\pm 3.0\%$ by volume of asphalt cement.
- b) A system to monitor and control all aspects of the mixing process, including percent expanded asphalt, rate of application, and percent water for optimum compaction.
- c) A system of nozzles that provides uniform application of the expanded asphalt across the full width of treatment. The application system shall be adjustable for varying widths of treatment.

The aggregate delivery vehicle shall have a system for controlled application of the corrective aggregate.

331.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade shall be used to place the EAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

331.06.03 Pilot Vehicle

The pilot vehicle used to control traffic shall be according to OTM, Book 7.

331.07 CONSTRUCTION

331.07.01 Operational Constraints

In-place full depth reclamation including mixing, shaping and compacting to final grade shall be completed across the full pavement width prior to closing down operations each day.

The existing shoulders shall be shaped and compacted to match the adjacent lane prior to closing down operations each day.

Expanded asphalt stabilization shall not proceed during periods of rain or when the surface is in a saturated condition.

Traffic, including construction traffic, shall be kept off the freshly placed EAM until such time as it is able to carry traffic without damage. The Contractor shall be responsible for repair of damaged EAM.

The HMA course(s) shall not be placed on the EAM until the following requirements have been met:

- a) The EAM has been allowed to cure for a minimum of 3 Days.
- b) It has been demonstrated that the EAM meets all the requirements of this specification.
- c) All defective areas in the EAM have been repaired to the satisfaction of the Contract Administrator.

331.07.02 In-Place Full-Depth Reclamation

The existing asphalt pavement and underlying granular base shall be reclaimed to the depths and widths specified in the Contract Documents.

The graded surface of the reclaimed material, including existing shoulders shall be according to the surface tolerance requirements of OPSS 301. Reclaimed material exceeding 50 mm in size shall be removed from the work. The material shall be compacted according to OPSS 501.

331.07.03 Expanded Asphalt Trial Section

Prior to carrying out expanded asphalt stabilization, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out expanded asphalt stabilization according to this specification by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the Contractor has demonstrated the ability to successfully mix, handle, place, and compact EAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing EAM on another Contract within the last 12 months.

The trial section shall be a minimum of 3,500 m² or the equivalent of one tanker load of asphalt cement. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the expanded asphalt stabilization work based on an acceptable visual assessment of the trial section according to the requirements of the Grading and Compacting the Expanded Asphalt Mix subsection. When EAM is rejected by visual assessment, the Contractor shall repeat additional trial sections until the EAM meets the requirements of the Surface Appearance subsection.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section according to the Repairing and Re-Evaluating subsection.

331.07.04 Expanded Asphalt Stabilization

Expanded asphalt stabilization shall be to the depth and limits detailed in the Contract Documents. The overlap between successive passes of the reclaimer-stabilizer shall be a minimum of 100 mm and a maximum of 150 mm.

If required, corrective aggregate or active filler or both shall be added to the roadway prior to stabilizing.

In areas that are inaccessible to the reclaimer-stabilizer equipment, existing asphalt pavement shall be removed and replaced with a minimum 100 mm of binder course hot mix placed flush with the adjacent EAM surface.

331.07.05 Compacting the Expanded Asphalt Mix

The surface of the EAM shall be uniform in texture and free of surface defects.

Granular material shall be compacted according to OPSS 501.

The compacted surface of the EAM shall be according to the surface tolerances as specified in this specification.

331.07.06 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the expanded asphalt stabilization is able to carry traffic without damage.

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance of the EAM shall be based on the following criteria:

- a) Surface Appearance
- b) Asphalt Cement Content
- c) Tensile Strength of EAM
- d) Thickness

- e) Surface Tolerance
- f) Compaction
- g) EAM Gradation
- h) Corrective Aggregates, if required.

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

331.08.02 Sampling

331.08.02.01 Lot Size

A lot size shall be a maximum of 50,000 m² of expanded asphalt stabilization divided into 10 sublots of equal size. The lot size may be adjusted at the discretion of the Contract Administrator and after discussion with the Contractor, prior to starting the work and when changes occur in the mix design or in the sequence of expanded asphalt stabilization. The maximum subplot size shall be 5,000 m². The minimum number of sublots in a lot shall be three.

331.08.02.02 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administration at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Sample containers supplied by the Contractor shall be triple tight steel containers or suitable containers that can be sealed to prevent leakage or contamination.

331.08.02.03 Corrective Aggregate

Where the quantity of corrective aggregate is greater than 5,000 tonnes, two 25 kg samples shall be taken in the presence of the Contract Administrator for each 25,000 tonnes of material produced, and whenever material is produced from a new source or new bench in a quarry, or whenever a significant change in production of materials occurs.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

331.08.02.05 Expanded Asphalt Mix

For the purpose of accepting the asphalt cement content, samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per subplot. To obtain a set of samples, one 15 kg sample of unstabilized material shall be obtained immediately following in-place full depth reclamation and, from the same approximate location, a second 15 kg sample of EAM immediately following stabilization. The maximum sampling depth shall be 100 mm. The second sample may be obtained after placement and prior to compaction.

For the purpose of determining the EAM gradation, another 30 kg sample of EAM shall be taken from each of three randomly selected sublots for every lot.

The samples shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. The samples shall be transported in a manner that avoids stacking and extreme temperatures.

331.08.03 Acceptance Criteria

331.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on SP-027 manual after the EAM mat has been opened to traffic. The finished EAM surface shall have a uniformly smooth texture and be free from surface defects of ravelling, deformation, flushing, and rutting prior to placement of the HMA overlay.

331.08.03.02 Asphalt Cement Content

For each subplot, the sample of unstabilized material taken immediately following in-place full depth reclamation and the sample of EAM taken immediately after stabilization, shall be tested for total asphalt cement content according to LS-282. The total asphalt cement content of the EAM includes existing aged asphalt cement and new asphalt cement. The per cent by mass of new asphalt cement added to the unstabilized material shall be determined from the two samples at each location by subtracting the total asphalt cement content of the unstabilized material from the total asphalt cement content of the EAM.

The average new asphalt cement content of a lot shall not be less than 0.4% or more than 0.6% of the established mix design.

331.08.03.03 Tensile Strength

Samples of EAM shall also be tested for dry tensile strength and wet tensile strength according to LS-297.

Dry tensile strength requirements for the lot are met when the following are satisfied:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when the following are satisfied:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

EAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

331.08.03.04 Thickness

Thickness of the EAM shall be measured by the Contract Administrator at a minimum frequency of one thickness measurement per subplot. Measurements shall be taken by excavating along the edge of the stabilized pass with a shovel and measuring the depth of stabilization from the bottom of the EAM to the surface of the adjacent unstabilized material. Thickness requirements for the lot are met when the following are satisfied:

- a) At least 90% of all thickness measurements are equal to or greater than the specified thickness minus 20 mm, and

- b) No individual thickness measurement for the lot is less than the specified thickness minus 30 mm.

331.08.03.05 Surface Tolerance

The surface tolerance of any EAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the EAM surface, including the edge of the EAM, in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the EAM greater than 10 mm according to OPSS 301.

331.08.03.06 Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials and at a minimum frequency of one QA measurement per subplot. Compaction requirements of the EAM placed for the lot are met when the following are satisfied:

- a) The lot average of all compaction measurements is greater than or equal to 97% of the target density; and
- b) No individual compaction measurement for the subplot is less than 95% of the target density.

331.08.03.07 Expanded Asphalt Mix Gradation

If the EAM does not meet the gradation requirements, the Contractor shall submit an action plan of mediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

331.08.03.08 Corrective Aggregate

QA testing shall be carried out to ensure that corrective aggregate to be used in the work is according to the physical property requirements of Granular A according to OPSS 1010.

331.08.04 Repairing and Re-Evaluating

331.08.04.01 General

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full lane width.

For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the reclaimer-stabilizer equipment. For other repairs based on the lot and subplot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313. All repairs shall be made using the same equipment as was used during initial production and placement.

All repairs will be re-evaluated and retested according to Acceptance Criteria subsection.

331.08.04.02 Surface Appearance

Unacceptable EAM due to the surface appearance defects, including any area damaged or contaminated by traffic, by water added by Contractors during compaction, or by nature, shall be reprocessed by the reclaimer-stabilizer. If required, additional expanded asphalt shall be added during reprocessing.

Alternatively, the Contractor shall remove and replace damaged or otherwise unacceptable EAM with the same hot mix type to be used in the overlying hot mix lift to a minimum depth of 50 mm according to OPSS 313.

331.08.04.03 Asphalt Cement Content

For sublots with insufficient asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of asphalt cement during reprocessing. For sublots with excessive asphalt cement content, the EAM mat shall be reprocessed by the reclaimer-stabilizer with addition of corrective aggregates during reprocessing. The unacceptable sublots are repaired until the corresponding lot mean is within the acceptance tolerance.

331.08.04.04 Tensile Strength

The rejectable sublots shall be reprocessed by the reclaimer-stabilizer, if required, with addition of asphalt cement during reprocessing until the corresponding lot mean is above the acceptance criterion. Alternatively, the EAM mat shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator.

331.08.04.05 Thickness

For sublots with insufficient thickness, the Contractor shall determine the limits of the unacceptance EAM based on additional measurement. The pavement segments with insufficient thickness shall be overlaid with binder course or surface course with additional thickness so as to compensate for the insufficient thickness as found in EAM layer.

331.08.04.06 Surface Tolerance

To meet the specified surface tolerance, all deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.

331.08.04.07 Compaction

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by HMA approved by the Contract Administrator.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Measurement of full-depth reclamation with expanded asphalt stabilization shall be by horizontal area in square metres.

331.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

331.10 BASIS OF PAYMENT

331.10.01 Full-Depth Reclamation with Expanded Asphalt Stabilization - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate, active filler or other additives, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable EAM shall be at no extra cost to the Owner.

PGAC shall be included in the Full-Depth Reclamation with Expanded Asphalt Stabilization item.

Repair of unacceptable EAM shall be carried out at no extra cost to the Owner.

The additional expanded asphalt, if required, added during reprocessing of unacceptable EAM shall be carried out at no extra cost to the Owner.

Repair of areas of EAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

Appendix 331-A, November 2015

FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
HOT IN-PLACE RECYCLING**

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332.01 SCOPE

This specification covers the requirements for the preparation of the existing pavement surface; heating and hot milling the existing hot mix asphalt (HMA); adding and mixing in one or more of rejuvenating agent and beneficiating HMA; and redistribution and compaction of the hot in-place recycled (HIR) mix in a single operation.

332.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 308 Tack Coat
OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

LS-100	Rounding-Off of Test Data and Other Numbers
LS-101	Calculation of Per Cent within Limits
LS-262	Bulk Relative Density of Compacted Bituminous Mixtures
LS-264	Theoretical Maximum Relative Density of Bituminous Paving Mixtures
LS-265	Determination of Percent Air Voids in Compacted Dense Bituminous Pavement Mixtures
LS-282	Quantitative Extraction of Asphalt Cement and Analysis of Extracted Aggregate from Bituminous Paving Mixtures
LS-284	Recovery of Asphalt from Solution by Rotary Evaporator
LS-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-294	Measuring Pavement Lift Thickness
LS-306	Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-317	Determination of the Severity of a Segregated Asphalt Pavement Surface

American Association of State Highway and Transportation Officials (AASHTO)

T 166-16	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 312-19	Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyrotory Compactor

ASTM International

D6752 - 18	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
E178 - 16	Standard Practice for Dealing with Outlying Observations

332.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 313, OPSS 1151, and the following definitions apply:

Attribute means one of the following properties: designated large sieve (DLS), 4.75 mm sieve, 75 µm sieve, AC content, air voids, lift thickness, compaction, or recovered asphalt cement (RAC) performance grade.

Beneficiating HMA means a HMA designed such that the final HIR mix shall be according to the Contract Documents.

Design Lift Thickness (T_D) means the thickness in millimetres of the HIR mix as specified in the Contract Documents.

Field Adjustment to the Job Mix Formula (JMF) means a change in the target gradation, rejuvenating agent content, beneficiating HMA content, or any combination, of a HIR mix without a redesign of the HIR mix, resulting in an adjusted JMF.

Hot In-place Recycled (HIR) Mix means the mixture of hot milled material containing one or more of the following components: rejuvenating agent and beneficiating HMA.

Hot Milled Material means the material produced during the heating and hot milling of the existing HMA.

Hot Milling means the process of applying adequate heat to the pavement to sufficiently soften the pavement, followed by the use of milling heads to uniformly remove the heated material to the depth specified in the mix design submission with minimal fracturing of the existing aggregates.

Job Mix Formula (JMF) means the percentage passing on each designated sieve of the total mass of aggregate, the amount of rejuvenating agent, and the amount of asphalt cement as a percent by mass of the HIR mix that are based on specified mix design procedures.

Joint means a vertical contact between a HIR mix and any pavement or any rigid object that exists at the time the HIR mix is laid.

Lift Thickness means the thickness in millimetres, measured according to LS-294, of the placed and compacted HIR mix.

Loose Mix means a representative sample of uncompacted HIR mix for testing mix properties or the RAC performance grade.

Mix Design means the design of the proportions of new and existing aggregates; new and existing AC; rejuvenating agent; and additives; when uniformly mixed, that results in an acceptable HIR mix.

Mix Properties means the AC content, gradation, and air voids.

Recovered Asphalt Cement (RAC) means the AC extracted and recovered from the HIR mix according to LS-284, using re-agent grade trichloroethylene, or other solvent acceptable to the Owner.

Rejuvenating Agent means a product that when added to the hot milled material; the RAC from the HIR mix meets the requirements of the Contract Documents.

Screed means the unit of the placement unit of the recycling train that strikes off and imparts initial compaction to the HIR mix.

332.04 DESIGN AND SUBMISSION REQUIREMENTS

332.04.01 Design Requirements

The HIR mix design shall be according to OPSS 1151 and as specified in the Contract Documents.

332.04.02 Submission Requirements

A copy of the technical data sheet and safety data sheet of the release agent(s) shall be submitted to the Contract Administrator.

The submission of additional information for HIR mixes shall be according to OPSS 1151 and as specified in the Contract Documents.

332.05 MATERIALS

332.05.01 Hot In-place Recycled Mix

The HIR mix produced shall be according to the mix design and meet the requirements of Table 1. Asphalt cement, anti-stripping treatments, release agents, rejuvenating agents, and other additives shall be compatible with the other components of the HIR mix.

332.05.01.01 Recovered Asphalt Cement

The RAC recovered from the HIR mix produced shall be according to OPSS 1101 and as specified in the Contract Documents.

332.05.01.02 Beneficiating Hot Mix Asphalt

The aggregates used in the beneficiating HMA shall be according to OPSS 1003 for the HMA mix type the HIR mix is required to meet as specified in the Contract Documents. Asphalt cement, anti-stripping treatments, release agents, and other additives shall be compatible with the other components of the beneficiating HMA.

The PGAC used in the beneficiating HMA shall be according to OPSS 1101 and as specified in the Contract Documents for the performance grade specified for the HIR mix in the Contract Documents.

RAP, RST, or both shall not be used in the composition of the beneficiating HMA.

332.05.01.03 Rejuvenating Agents

The rejuvenating agent incorporated into the HIR mix shall not contain any wax components.

332.05.02 Release Agents

No release agents shall be used that may adversely affect the quality or performance of the HIR mix. Release agents shall be used according to the proprietary requirements.

Petroleum based release agents, excess water, or excess release agents shall not be used.

332.06 EQUIPMENT

332.06.01 Heating Unit

Heating units shall apply heat in a uniform manner to the surface of the existing pavement to be hot milled. Open flame heating of the existing HMA pavement shall not be permitted.

Heaters shall be spaced and operated such that:

- a) Sufficient heat penetration of the pavement shall be achieved, with heat penetration into the underlying pavement beneath the hot milling depth specified in the mix design submission,
- b) The desired HIR mix temperatures are achieved, and
- c) The existing HMA surface is not burnt or scorched.

332.06.02 Recycling Train

The recycling train shall be self-contained mechanical units specifically designed for HIR of HMA pavements. The recycling train shall have the capability to process the existing pavement to a depth of at least 50 mm.

Heaters used as part of the recycling train shall be according to the Heating Unit subsection.

The recycling train shall include hot milling, blending, and placement units.

332.06.02.01 Hot Milling Unit

The hot milling unit shall be capable of uniformly milling the preheated HMA to the hot milling depth specified in the mix design submission.

332.06.02.02 Blending Unit

The blending unit shall be capable of thoroughly mixing the hot milled material, rejuvenating agent, and beneficiating HMA.

332.06.03 Diamond Grinding

A diamond grinder shall be power-driven, self-propelled, and designed for grinding HIR mix or HMA. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 1.2 m wide. The grinder shall be equipped with the capability to adjust the depth, slope, and crossfall to remove HIR mix or HMA to the required profile and shall also include a slurry pick-up system.

332.07 CONSTRUCTION

332.07.01 Quality Control

The QC procedures shall be conducted to ensure the HIR mix meets the requirements of the Contract Documents. Interpretation of QC inspections, test results, and measurements and the determination of any action to be taken shall be carried out to ensure that the work is according to the requirements of the Contract Documents.

A single sample for QC purposes may be obtained at the same time and location as QA acceptance samples. No additional loose mix samples shall be taken from the placed HIR mix.

Up to three additional cores may be taken in each surface lot for QC purposes. Cores shall not be spaced closer than one metre from any other core. If further additional samples are required, a written request shall be made to the Contract Administrator and samples shall only be taken upon written approval of the Contract Administrator. All sample locations shall be restored as specified in the Contract Documents.

332.07.02 Preparation of Existing Pavement

Prior to the HIR operation:

- a) Existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials.
- b) Milled existing HMA surfaces shall be clean and free of all loose, broken, and foreign materials and shall be swept with a power broom.
- c) The Contractor shall be responsible for preparing the existing HMA surface by removing all materials such as cold mix patching material, crack sealant, and spray patch material, as the deemed necessary for the HIR mix to meet the requirements of the Contract Documents.

Existing surfaces to be HIR may be corrected by additional cold milling, hot milling, addition of beneficiating HMA or a combination in order to place and compact the HIR mix to the design thickness specified in the Contract Documents.

Removal of the existing pavement by the hot milling unit shall be performed in such a manner as to leave adjacent pavement and structures remaining in place undisturbed and undamaged. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. Broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

332.07.03 Transportation of Beneficiating Hot Mix Asphalt

Truck boxes used to transport beneficiating HMA shall be clean and, if required, lightly coated with a uniform application of a release agent. Truck boxes shall be drained after each application and before loading.

332.07.04 Placing Hot In-place Recycled Mix

332.07.04.01 Operational Constraints

The HIR mix shall not be placed unless the ambient air temperature is at least 7 °C.

The HIR process shall be carried out when the roadway is clean and free of standing water. The HIR process shall not proceed in the rain.

The supply of any materials to the recycling train shall be accomplished with no traffic on the uncompacted mat. Public traffic shall not be permitted on freshly laid HIR mix until the temperature of the mat is 50 °C or less.

A lot shall be closed before paving begins on a different lot using the same tender item, the same mix design, or both, unless otherwise allowed by the Contract Administrator.

332.07.04.02 Paving

The heating units and recycling train shall heat and hot mill the HMA pavement across the complete lane width and partial width shoulder, if applicable, to the hot milling depth specified in the mix design submission.

The underlying pavement, immediately in front of the placement unit, shall be heated to a temperature of 60 to 80 °C.

When inspection and testing indicate that the required average depth of heating and hot milling is not being met, the process shall be immediately corrected.

Rejuvenating agent and/or beneficiating HMA shall be added to and mixed with all the hot milled material from the road, in a blending unit, and in the amount specified in the mix design. The HIR mix shall be homogeneous after mixing.

The final placement of the HIR mix by the recycling train shall be uniformly distributed to the specified profile and crossfall. The HIR mix shall be compacted to the design lift thickness specified in the Contract Documents and meet all acceptance criteria specified in the Contract Documents.

Each successive pass of the recycling train shall reprocess the edge of the previously HIR adjacent surface. Heating units shall overlap the previously HIR adjacent surface by a minimum of 100 mm such that it is heated to a temperature of 80 to 100 °C immediately prior to placement of the HIR mix. The hot milling units shall reprocess the edge of the previously HIR adjacent surface by a minimum of 50 mm.

The HIR mix shall be a minimum temperature of 110 °C, immediately behind the screed, to meet the compaction requirements specified in the Contract Documents.

Prior to roller compaction, obvious defects in the HIR mix placed shall be corrected. Irregularities in the alignment and grade along the outside edges shall be corrected. Excess HIR mix shall not be cast onto the surface of the freshly laid mat. After final compaction the surface shall be smooth and true to the established crown and grade, uniform in texture, and shall be free of any defects including, but not limited to, cracks, segregation, fat spots, oil spills, chatter, and roller marks.

All through lane HIR mix shall be completed prior to the placement of adjacent sideroads.

Areas that are not accessible to the heating and hot milling equipment shall have the HMA removed to the depth required to meet the design lift thickness requirements specified in the Contract Documents. These areas shall be tack coated according to OPSS 308, paved according to OPSS 313, and the HMA mix type and the HIR mix shall be as specified in the Contract Documents. The surface of each layer placed and compacted shall be level with the adjacent pavement. The paving of such areas shall be completed prior to the placing of any subsequent course on the HIR mix, if applicable, and as a separate operation from any other paving.

If actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct to cease HIR operations until the problem has been corrected.

332.07.05 Longitudinal and Transverse Joints

All joints shall be made to obtain a complete bond between the two pavement edges and a smooth riding surface. The existing or previously placed pavement edge shall be a straight clean vertical surface for the full depth of the course. Where ramping or damage has occurred, trimming shall be required. All dirt or other foreign material and all loose material shall be removed from all vertical surfaces.

Longitudinal and transverse joints between the new HIR pavement and the existing pavement shall be butt joints as specified in the Contract Documents. All longitudinal joints at intersecting roads shall be butt joints. Heating beds on the heating units shall heat and soften material beyond the hot milling width by a minimum of 100 mm to achieve proper thermal bonding between the existing asphalt pavement and the HIR mix along the longitudinal joints. The longitudinal joints shall be parallel to the lane and visually uniform longitudinally and offset 50 mm from the edge of the demarcation between the lanes as specified in the Contract Documents.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction.

332.07.06 Compaction

Compaction of the HIR mix shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat as specified in the Contract Documents.

At all places not accessible to rollers, the HIR mix shall be compacted by mechanical self-powered gas-, electric-, or air-powered equipment.

332.07.07 Field Adjustments to the Job Mix Formula

The JMF may be adjusted to more closely reflect the HIR mix being produced unless a new mix design is required according to OPSS 1151 and as specified in the Contract Documents. The adjusted JMF shall be submitted in writing to the Contract Administrator within one Business Day of the field adjustment to the JMF.

332.07.08 Sampling

332.07.08.01 Mix Properties and Recovered Asphalt Cement Performance Grade

Samples shall be appropriately labelled with the Contract number, highway number, Region, lot number, subplot number, mix type, station, and date and time of sampling.

Each random sample location from which the sample is to be taken shall be as designated by the Contract Administrator. A set of two samples shall be taken according to Table 2. One of these samples shall be for QA testing and the other shall be for referee testing. Samples for QA and referee testing shall be obtained concurrently at the paver once the rejuvenating agent, or beneficiating HMA, or both have been added.

When the mass of the sample does not meet the requirements of Table 2, the sample shall be discarded and a new one taken immediately.

332.07.08.02 Compaction

Upon completion of each subplot, the Contract Administrator shall submit in writing, notification of each random sample location. Pavement core samples shall be obtained in duplicate from each subplot no later than the next Business Day after the completion of the subplot. Each core shall meet the following requirements:

- a) Have a minimum nominal diameter of 150 mm and a maximum nominal diameter of 200 mm, and

b) Consist of the full layer being sampled and at least one underlying layer, if one is present.

Cores shall not be taken within 250 mm of a longitudinal or transverse joint or the edge of pavement.

Each set of samples shall be taken from the same lane, same transverse offset, and at a spacing of 1.0 m $\pm$ 0.1 m between each individual core edge.

Cores shall not be damaged during coring operations or in transit. If a core is damaged, a replacement core shall be extracted at a location adjacent to the original core.

Core samples shall also include design lift thickness on the label. The lot and subplot numbers shall be clearly marked with a permanent marker on all compaction cores.

HIR mix and compaction requirements for filling the sample holes shall be the same as the adjacent undisturbed pavement. Sample holes shall be cleaned, dried, and filled and then compacted using a mechanical self-powered gas-, electric-, or air-powered compactor immediately after sampling.

A one-litre sample of the release agent(s) shall be delivered to the Contract Administrator upon request.

332.07.08.03 Lift Thickness

Single cores consisting of the HIR mix placed shall be used to evaluate the lift thickness of the HIR tender item placed at each sample location. Sample locations shall be determined based on the surface area of the HIR mix placed as specified in the Contract Documents.

All areas of HIR paving as specified in the Contract Documents, including paved shoulders, shall be sampled for lift thickness.

Upon completion of each subplot, the Contract Administrator shall submit in writing notification of the location to be used for sampling. One pavement core sample shall be obtained from each subplot no later than the next Working Day after completion of the subplot. This one core shall be used for both QA and referee testing.

Each core shall have a nominal diameter of 50 mm, shall consist of the HIR mix placed in the subplot, and at least one underlying HMA layer if one exists. Each core shall have its vertical side cored perpendicular to the upper surface of the core. Each sample shall be placed in a suitable container to protect the sample integrity during transport and until testing. The subplot number shall be clearly marked with a permanent marker on each core.

No replacement thickness cores shall be obtained for QA or referee testing. When a core thickness is reported as "indeterminate", a new 150 mm core shall be taken centred over the subplot's previously taken 50 mm core.

Holes resulting from the removal of thickness core samples shall be cleaned, dried, and filled with a material acceptable to the Contract Administrator immediately after sampling.

332.07.09 Performance Graded Asphalt Cement

If beneficiating HMA is used, samples of the PGAC added to the beneficiating HMA shall be taken according to OPSS 1101 and as specified in the Contract Documents.

332.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

332.08 QUALITY ASSURANCE

332.08.01 Acceptance Criteria

The Owner shall conduct tests, carry out calculations, and provide values according to Table 3. The Contractor shall be provided with results from the completed tests. Payment factors and payment adjustments for each lot shall be determined by the Contract Administrator based on the QA test results as specified in the Contract Documents. Unless referee testing is invoked, in which case referee results shall be used.

Acceptance of HIR mix shall be based on the following criteria:

- a) Air Voids and Compaction
- b) Gradation and AC Content
- c) RAC Performance Grade
- d) Surface Tolerance
- e) Surface Appearance
- f) Surface Smoothness
- g) Lift Thickness
- h) Geometrics and Longitudinal Joint Location
- i) PGAC Physical Requirements

332.08.01.01 Air Voids and Compaction

332.08.01.01.01 Lot Size

Before the HIR operation starts, a discussion with the Contract Administrator shall happen regarding their determination of the size and location of the lots and sublots. Guidelines for the breakdown of the tender item quantity into lots are as listed in Table 4. Generally, lot size is 40,000 m² with sublots of 4,000 m²; however, subplot sizes shall be adjusted to ensure a minimum of three sublots per lot.

When the tender item quantity is less than 4,000 m², the lot shall be divided into at least three sublots as determined by the Contract Administrator, unless such division is deemed impractical by mutual agreement.

When only one or two sublots are completed at the end of placement of the tender item due to a change in the JMF or when a delay of more than 20 Business Days occurs in placing the complete lot, the test results obtained shall be considered as part of the previous lot and the previous lot shall then have 11 or 12 sublots. When only three to nine sublots are completed due to the above circumstances, then the three to nine sublots shall be considered as a lot.

When a delay of more than 20 Business Days occurs in placing the complete lot and this lot shall be completed during the same calendar year, a request in writing prior to the end of the 20 Business Days, may be submitted to the Contract Administrator that the lot be continued upon the resumption of placement of that tender item. If the request is not made or is not accepted by the Contract Administrator, the lot shall be terminated and evaluated for acceptance.

332.08.01.01.02 Basis of Acceptance

Acceptance for HIR mix for air voids and compaction is based on the lot PWL for each attribute. PWL shall be determined using lot test results, LS-101, and lower and upper limits as specified in Table 1. The PWL of the lot for each criterion shall be used to determine the payment adjustment factor from Table 5. If the PWL is less than 50% for air voids or compaction, the lot is rejectable and shall be subject to repair or payment adjustment.

The Contract Administrator shall determine if a rejectable lot may remain in the work without repairs. When the Contract Administrator has determined that a rejectable lot may remain in the work without repair, the lot shall be subjected to a payment adjustment. If repair of the lot is chosen in lieu of a payment adjustment or if the Contract Administrator determines that a rejectable lot requires repair, the lot shall be repaired and re-evaluated as detailed in the Repairs subsection.

332.08.01.02 Gradation and Asphalt Cement Content

332.08.01.02.01 Lot Size

The lots and sublots for gradation and AC content shall be according to the Lot Size clause under the Air Voids and Compaction clause of the Acceptance Criteria subsection.

332.08.01.02.02 Basis of Acceptance

Acceptance for HIR mix for gradation and AC content shall be determined using the lot mean, LS-282 or LS-292, the specification limits specified in Table 1, and subplot acceptability.

Sublot test results shall be acceptable if they meet the specification limits specified in Table 1. If a subplot test result for any payment adjustment sieve or AC content does not meet the specification limits specified in Table 1, the subplot shall be deemed rejectable and shall be repaired as detailed in the Repairs subsection. When a lot contains any subplot that is deemed rejectable, the lot is rejectable until the subplot has been repaired and re-evaluated as acceptable. The repaired subplot shall be re-evaluated using the test results for the repaired subplot and used in determining payment and acceptance of the lot. When the Contract Administrator allows a rejectable subplot to remain in place without repair, the subplot test result for the rejectable subplot shall be treated as a lot with one subplot and the remaining sublots shall form a separate lot.

The Contract Administrator shall calculate the gradation payment adjustment and AC content payment adjustment for the lot once all subplot test results for the lot have been completed. The Contract Administrator shall calculate the lot mean to one decimal point and the lot gradation and the lot AC content payment adjustments based on all the subplot test results in the lot according to LS-100. If the lot mean does not meet the specification limits specified in Table 1, the lot is rejectable.

332.08.01.03 Recovered Asphalt Cement Performance Grade

332.08.01.03.01 Basis of Acceptance

Acceptance of the RAC performance grade in the HIR mix shall be according to OPSS 1101 and as specified in the Contract Documents.

Disposition of HIR mix with borderline or rejectable lots shall be according to OPSS 1101 and as specified in the Contract Documents.

332.08.01.04 Surface Tolerance

Surface tolerance shall be according to OPSS 313. Surface tolerance related repairs shall be carried out according to the Repairs subsection.

332.08.01.05 Surface Appearance

The HMA deemed by visual appearance to have flushing, bleeding, segregation, fat spot, surface damage, cracking, chatter, or surface contamination but not limited to these, shall be considered deficient material or work. Traffic control shall be provided for all surface appearance assessments. Deficient material, mixture, and work shall be removed and replaced or repaired or assessed a payment reduction.

332.08.01.05.01 Segregation

The HIR mix exhibiting medium or severe mid-lane segregation shall be assessed a payment reduction or shall be repaired at the discretion of the Contract Administrator.

The HIR mix exhibiting other segregation shall be addressed in accordance with the following:

- a) Slightly segregated HIR mix shall be accepted into the work with no payment reduction.
- b) Medium segregated HIR mix shall be assessed a payment reduction or repaired at the discretion of the Contract Administrator.
- c) Severely segregated HIR mix shall be repaired by removal and replacement according to the Repairs subsection.

Bullnoses and tapers that were not machine-laid and any areas of handwork shall not be assessed based on segregation but because of other workmanship-related problems.

332.08.01.06 Surface Smoothness

The acceptability of surface smoothness shall be as specified in the Contract Documents.

332.08.01.07 Lift Thickness

332.08.01.07.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots before the HIR process starts. There shall be one lot consisting of all HIR tender items when the entire Contract has the same T_D . When more than one T_D is specified for the HIR tender item, there shall generally be a separate lot for each T_D specified in the Contract Documents for the HIR tender item. Each lot shall be divided into sublots, which shall normally be 2,000 m² in size. A minimum of three sublots are required for each lot.

332.08.01.07.02 Basis of Acceptance

Acceptance of HIR mix for lift thickness is based on subplot lift thickness measurements and lot mean lift thickness of the tender item. The Contract Administrator shall calculate the thickness payment adjustment for the lot once all measurements for the lot have been completed.

Sublot lift thickness shall be acceptable if they are equal to or greater than the minimum subplot lift thickness specified in Table 6 for the tender item's T_D . The subplot shall be deemed rejectable and shall be repaired if the lift thickness measurement is less than the minimum subplot lift thickness specified in Table 6. The repaired subplot shall be re-evaluated using the lift thickness measurement for the repaired subplot and used in determining payment of the lot.

The Contract Administrator shall calculate the lot mean lift thickness for each tender item to one decimal point and the lot payment adjustment for lift thickness based on all the subplot lift thickness measurements in the lot according to LS-100 and the Payment Adjustment for Lift Thickness clause. If the lot mean is less than 85% of the T_D , the lot is rejectable.

When a lift thickness lot contains any subplot that is deemed rejectable, the lot shall be rejectable until the subplot has been repaired and re-evaluated as acceptable. When the Contract Administrator allows a rejectable subplot to remain in place without repair, the subplot shall be subjected to a payment reduction according to the Payment Adjustment for Lift Thickness clause. A subplot lift thickness measurement for a rejected subplot that receives a payment reduction shall not be used to assess the lot mean for the tender item.

The Owner shall determine if a rejectable lot may remain in the work without repairs. When the Owner has determined that a rejectable lot may remain in the work without repair, the lot shall be subject to a payment reduction as determined by the Owner.

332.08.01.08 Geometrics and Longitudinal Joint Location

332.08.01.08.01 Basis of Acceptance

After final compaction, the HIR mix shall be smooth and true to the design profile and cross-section and constructed to the design width.

The Contract Administrator shall conduct spot checks of the width of the HIR mix to determine if the complete lane and shoulder widths, as specified in the Contract Documents, have been HIR processed, placed, and compacted for acceptance.

The width of HIR mix shall be accepted provided:

- a) The outside edges of the lanes and the paved shoulders are parallel to the lane and visually uniform longitudinally,
- b) The width across all the adjacent HIR lanes and shoulders, when specified, from the outside edge to outside edge is not less than the sum of the specified widths, and
- c) The width of retrofitted partially paved shoulder is not less than the specified width, when specified in the Contract Documents.

If the width is not acceptable at any location, the Contract Administrator shall provide notification in writing that the pavement is rejectable. A written proposal for corrective action shall be submitted to the Contract Administrator within three Business Days of receiving the notification.

Longitudinal joints not meeting the Contract requirements shall be removed and replaced or assessed a payment reduction.

332.08.01.09 Performance Grade Asphalt Cement Physical Requirements

The Contract Administrator shall determine the acceptability of the PGAC incorporated into the benefiting HMA according to OPSS 1101 and as specified in the Contract Documents.

332.08.01.10 Optional Trial

When the HIR tender item quantity is 40,000 m² or more, an optional trial of one lot, not exceeding 4,000 m², with one subplot shall be permitted. If this optional trial is chosen, the Contract Administrator shall be advised in writing prior to placing the trial lot. The optional trial shall not be placed in a critical location. The optional trial will be treated as a small quantity lot for basis of acceptance and payment.

332.08.01.11 Small Quantity Lots

Small quantity lots shall not be subject to payment adjustment unless the HIR mix is rejectable. Acceptance for these lots shall be on a subplot-by-subplot basis. The subplot shall be considered acceptable if the HIR mix complies with the limits specified in Table 1. HIR mix that does not comply with Table 1 shall be considered rejectable.

332.08.02 Referee Testing

332.08.02.01 General

A single request for referee testing for a given lot can only be invoked within five Business Days after the QA test results for that lot have been received and where applicable, the Contract Administrator's calculated QA payment factors and payment adjustments for that lot have been received.

Referee testing may only be invoked if all referee samples have been received in a condition suitable for testing.

332.08.02.02 Mix Properties and Compaction

Referee testing may only be requested for the entire lot, or a maximum of two sublots from that lot. For all sublots in the referee request, referee testing shall fall into one of three categories:

- a) Mix properties only,
- b) Compaction only, or
- c) Mix properties and compaction.

The referee laboratory shall use the same test method as the QA laboratory except when the QA laboratory chooses LS-292, the referee laboratory shall use that method provided the calibration requirements are met. If they are not met, the referee laboratory shall use LS-282.

When referee testing of mix properties is invoked, the referee laboratory shall conduct all necessary testing, except for the combined aggregate density, which will be supplied by the Contract Administrator.

When referee testing for compaction is invoked, the referee laboratory shall determine the MRD of the referee loose mix sample for the subplot, and this value shall be used in the calculation of compaction for the referee core.

The results generated by the referee laboratory shall be used to re-evaluate the lot to determine the payment factors for the acceptance of the disputed properties for the disputed lots of HIR mix. The referee test results are binding on both the Owner and the Contractor.

332.08.02.03 Recovered Asphalt Cement Performance Grade

Referee testing for RAC performance grade shall be according to OPSS 1101 and as specified in the Contract Documents.

332.08.02.04 Challenging Severity of Segregation

A challenge, in writing, of the severity of any segregated area assessed as either medium or severe, may be submitted within five Business Days of receiving the Owner's first visual assessment. The written challenge shall list the dimensions and assessment of the severity of each disputed segregated area.

For Contracts with up to 240,000 m² of HIR mix, a maximum of two separate written challenges for each tender item shall be permitted. For Contracts with more than 240,000 m² of HIR mix, a maximum of four separate written challenges for each tender item shall be permitted. Each written challenge may involve more than one disputed segregated area.

The Owner or a representative of the Owner, who did not carry out the original assessment and who is not the Contract Administrator shall make a second visual assessment of the disputed areas. All necessary surface preparations and traffic control shall be provided so that this second visual assessment shall be carried out within five Business Days after the Contract Administrator has received the written challenge. The results of that second visual assessment shall be binding on both the Owner and Contractor.

A further challenge may be made to the Owner's second visual assessment of the segregation severity. Such a challenge shall be made in writing within five Business Days of receiving the Owner's second visual assessment. Such a challenge shall be resolved by the Owner or a representative of the Owner determining the macrotexture ratio, according to LS-317. All necessary surface preparations and traffic control shall be provided during the field measurements for macrotexture ratio. Table 7 shall be used with the macrotexture ratio to determine the degree of severity and the disposition of the disputed area of segregation. The macrotexture ratio results shall be binding on both the Owner and the Contractor.

332.08.02.05 Lift Thickness

An individual lift thickness measurement may be challenged by requesting referee testing in writing to the Contract Administrator within five Business Days after receiving the subplot thickness measurement. An opportunity shall be permitted to view the re-measurement of the QA designated pavement core for that subplot at an alternative Owner designated laboratory together with the Owner's representative. The re-measured lift thickness measurement shall be considered binding and shall replace the original lift thickness measurement for assessment of the subplot.

332.08.02.06 Outlier in Referee Results

Where an entire lot of three or more sublots has been referee tested, an individual value for any attribute of a subplot's test result, excluding lift thickness may be questioned. The request shall be made within three Business Days after receiving all the test results for the lot, and only when the payment factor for the attribute with an outlier is less than 1.0 or a payment adjustment applies. The validity of the questioned attribute shall be ascertained in accordance with ASTM E178 using a T test at a 10% significance level.

If the T test procedure shows that the questioned value of the attribute is not an outlier, then the test result shall be used in the calculations. If the T test procedure shows that the questioned value of the attribute is an outlier, then the test result for the subplot shall be checked for mathematical errors. If there are no mathematical errors, the subplot with the outlier is treated as a lot with one subplot and the remaining sublots shall form a separate lot with no further consideration for outliers.

If only two sublots remain, the two sublots shall be treated as two separate lots each with one subplot.

332.08.03 Repairs

332.08.03.01 General

All repairs shall be performed at no additional cost to the Owner. No repairs are permitted prior to completion of a lot.

The materials and the construction of repairs shall meet the acceptance criteria and other requirements specified in the Contract Documents.

Repairs shall be full lane or full shoulder width except where localized repairs are allowed as specified in the Contract Documents. The limits and type of repairs shall be subject to the approval of the Contract Administrator and shall be approved prior to the repairs being carried out.

All transverse joints in repairs shall butt up to a full depth vertical surface. Repairs shall consist of the removal and replacement of the full thickness of the HIR mix or the placement of an overlay when permitted by the Contract Administrator. A paver or recycling train shall be used in carrying out the repair.

Repairs of an urgent nature, including moderate to very severe aggregate loss, moderate to very severe flushing, and wheel track rutting 16 mm in depth or greater shall be repaired within seven Days, unless extended by mutual agreement. Except for urgent repairs, repairs shall be completed within 60 Days or prior to seasonal shutdown each year, whichever is the lesser, unless extended by mutual agreement.

332.08.03.02 Repairs for Mix Properties, Compaction, and Recovered Asphalt Cement Performance Grade

For a lot that is not rejected, repairs may be chosen in lieu of accepting a payment adjustment if for air voids and compaction the total payment factor for the lot is less than 0.940. When the Contract Administrator requires a rejectable lot to be repaired or repairs are chosen in lieu of accepting a payment adjustment, areas of HIR mix in a lot that are to be repaired shall be determined subject to the minimum lengths and widths specified in the Contract Documents. Each repair area shall include at least one of the loose mix or compaction core sample locations or both representing that subplot.

The minimum length of a single repair to one lane shall be 250 m. The minimum length of a single repair that extends over more than one lane shall be 250 lane-metres and no portion of the single repair in a lane shall be less than 125 m in length.

The minimum limits of each repair shall be at least 125 lane-metres from the location of the loose mix or compaction core or both that represents the subplot; otherwise, a repair limit shall coincide with one end of the subplot when the sample location is less than 125 lane-metres from it. If the proposed limit of a single repair falls within the proposed limit of another single repair, the overlap shall count towards the 250 lane-metre minimum for both repairs. Repair areas within a single lane shall be separated by at least 100 m. If the delineation of repair areas results in patches less than 100 metres apart, these repair areas shall be re-established to form a continuous repair.

A list and sketch identifying the proposed locations of the repairs shall be submitted to the Contract Administrator for review at least five Business Days prior to the intended start of the repair work. Each subplot and single repair shall be uniquely labelled. Overlapping repair areas and discontinuous portions of a single repair shall be labelled so that they are readily identified with their single repair.

Prior to the repair, slab samples or cores shall be taken for testing of mix properties, RAC performance grade, or compaction, or all in the unrepaired area within 1 m of the limits of each end of the repair area. Additional samples or cores shall not be permitted to be taken beyond these locations until after QA, or referee testing demonstrates that the remaining Material in the subplot proposed for repair is deemed to be rejectable. If the proposed repair limit coincides with the beginning of a subplot that is being left unrepaired, samples are not required at this location. Sufficient Material shall be obtained for testing by the Owner's QA laboratory, and for possible referee testing.

Testing shall demonstrate that the remaining Material in the subplot proposed for repair is not rejectable. To determine if the HIR mix is rejectable, the mix properties, RAC performance grade, and compaction shall comply with the basis of acceptance of lots with one or two sublots. If the Material is deemed to be rejectable, the proposed limit of the repair shall be extended by a minimum of 25 m and the sampling and testing repeated. The repair area selected shall incorporate the location used for obtaining samples that shall be used to confirm that the remaining HIR mix is not rejectable. If the repair proposal results in the removal of at least half the subplot quantity, the Contract Administrator may waive testing demonstrating the suitability of the remainder of that subplot.

The unrepaired sublots combined with the unrepaired areas of any repaired sublots shall comprise one lot and shall be assessed based on the loose mix and core samples representing the unrepaired sublots. When a repaired subplot consists of two or more separate unrepaired areas, the Contract Administrator shall decide whether to combine these unrepaired areas as one subplot or to consider each unrepaired area as a separate subplot. If there are only one or two sublots in a lot that are not repaired, the Contract Administrator shall include those sublots as part of the previous or next lot.

The HIR or HMA mix used for the repair shall comprise a separate lot or, prior to beginning any repair, the Contract Administrator in conjunction with the Contractor may decide to include it as part of the current lot being produced. The repaired area shall be tested and assessed for all acceptance criteria specified in the Acceptance Criteria subsection and re-evaluated for acceptance.

The two reconfigured lots shall be accepted at the full Contract price, subjected to a payment adjustment or rejected according to the Payment Adjustment for Air Voids and Compaction clause, Payment Adjustment for Gradation clause, Payment Adjustment for Asphalt Cement Content clause, and Payment Adjustment for Recovered Asphalt Cement Performance Grade clause.

332.08.03.03 Repairs for Surface Tolerance

All areas not meeting the surface tolerance requirements shall be repaired by diamond grinding to a maximum of 5 mm or removed and replaced. Slurry produced from diamond grinding shall be removed from the site and managed as specified in the Contract Documents. The repaired areas shall be re-evaluated for surface tolerance acceptance by means of a 3 m straight edge as specified in the Surface Tolerance clause.

332.08.03.04 Repairs for Lift Thickness

Any repairs solely to correct for excess lift thickness shall not be permitted. The minimum length of a repair is the entire length of the subplot being repaired.

Acceptance for lift thickness of the repaired subplot shall be based on the individual subplot lift thickness measurement and the lot thickness payment adjustment shall be calculated based on the re-evaluated subplot measurement.

332.09 MEASUREMENT FOR PAYMENT

332.09.01 Actual Measurement

332.09.01.01 Hot In-place Recycled Mix

Measurement of HIR mix shall be by the horizontal area in square metres in place.

332.09.01.02 Tonne to Square Metre Conversion

When the Contract Documents refer to a quantity of material for HIR mix in tonnes and the Contract Documents do not already modify the quantity to relate to square metres, the Contract Administrator shall determine the theoretical quantity in square metres (Q_A) that shall replace the non-payment tonnage quantity (Q_i) references as follows:

$$Q_A = Q_t / [0.975 \times BRD_{MD} \times (T_D/1000)] \quad (\text{Formula 1})$$

Where:

BRD_{MD} = the bulk relative density in t/m^3 , provided in the HIR mix design submitted for HIR mix, the Q_A is calculated for

T_D = the design thickness, in millimetres, of the HIR mix

Q_t = non-payment tonnage quantity referred to elsewhere in the Contract Document for the HIR mix under the measurement by square metre tender item

332.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement. The Plan Quantity shall not be adjusted due to any of the exceptions specified in the Lift Thickness clause under the Sampling subsection.

332.10 BASIS OF PAYMENT

332.10.01 Hot In-place Recycled Mix - Item

Payment at the Contract price for the above tender item shall include full compensation for all labour, Equipment, and Materials required to do the work, including rejuvenating agent and beneficiating HMA quantities if used, and the applicable payment adjustments.

No additional payment shall be made for the work, labour, Equipment, and Materials required to remove the existing pavement and place HMA in areas not accessible to the heating and hot milling equipment.

The preparation and correction of existing HMA surfaces carried out in order to meet the requirements of the Contract Documents, including removal of materials such as cold mix patching material, crack sealant, and spray patch material; cold milling, hot milling, and the addition of beneficiating HMA; shall be at no additional cost to the Owner.

No additional payment shall be made under this item for HMA required to retrofit partially paved shoulders or for pavement widening.

When repairing HIR mix, all associated work and replacing or restoring all associated damage and removals shall be carried out at no additional cost to the Owner.

When the Contract Administrator instructs to cease HIR operations due to continued medium or severe segregation regardless of cause, there shall be no additional cost to the Owner.

332.10.01.01 Payment Adjustment for Air Voids and Compaction

When repair is not required or repair is not chosen for a lot, the payment adjustment for that lot due to air voids and compaction requirements shall be:

$$PA_{AVC} = \text{lot quantity} \times \text{Contract price} \times [PF_{AVC} - 1.0000] \quad (\text{Formula 2})$$

Where:

PA_{AVC} = payment adjustment for air voids and compaction

lot quantity = the horizontal area of HIR mix in the lot in m^2

Contract price = for the purposes of payment adjustment due to air voids and compaction, means the Contract price of the HIR tender item

PF_{AVC} = payment factor for combined air voids and compaction as determined according to the Calculations clause

When the PF_{AVC} is:

- a) Less than 1.0000, there shall be a reduction in payment, and
- b) Equal to 1.0000 there shall be no adjustment.

332.10.01.01.01 Calculations

332.10.01.01.01.01 General

The PF_{AVC} shall be based on the individual payment factors obtained from Table 5, based on PWL, determined for air voids and compaction using LS-101, Table 1, and the formulae in the Payment Factor for Combined Air Voids and Compaction clause. Rounding-off procedures for all calculations shall follow LS-100.

When there is no sampling or testing specified in the Contract Documents for an attribute or when the requirement for sampling or testing for an attribute is waived by the Owner, the payment factor for that attribute shall be equal to either:

- a) The payment factor it is added to in Formula 3, if that payment factor is less than 1.0000; or,
- b) 1.0000, if the payment factor it is added to in Formula 3, is equal to 1.0000.

332.10.01.01.01.02 Payment Factor for Combined Air Voids and Compaction

The payment factor for combined air voids and compaction (PF_{AVC}) shall be calculated using the following formulae:

$$PF_{AVC} = (PF_C + PF_{AV}) / 2 \quad \text{(Formula 3)}$$

Where:

PF_C = payment factor for compaction from Table 5

PF_{AV} = payment factor for air voids from Table 5

The PF_{AVC} shall be rounded and reported to four decimal places.

When the Contract Administrator decides that the unrepaired area of an original lot that has been partially repaired shall not be resampled, the PF_{AVC} for the unrepaired area shall be 1.0000.

332.10.01.01.01.03 Small Quantity Lots

For small quantity lots, each subplot shall be assigned a PF_{AVC} of 1.0000 if the subplot is not rejectable. If the subplot is determined to be rejectable, it shall be administered as described in the Repairs subsection. When the Owner has determined that a rejectable subplot may remain in the work without repair, the lot shall be subject to a payment reduction reflecting the extent of the non-conformance as determined by the Owner.

332.10.01.02 Payment Adjustment for Gradation

When repair is not required or repair is not chosen for a lot, the payment adjustment for that lot due to gradation requirements shall be a reduction in payment. The payment adjustment for gradation shall be calculated using the following formula:

$$PA_G = \text{lot quantity} \times \text{Contract price} \times [PF_{DLS} + PF_{4.75} + PF_{75}] \quad \text{(Formula 4)}$$

If DLS gradation is rejectable then $PF_{DLS} = 0.04$

If DLS gradation is acceptable then $PF_{DLS} = 0$

If the 4.75 mm sieve gradation is rejectable then $PF_{4.75} = 0.04$

If the 4.75 mm sieve gradation is acceptable then $PF_{4.75} = 0$

If the 75 μ m sieve gradation is rejectable then $PF_{75} = 0.04$

If the 75 μ m sieve gradation is acceptable then $PF_{75} = 0$

Where:

PA_G = payment adjustment for gradation

PF_{DLS} = payment factor for the DLS gradation

$PF_{4.75}$ = payment factor for the 4.75 mm sieve gradation

PF_{75} = payment factor for the 75 μ m sieve gradation

lot quantity = shall be the horizontal area of HIR mix in the lot in m^2

Contract price = for the purposes of payment adjustment due to gradation, means the Contract price of the HIR tender item

332.10.01.03 Payment Adjustment for Asphalt Cement Content and Changes in the Asphalt Cement Price Index

332.10.01.03.01 Hot In-place Recycled Mix Quantity Calculation

The quantity of HIR mix for use in the calculations (T_{HIR}) shall be the theoretical tonnage of HIR mix accepted into the work.

The theoretical tonnage shall be calculated by the Contract Administrator as follows and rounded to one decimal according to LS-100:

$$T_{HIR} = [0.975 \times BRD_{HIR} \times (T_D/1000) \times \text{lot quantity}] \quad (\text{Formula 5})$$

Where:

T_{HIR} = the theoretical tonnage of HIR mix in the lot

BRD_{HIR} = the lot average bulk relative density in t/m^3 , calculated from values obtained in the testing of bulk samples obtained during production of the first complete lot of at least three sublots of HIR mix placed in the work. The values shall be the same as those used in calculating the final air voids payment factor for the lot.

T_D = the design thickness, in millimetres, of the HIR mix

lot quantity = shall be the horizontal area of HIR mix in the lot in m^2

332.10.01.03.02 Payment Adjustment for Asphalt Cement Content

The payment adjustment for AC content shall apply to all placed and compacted HIR mix using the theoretical tonnage as calculated in the Hot In-place Recycled Mix Quantity Calculation clause.

A payment adjustment shall be applied based on the Ministry's PGAC price index. The price index is published monthly in the Contract Bulletin.

The price index shall be based on the price, excluding taxes, FOB the depots in the Toronto area, of AC grade PG 58-28 or equivalent. One index shall be used to establish and calculate the payment adjustment for all grades.

The payment adjustment for AC content for each lot shall be calculated using the following formulae:

When $AC_{HIR} < AC_{SPEC} - 0.1\%$:

The payment adjustment for AC content shall be a reduction in payment for the lot.

$$PA_{AC} = T_{HIR} \times I_{TO} \times \{[AC_{HIR} - (AC_{SPEC} - 0.1)]/100\} \quad (\text{Formula 6})$$

When $AC_{HIR} \geq AC_{SPEC}$ and $\leq AC_{SPEC} + 0.5\%$:

The payment adjustment for AC content shall be an increase in payment for the lot.

$$PA_{AC} = T_{HIR} \times I_{TO} \times \{[AC_{HIR} - AC_{SPEC}]/100\} \quad (\text{Formula 7})$$

When $AC_{HIR} > AC_{SPEC} + 0.5\%$:

The payment adjustment for AC content shall be a reduction in payment for the lot.

$$PA_{AC} = T_{HIR} \times I_{TO} \times \{[(AC_{SPEC} + 0.5) - AC_{HIR}]/100\} \quad (\text{Formula 8})$$

Where:

AC_{HIR} = the lot mean percentage by mass of AC in the HIR mix

AC_{SPEC} = the percentage by mass of AC specified for the work as specified elsewhere in the Contract Documents

PA_{AC} = payment adjustment for AC content

T_{HIR} = the theoretical tonnage of HIR mix in the lot as calculated in Formula 5

I_{TO} = PGAC price index for the month prior to Tender Opening

332.10.01.03.03 Payment Adjustment for Changes in the Asphalt Cement Price Index

When beneficiating HMA is used, a payment adjustment shall be applied based on changes to the Ministry's PGAC price index unless the Contract Administrator is notified in writing of the choice to opt out within five Business Days of receiving permission to start work. Once opted out of payment adjustments based on the price index, opt back in shall not be permitted. The price index is published monthly in the Contract Bulletin. The price index is used to calculate the amount of the payment adjustment per tonne of new AC accepted into the Work.

The price index is based on the price, excluding taxes, FOB the depots in the Toronto area, of AC grade PG 58-28 or equivalent. One index is used to establish and calculate the payment adjustment for all grades.

A payment adjustment per tonne of new AC is established for each month in which paving occurs when the price index for the month differs by more than 5% from the price index for the month prior to Tender Opening. When the price index differential is less than 5%, there is no payment adjustment established for that month. Payment adjustments due to changes in the price index are independent of any other payment adjustments made to the HIR tender items.

The payment adjustment for the month is calculated from the following formulae:

When $I_P > 1.05 I_{TO}$:

The payment adjustment for changes in the PGAC Price Index shall be an increase in payment for the lot.

$$PA_{PI} = (I_P - 1.05 I_{TO}) \times T_{AC} \quad (\text{Formula 9})$$

When $I_P < 0.95 I_{TO}$:

The payment adjustment for changes in the PGAC Price Index shall be a reduction in payment for the lot.

$$PA_{PI} = (0.95 I_{TO} - I_P) \times T_{AC} \quad (\text{Formula 10})$$

Where:

PA_{PI} = payment adjustment for new AC due to changes in the PGAC price index, in dollars

I_P = PGAC price index for the month in which paving occurs

I_{TO} = PGAC price index for the month prior to Tender Opening

T_{AC} = quantity of new AC in the HIR mix, in tonnes calculated as follows:

$$T_{AC} = [AC_{ben} / 100] \times [\%ben / 100] \times T_{HIR\_mnth} \quad (\text{Formula 11})$$

Where:

AC_{ben} = the percentage of new AC in the beneficiating HMA as required by the JMF

$\%ben$ = the percentage of beneficiating HMA in the HIR mix as required by the JMF

T_{HIR_mnth} = the tonnage of HIR mix, as calculated in the Hot In-place Recycled Mix Quantity Calculation clause, accepted into the work during the month for which the payment adjustment was calculated.

The payment adjustment per tonne applies to the quantity of new AC in the beneficiating HMA accepted into the Work during the month for which it is established. The quantity of new AC includes all grades of AC supplied with and without polymer modifiers.

For each month in which a payment adjustment has been established, the quantity is calculated using the percentage of beneficiating HMA in the HIR mix accepted into the Work and the corresponding AC content of the beneficiating HMA as required by the JMF.

For beneficiating HMA mixes containing an AST-AC, the percentage of AST-AC is deducted from the percentage of new AC in the beneficiating HMA. No other deductions are made for any other additives.

332.10.01.04 Payment Adjustment for Segregated Hot In-place Recycled Mix

Where a payment reduction for segregation is allowed in lieu of repairs, the payment reduction shall be calculated as follows:

- a) \$2,000 once for each tender item;
- b) An additional payment reduction of \$2.50/m for mid-lane segregation; and
- c) An additional payment reduction of \$5.00/m² for other segregation. The area of each repair shall be computed by multiplying the full lane width by the length of the repair and rounded to the next whole square metre.

332.10.01.05 Payment Adjustment for Surface Smoothness

Payment adjustment for surface smoothness shall be as specified in the Contract Documents.

332.10.01.06 Payment Adjustment for Lift Thickness

The payment adjustment for lift thickness shall apply to all placed and compacted HIR mix using the horizontal area of the HIR mix in the lot. The payment adjustment for lift thickness shall be a reduction in payment. The payment adjustment for lift thickness shall be calculated using the following formula:

$$PA_T = \text{lot quantity} \times \text{Contract price} \times \{[1.000 - (T_L / T_D)] \times 2.0\} \quad (\text{Formula 12})$$

Where:

PA_T = payment adjustment for lift thickness

T_L = lot mean, if lot mean is less than or equal to T_D (see definition)

or

T_L = T_D , if lot mean is greater than T_D

lot quantity = the horizontal area of the HIR mix in the lot in m²

Contract price = the Contract price of the HIR tender item

When a rejectable subplot remains in the work without repair, the subplot shall be subject to a payment reduction. The payment adjustment for each rejectable subplot lift thickness shall be:

$PA_{\text{SUBLOT}} = \text{sublot quantity} \times \text{Contract price} \times 0.5$

(Formula 13)

Where:

PA_{SUBLOT} = subplot payment adjustment for lift thickness

subplot quantity = the horizontal area of HIR mix in the subplot in m²

Contract price = the Contract price of the HIR tender item

332.10.02 Referee Testing and Segregation Challenge

332.10.02.01 Air Voids and Compaction

If the referee test results show that the referee payment factor for air voids or compaction is higher than the payment factor for air voids or compaction based on the original QA test results by more than 0.025 and the referee results show that the lot is not rejectable, the Owner shall bear the cost of the referee testing for that attribute.

If the referee test results show that the lot is rejectable, or the referee test results show that the referee payment factor for air voids or compaction is not higher than the payment factor for air voids, or compaction based on the original QA test results is more than 0.025, the Owner shall charge the cost of the referee testing.

When there is an outlier in the referee test results, the Owner shall charge 50% of the total cost for referee testing of all sublots in the original lot.

The cost of the referee testing shall be based on the referee testing rates as specified in the Contract Documents.

332.10.02.02 Gradation and Asphalt Cement Content

The cost of the referee testing shall be charged, unless the testing confirms total conformance of the attribute to the Contract Documents, in which case the costs shall be borne by the Owner.

332.10.02.03 Segregation Challenge

When a challenge is successful, as described in the Challenging Severity of Segregation clause, the Owner shall pay for the cost of the traffic control, if the traffic control was not necessary for any other reason. The Owner shall not be responsible for any other costs associated with the assessment, including the cost of delays.

When a challenge is not successful, as described in the Challenging Severity of Segregation clause, all costs associated with the assessment, including the cost of traffic control and delays shall be at no additional cost to the Owner.

332.10.02.04 Lift Thickness

If the referee test result is 3.0 mm or more greater than the original QA test result, the Owner shall bear the cost of the thickness measurement referee testing. Otherwise, the Contractor shall be charged the cost of the thickness measurement referee testing.

332.10.03 Repairs

No payment shall be made for the:

- a) Quantity of HIR mix that is removed and replaced, overlaid, or otherwise repaired; or
- b) For additional shouldering, traffic control, and other work such as zone painting or bridge deck waterproofing.

When:

- a) In lieu of a reduction in payment, repairs to the lot, subplot, or visually defective HIR mix are completed; or
- b) The Contract Administrator has determined that a rejectable lot or subplot requires repair.

No payment shall be made to repair areas of HIR mix damaged by traffic.

For all additional testing resulting from a repair to a lot a charge shall be applied at the rates established by the Owner for the year in which the testing was carried out.

No additional payment shall be made for the cost of tolerance measurements of the repaired areas that are required by the Contract Administrator.

TABLE 1
Specification Limits for Hot In-place Recycled Mix Acceptance Attributes

Properties and Attributes	Mix Type HIR Mix is Required to Meet	Lower Limit (LL) %	Upper Limit (UL) %
AC Content	All HMA types	AC _{SPEC} - 0.4 (Note 1)	AC _{SPEC} + 0.5 (Note 1)
Designated Large Sieve (DLS)	Superpave 12.5, 12.5FC 1, and 12.5FC 2	40	95
4.75 mm Sieve	Superpave 12.5, 12.5FC 1, and 12.5FC 2	40	65
75 µm Sieve	Superpave 12.5, 12.5FC 1, and 12.5FC 2	2	13
Air Voids	All HMA types	2.0	5.5
Pavement Compaction	Superpave 12.5 and 12.5FC 1	92.0	97.0
	Superpave 12.5FC 2	92.0	98.0
Notes: 1. AC _{SPEC} is the AC content specified in the Contract Documents.			

TABLE 2
Sample Size and Frequency

Material Sample	Properties and Attributes	Sample Size (Note 1)	Frequency of Sampling
HIR Loose Mix (Note 2)	Air Voids, Gradation, and AC Content	20 to 30 kg (Note 3)	Every subplot
	RAC Performance Grade	10 kg	Every lot
HIR Core	Compaction	150 to 200 mm diameter	Every subplot
	Lift Thickness	50 mm diameter	Every thickness subplot
Notes: 1. Each material sample receptacle shall have a maximum mass of 30 kg. For ease of handling, especially when the larger sample size is required, splitting of material at the paving site is permitted such that a sample is contained in a maximum of two receptacles whose total mass does not exceed the maximum specified above. Once delivered to testing laboratories, combining of the material from the two receptacles is only mandatory if a single receptacle contains insufficient material to carry out the full suite of tests required. 2. Loose mix samples shall be representative of the final HIR mix and shall be taken at the paver after the rejuvenating agent or beneficiating HMA or both have been added. 3. The larger sample size shall be applicable when samples are designated for testing to the maximum number of gyrations. The frequency of the larger samples shall be one per lot, as designated by the Contract Administrator.			

TABLE 3
Testing Requirements

Properties and Attributes	Testing Method (Note 1)	Calculations, Values, and Results Required
HIR Mix Properties		
AC Content and Gradation for HIR mix samples	LS-282 or LS-292	% AC % passing DLS sieve % passing 4.75 mm sieve % passing 75 μ m sieve
Volumetric Properties of HIR Mix		
Laboratory Compaction to: i. Design number of gyrations (N_{des}) ii. Maximum number of gyrations (N_{max}) Maximum Theoretical Specific Gravity (G_{mm})	AASHTO T 166 using the same laboratory compaction protocol as was used in mix design. (Note 2) AASHTO T 312, LS-264 In addition to compacting all samples to the design number of gyrations, one sample from each lot of HIR mix shall be compacted to the maximum number of gyrations. Bulk Relative Density for HIR mix samples, BRD_m	BRD_m BRD at N_{des} BRD at N_{max} G_{mm} % G_{mm} @ N_{des} % G_{mm} @ N_{max}
Air Voids for mix (V_a)	LS-265	V_a
Compaction of HIR Mix		
Compaction and Thickness of Cores	BRD_c = Bulk Relative Density for core samples, LS-262 (Note 2) MRD_m = G_{mm} (Maximum Relative Density for loose mix samples, LS-264) % Compaction = $(100 \times BRD_c / MRD_m)$	Thickness of Core % Compaction
Lift Thickness of HIR Mix		
Lift Thickness	LS-294	Thickness of Lift
Notes: 1. The rounding-off procedure, for all values, shall be according to LS-100. 2. For all gyratory-compacted specimens and cores, if the per cent water absorbed by the specimen is found to exceed 2% by volume, as described in AASHTO T 166, then the bulk relative density shall be determined using either LS-306 or ASTM D6752.		

TABLE 4
Breakdown of the Tender Item Quantity into Lots for Air Voids and Compaction

Quantity of Square Metres	Number of Lots
< 40,000	1
40,000 to 80,000	2
80,000 to 100,000	2 or 3 (Note 1)
> 100,000	3 +
Notes: 1. As determined by the Contract Administrator in consultation with the Contractor.	

TABLE 5
Payment Factors Based on Per Cent Within Limits

PWL	Air Voids	Compaction	PWL	Air Voids	Compaction	PWL	Air Voids	Compaction
100	1.000	1.000	66	0.891	0.790	32	0.320	0.416
99	1.000	1.000	65	0.875	0.781	31	0.310	0.403
98	1.000	1.000	64	0.858	0.773	30	0.300	0.390
97	1.000	1.000	63	0.839	0.764	29	0.290	0.377
96	1.000	1.000	62	0.820	0.755	28	0.280	0.364
95	1.000	1.000	61	0.799	0.746	27	0.270	0.351
94	1.000	1.000	60	0.778	0.738	26	0.260	0.338
93	1.000	1.000	59	0.755	0.729	25	0.250	0.325
92	1.000	1.000	58	0.731	0.720	24	0.240	0.312
91	1.000	1.000	57	0.706	0.711	23	0.230	0.299
90	1.000	1.000	56	0.680	0.703	22	0.220	0.286
89	1.000	0.991	55	0.653	0.694	21	0.210	0.273
88	1.000	0.983	54	0.624	0.685	20	0.200	0.260
87	1.000	0.974	53	0.595	0.676	19	0.190	0.247
86	1.000	0.965	52	0.564	0.668	18	0.180	0.234
85	1.000	0.956	51	0.533	0.659	17	0.170	0.221
84	1.000	0.948	50	0.500	0.650	16	0.160	0.208
83	1.000	0.939	49	0.490	0.637	15	0.150	0.195
82	1.000	0.930	48	0.480	0.624	14	0.140	0.182
81	1.000	0.921	47	0.470	0.611	13	0.130	0.169
80	1.000	0.913	46	0.460	0.598	12	0.120	0.156
79	0.999	0.904	45	0.450	0.585	11	0.110	0.143
78	0.998	0.895	44	0.440	0.572	10	0.100	0.130
77	0.995	0.886	43	0.430	0.559	9	0.090	0.117
76	0.991	0.878	42	0.420	0.546	8	0.080	0.104
75	0.986	0.869	41	0.410	0.533	7	0.070	0.091
74	0.980	0.860	40	0.400	0.520	6	0.060	0.078
73	0.973	0.851	39	0.390	0.507	5	0.050	0.065
72	0.964	0.843	38	0.380	0.494	4	0.040	0.052
71	0.955	0.834	37	0.370	0.481	3	0.030	0.039
70	0.944	0.825	36	0.360	0.468	2	0.020	0.026
69	0.933	0.816	35	0.350	0.455	1	0.010	0.013
68	0.920	0.808	34	0.340	0.442	0	0.000	0.000
67	0.906	0.799	33	0.330	0.429			

TABLE 6
Minimum Sublot Lift Thickness

Design Lift Thickness (T_D) mm	Minimum Sublot Lift Thickness mm
< 40	$T_D - 7$
≥ 40	$T_D - 10$

TABLE 7
Allowable Macrotexture Ratios for Hot In-place Recycled Mixes

Macrotexture Ratio (M_R)		
Degree of Segregation		
Slight	Medium	Severe
< 1.6	1.6 to 2.2	> 2.2



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING

TABLE OF CONTENTS

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333.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing emulsified asphalt, and spreading and compacting the cold in-place recycled (CIR) mix.

333.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

333.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

333.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications.

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1103 Emulsified Asphalt
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-291 Quantitative Extraction of Asphalt Cement and Mechanical Analysis of Extracted Aggregate from Bituminous Paving Mixtures - Ontario Procedure
LS-300 Preparation of Marshall Specimens for Cold In-Place Recycled Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602 Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):
OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D6752/D 6752M-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

333.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled (CIR) Mix means the in-place mixture of existing reclaimed HMA pavement, emulsified asphalt, and water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for the lot established according to LS-300 by the QA testing laboratory, and used to determine the per cent compaction.

333.04 DESIGN AND SUBMISSION REQUIREMENTS

333.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of emulsified asphalt as a percent by mass of the RAP. The design rate of the emulsified asphalt shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out CIR mix design. Where the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the type, manufacturer, and supplier of the emulsified asphalt.
- b) The percent by mass of emulsified asphalt in the CIR, referred to as the design rate, and all calculations performed to determine the design rate of emulsified asphalt.
- c) The optimum moisture content and the mix design bulk relative density.
- d) The amount of water to be added to the mix.
- e) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.
- f) Recovered penetration for the binder of the existing pavement according to LS 200.

g) Type, source and quantity of active filler, if required.

333.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIR operations. Within 4 Business Days after receiving the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the emulsified asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

333.05 MATERIALS

333.05.01 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve after processing, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

333.05.02 Emulsified Asphalt

Emulsified asphalt shall be polymer modified mixing grade according to OPSS 1103 and be compatible with the process and materials used.

333.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

333.05.04 Active Filler

When active filler is required, it shall be incorporated into the existing reclaimed asphalt pavement at the application rate specified in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

333.06 EQUIPMENT

333.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A screening and sizing unit capable of processing the RAP.

- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the emulsified asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.
- d) An emulsified asphalt control system equipped with a flow meter calibrated in litres per tonne and a total delivery meter calibrated in litres to continuously maintain the required amount of emulsified asphalt added to within 0.2% by mass of the reclaimed material feed.
- e) A means of monitoring and controlling the addition of water.
- f) A mixing unit capable of producing a uniform and thoroughly blended CIR mix.

333.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIR mix. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

333.06.03 Compaction Equipment

Compaction equipment shall be selected to achieve the required compaction.

333.06.04 Drying Unit

A drying unit specifically designed to provide radiant heat to the CIR mat may be used. Open flame heating shall not be used. The entire heater assembly shall be capable of readily adjusting the intensity of heat on the pavement surface.

333.06.05 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

333.06.06 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

333.07 CONSTRUCTION

333.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIR depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

333.07.02 Operational Constraints

The work shall not be carried out when the ambient temperature is less than 10 °C or when the overnight low is forecast to be less than 2 °C. Cold in-place recycled mix shall not be placed after September 1st without the written approval from the Contract Administrator. The work shall be carried out when the roadway is clean and free of standing water. The work shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIR mat until it is able to carry traffic without damage. Any damage to the CIR mat shall be repaired.

The wearing surface shall not be placed on the CIR mat until the following requirements have been met:

- a) The CIR mat has been opened to traffic and allowed to cure for a minimum of 14 Days.
- b) The specified moisture content has been achieved according to the Acceptance Criteria section.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIR mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIR mat. The 30 Day requirement may be waived by the Contract Administrator if the CIR mix does not meet the requirements of this specification and is subject to repair.

333.07.03 Cold In-Place Recycling Trial Section

Prior to carrying out CIR, the ability to successfully carry out CIR according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIR with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIR has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIR work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIR is rejected by visual assessment, the trial section shall be repaired or removed and replaced until the CIR meets the requirements of the Surface Appearance subsection.

333.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIR work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIR mix.

Existing crack sealant shall be removed and disposed of prior to CIR reclaiming operations.

333.07.05 Mixing

The emulsified asphalt shall be added at the design rate. The rate of addition of emulsified asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIR mix that can be compacted to the specified density. The emulsified asphalt added shall not be less than 1.2%.

Water may be added in a controlled manner to facilitate uniform mixing.

333.07.06 Compaction

The CIR mix shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

333.07.07 Surface Appearance

The compacted CIR mat shall be smooth and constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIR mat shall be of uniform texture and free of segregation, raveling, rutting, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

333.07.08 Drying

Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CIR shall not be allowed.

333.07.09 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIR mat is able to carry traffic without damage.

333.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

333.08 QUALITY ASSURANCE

333.08.01 General

Acceptance of the CIR mix shall be based on the following criteria:

- a) Surface Appearance
- b) Surface Tolerance
- c) Moisture Content
- d) Compaction
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.02 Sampling

333.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIR production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

333.08.02.02 Cold In-Place Recycling Material

Samples of CIR material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

333.08.02.02.01 Slabs

At least 4 Business Days prior to the planned overlay of the CIR mat, 2 slab samples of the CIR material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab sample shall be dry cut 150 mm x 150 mm and removed intact from the CIR mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content. The result of the moisture content will be used for both the moisture acceptance, and moisture adjustment for compaction calculation according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve moisture content and/or compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.

333.08.02.02.02 Loose Mix Samples

For the purpose of determining the RAP gradation, 30 kg of loose CIR mix samples shall be taken from each of two randomly selected sublots for every lot.

333.08.02.03 Reclaimed Material

At the start of production of each new lot or whenever the existing pavement material significantly changes composition, one 15 kg sample of material reclaimed from the roadway shall be obtained prior to adding emulsion for the purpose of determining the target density for compaction. Samples shall be taken at random locations as directed by the Contract Administrator.

333.08.02.04 Emulsified Asphalt

Samples of emulsified asphalt used in the mix shall be taken at the job site from the tankers according to the Contractor's health and safety plan at a frequency of three sets of samples per Contract randomly taken from three different lots. Each sample shall be taken either from a sampling spigot on the transfer line, if available, or from the end of the transfer line after a minimum of 4,000 kg has been drawn from the tanker. Each set of samples shall be a minimum of 2 full four-litre containers. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

The sample containers supplied by the Contractor shall be new triple tight epoxy lined pails or suitable leak-proof plastic containers. The sample labels shall be obtained from the Contract Administrator.

333.08.03 Acceptance Criteria

333.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIR mat has been opened to traffic. The finished CIR surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

333.08.03.02 Surface Tolerance

The surface tolerance of any CIR surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIR surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIR greater than 6 mm.

333.08.03.03 Moisture Content

The QA laboratory shall test one sample from each subplot to determine the moisture content of CIR mix according to LS-291, and the test result of the moisture content shall be rounded to one decimal place according to LS-100. The test result for each subplot shall be used to compute the lot mean for moisture content of CIR mix.

The moisture content of CIR mix acceptance shall be based on the mean moisture content of the lot and the moisture content of the individual sublots. The lot is acceptable if the lot mean moisture content is equal to or less than 2% with no individual subplot's moisture content greater than 3%. The lot is rejectable if the lot mean moisture content of CIR mix is greater than 3%. Any subplot with its moisture content greater than 3% shall be deemed rejectable.

If the lot mean moisture content of CIR mix is less than 3% and greater than 2%, the Contractor may elect to accept a payment reduction or repair for the lot. The payment reduction shall be calculated according to Table 2. If the Contractor elects to repair the lot in lieu of a payment reduction, the lot shall be repaired according to the Repairing and Re-Evaluating subsection.

333.08.03.04 Compaction

The compaction of the CIR mix shall be calculated for each subplot from the bulk relative density determined from slab samples according to LS-306 or ASTM D-6752, and the target density for the lot as follows:

$$\text{Compaction} = (\text{bulk relative density of slab sample} / \text{target density}) \times 100\%$$

where the target density to be used for acceptance purposes shall be calculated for each lot from material reclaimed from the roadway prior to adding emulsion. The target density shall be established according to LS-300.

Each lot of CIR mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot's bulk relative density result falling below 95.0% of the target density. CIR that is not compacted to the required density shall be deemed rejectable.

333.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

333.08.04 Repairing and Re-Evaluating

CIR mix that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall be according to the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIR shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

When repairs are made to rejectable sublots or those sublots that the Contractor elects to repair due to the non-conformance of the moisture content requirements, the lot shall be re-evaluated and re-decisioned for payment reduction. The original lot shall be divided into two reconfigured lots in the following way: All acceptable sublots (with moisture content equal to or less than 2%) shall be grouped as one lot and shall receive the full Contract price. The remaining sublots shall be grouped as another lot and shall use the retest results of the repaired sublots to calculate the mean lot moisture content, and shall be accepted either at the full Contract price, or subjected to a payment reduction, or deemed rejectable.

333.09 MEASUREMENT FOR PAYMENT

333.09.01 Actual Measurement

333.09.01.01 Cold In-Place Recycled Mix

Measurement of CIR mix placed shall be by area in square metres.

333.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

333.10 BASIS OF PAYMENT

333.10.01 Cold In-Place Recycled Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of active filler or other additives to the mix, including any emulsion that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIR material shall be at no extra cost to the Owner.

Emulsified asphalt shall be included in the Cold In-Place Recycled Mix item.

Repair of an unacceptable CIR mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the Cold In-Place Recycled Mix item.

Repair of areas of CIR damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

333.10.02**Payment Reduction for Moisture Content**

When test results show that the moisture content payment factor for the lot is less than 1.000 and the Contractor is not required to or does not elect to repair the lot, the payment reduction for the lot shall be as follows:

$(1.000 - \text{Payment Factor}) \times \text{item price} \times \text{lot quantity}$

For purposes of payment reduction, the term item price means the Contract price of the applicable tender item.

For purposes of re-decision after repairs, the lot quantity is the area of the reconfigured lot.

TABLE 1
Acceptance Criteria and Repair Requirements for CIR Mix

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIR to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straight edge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Moisture Content	Non-conformance for moisture Content as per the Moisture Content subsection of the Acceptance Criteria.	> 3% for Moisture Content of Lot or Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Use drying unit as specified in the Drying Unit subsection to dry the CIR mat, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Compaction	Non-conformance for compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompect the CIR mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIR material to full depth and replace with an acceptable binder course HMA.
Notes: 1) Defect and severity definitions according to SP-027. 2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.				

TABLE 2
Moisture Content of CIR Mix Payment Factors

Moisture Content Payment Factors Acceptance Criteria	Classification	Payment Factor, PFT
MC ≤ 2%	Acceptable	1.000
2% < MC ≤ 3%	Payment Reduction	$1 - \text{TODRF} \times (\text{MC} - 2)/10$
MC > 3%	Rejectable	N/A

Where:
MC = the mean of the lot sample of moisture content of CIR Mix in percent calculated to one decimal place according to LS-100.
PFT = the payment factor for moisture content calculated to three decimal places according to LS-100.
TODRF = Tender Opening Date Reduction Factor according to Table 3.

TABLE 3
Tender Opening Date Reduction Factor

Year of Tender Opening	Tender Opening Date Reduction Factor
2015	0.65
2016	0.8
2017	1.0

Appendix 333-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLING WITH EXPANDED ASPHALT

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335.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement, sizing, adding active filler if required, adding and mixing expanded asphalt, and spreading and compacting the cold in-place recycled expanded asphalt mix (CIREAM).

335.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

335.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

335.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications.

Ontario Provincial Standard Specifications, Construction

OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-200 Penetration of Bituminous Materials
LS-297 Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
LS-602 Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):

OTM Book 7 - Temporary Conditions

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

ASTM International

D 6752-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

American Association of State Highway and Transportation Officials (AASHTO)

T40-02 Sampling Bituminous Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 1st edition, 2012

335.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Filler means substances added to the reclaimed existing asphalt pavement that chemically alter the mix properties.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) means the in-place mixture of existing reclaimed asphalt pavement (RAP), active filler, and expanded asphalt.

Cold In-Place Recycled Expanded Asphalt Mix (CIREAM) Mat means a pavement course which comprises Cold In-Place Recycled Expanded Asphalt Mix

Expanded Asphalt means heated asphalt cement expanded from its normal volume by the addition of water.

Hot Mix Asphalt (HMA) means as defined in OPSS 313.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 313.

Quality Assurance (QA) means as defined in OPSS 313.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 313.

Target Density means the average bulk relative density for each subplot established according to LS-297, and used to determine the per cent compaction.

335.04 DESIGN AND SUBMISSION REQUIREMENTS

335.04.01 Design Requirements

For mix design purposes, prior to commencing the work, the Contractor shall obtain samples that are representative of the material that is produced during the milling operation. These samples shall be used to establish the design rate of expanded asphalt as a percent by mass of the RAP. The mix design shall meet the following requirements:

- a) The design rate of the expanded asphalt shall be a minimum of 1.0%.
- b) The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design shall be completed by a laboratory with Canadian Council of Independent Laboratories (CCIL) Type A certification or equivalent equipped to carry out expanded asphalt mix designs. When the existing pavement significantly changes composition, a separate mix design shall be completed.

Each mix design shall include the following:

- a) Information on the grade, manufacturer, and supplier of the PGAC.
- b) The percent by mass of expanded asphalt in the CIREAM, referred to as the design rate, and all calculations performed to determine the design rate of expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half-life, the expansion ratio and the percent of water added for foaming.
- d) The optimum moisture content and the mix design bulk relative density.
- e) The dry tensile strength, the wet tensile strength, and the tensile strength ratio.
- f) The amount of water to be added to the mix.
- g) Maximum field rate adjustment allowed to the design rate without adverse effects to the mix properties.
- h) Recovered penetration for the binder of the existing pavement according to LS-200.
- i) Type, source and quantity of active filler, if required.

335.04.02 Submission Requirements

A copy of the mix design shall be submitted to the Contract Administrator a minimum of 7 Business Days prior to the start of CIREAM operations. Within 4 Business Days commencing after the day of delivery of all required documents for the mix design, the Contract Administrator shall provide written confirmation of receipt of the submitted mix design documents or of any non-conformance to the contract requirements.

Confirmation of receipt of the mix design documents does not constitute any guarantee that the mix can be produced or constructed or both to Contract requirements, and does not relieve the Contractor of the responsibility for ensuring the specified quality of Materials and workmanship.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.20%. Separate or new mix designs shall be submitted if the composition or layer thicknesses of the existing pavement changes significantly. Where more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

335.05 MATERIALS

335.05.01 Reclaimed Asphalt Pavement

RAP material shall be 100% passing the 37.5 mm sieve, and 95% to 100% passing the 26.5 mm sieve after processing, and shall be measured based on air dried gradation according to the coarse sieving operation of LS-602.

335.05.02 Performance Graded Asphalt Cement

PGAC shall be according to OPSS 1101. The table of Additional Testing Requirements and Acceptance Criteria for PGAC Grades shall not apply. PGAC shall be selected with performance properties meeting the design maximum pavement temperature of 52 °C and the minimum pavement temperature of -28 °C at a minimum, and the selected PGAC shall have suitable expansion characteristics.

335.05.03 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

335.05.04 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. Not more than 1% by mass of Portland cement shall be added to the mix.

335.06 EQUIPMENT

335.06.01 Recycling Train

The recycling train shall include the following:

- a) A self-propelled cold milling unit with a cutting drum capable of reclaiming a full lane width of asphalt pavement to the depth specified in the Contract Documents in one pass.
- b) A screening and sizing unit capable of processing the RAP.
- c) An aggregate feed system that measures and regulates the mass of RAP being added into the mixing unit prior to the addition of the expanded asphalt. The scale shall be calibrated to the manufacturer's tolerance prior to the start of the work and when requested by the Contract Administrator.
- d) An asphalt cement expansion system capable of producing optimum expansion and an injection system capable of injecting and blending expanded asphalt uniformly throughout the reclaimed material.
- e) A system to control and regulate the application of expanded asphalt in relation to the mass of RAP being processed within a tolerance of $\pm 3.0\%$ by volume of asphalt cement.
- f) A mixing unit capable of producing a uniform and thoroughly blended CIREAM.

335.06.02 Placing Equipment

A mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade shall be used to place the CIREAM. The paver shall be equipped with distributing augers for the full width to be paved. The paver shall have a vibratory screed capable of vibrating the full width of mix placed.

335.06.03 Compaction Equipment

Compaction equipment shall be selected to achieve the required compaction.

335.06.04 Straight Edge

The straight edge shall be 3 m in length, metal, and have a level recessed in its upper edge parallel to the lower edge.

335.06.05 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

335.07 CONSTRUCTION

335.07.01 General

HMA pavement in areas inaccessible to the reclaiming equipment shall be removed and replaced with acceptable binder course HMA. The HMA shall be placed to the CIREAM depth specified in the Contract Documents in compacted lift thicknesses between 40 and 75 mm in depth.

The overlap between successive passes of the recycling train shall be a minimum 100 mm.

335.07.03 Operational Constraints

Cold in-place recycled expanded asphalt mix (CIREAM) shall not be placed after September 1st without the written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. Cold in-place recycled expanded asphalt mix shall not proceed during periods of rain or when the surface is in a saturated condition.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. Any damage to the CIREAM mat shall be repaired.

The wearing surface shall not be placed on the CIREAM mat until the following requirements have been met:

- a) The CIREAM mat has been opened to traffic and allowed to cure for a minimum of 3 Days.
- b) The specified tensile strength has been achieved according to the Quality Assurance section.
- c) The specified density has been achieved according to the Compaction subsection.
- d) All defective areas in the CIREAM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CIREAM mat. The 30 Day requirement may be waived by the Contract Administrator if the CIREAM does not meet the requirements of this specification and is subject to repair.

335.07.03 Cold In-Place Recycling Expanded Asphalt Trial Section

Prior to carrying out CIREAM, the ability to successfully carry out CIREAM according to this specification shall be demonstrated to the Contract Administrator by placing a trial section within the Contract limits.

In lieu of a trial section, the Contract Administrator may accept evidence that the ability to successfully mix, handle, place, and compact CIREAM with the same equipment, placing crew, and methodology to

meet the Contract requirements for placing CIREAM has been demonstrated on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The location of the trial section shall be proposed to the Contract Administrator for approval. A minimum of 48 hours notice shall be given to the Contract Administrator prior to placing the trial section.

The Contract Administrator shall allow the CIREAM work to continue based on an acceptable visual assessment of the trial according to the requirements of the Surface Appearance subsection. When the CIREAM is rejected by visual assessment, the trial sections shall be repaired or removed and replaced until the CIREAM meets the requirements of the Surface Appearance subsection.

335.07.04 Surface Preparation

When specified in the Contract Documents, milling prior to CIREAM work shall be carried out to achieve the specified crossfall and grade.

All deleterious and loose milled material shall be removed from the milled surfaces, and longitudinal and transverse joints after reclaiming operations are completed and before placing CIREAM.

All existing crack sealant shall be removed and disposed of prior to CIREAM reclaiming operations.

335.07.05 Mixing

The expanded asphalt shall be added at the design rate. The rate of addition of expanded asphalt shall be field adjusted as required to within 0.20% of the design rate and mixed to produce a uniformly coated CIREAM that can be compacted to the specified density. The expanded asphalt added shall not be less than 1.0%.

335.07.06 Compaction

The CIREAM shall be compacted according to the requirements of the Acceptance Criteria for Compaction subsection.

335.07.07 Surface Appearance

The compacted CIREAM mat shall be smooth and constructed to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and free of segregation, raveling, rutting, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Traffic Control with Moving Vehicles

Traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the CIREAM mat is able to carry traffic without damage.

335.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance of the CIREAM shall be based on the following criteria:

- a) Surface Appearance
- b) Surface Tolerance
- c) Compaction
- d) Tensile Strength
- e) RAP Gradation

Work that does not meet the acceptance criteria shall be repaired according to the Repairing and Re-Evaluating subsection.

335.08.02 Sampling

335.08.02.01 Lot Size

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before CIREAM production starts. A lot shall typically represent 25,000 m² with 5 equal sublots of 5,000 m² in size.

335.08.02.02 Cold In-Place Recycled Expanded Asphalt Mix Samples

Samples of CIREAM material shall be packaged in non-absorptive materials to protect sample integrity and sealed in waterproof containers. Samples shall be transported in a manner that avoids stacking and extreme temperatures.

335.08.02.02.01 Loose Samples

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each subplot, taken at random locations as directed by the Contract Administrator. The samples to be tested for acceptance of CIREAM shall be used to test for dry tensile strength and wet tensile strength according to LS-297.

For the purpose of determining the RAP gradation, another 30 kg sample of CIREAM samples shall be taken from each of two randomly selected sublots for every lot.

335.08.02.02.02 Slabs

Prior to the planned overlay of the CIREAM mat, two slab samples of the CIREAM material shall be obtained from each subplot. The two slab samples shall be located side-by-side and taken at random locations as directed by the Contract Administrator. Each slab samples shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

One slab sample shall be used to test for bulk relative density and the other slab sample shall be used to test for moisture content for the purpose of moisture adjustment according to LS-306.

Additional slab samples for QA acceptance tests shall only be taken after the Contractor has carried out remedial work to improve compaction in the rejected subplot. The Contractor shall be charged the cost of additional tests.

335.08.02.03 Performance Graded Asphalt Cement

Samples of PGAC to be used in the mix shall be taken from the storage tank at the terminal according to the Tank Tap Method specified in AASHTO T40-02 and the terminal's health and safety plan in the presence of the Contract Administrator at a frequency of three sets of samples per Contract for PGAC providing to three different lots. Each set of samples shall be a minimum of 2 full one-litre portions. The Contractor's health and safety plan and procedure for sampling shall be reviewed at the pre-pave meeting.

Samples of PGAC used in the mix shall be obtained, properly labelled and identified, and delivered to the designated QA testing laboratory as specified in the Contract Documents.

335.08.03 Acceptance Criteria

335.08.03.01 Surface Appearance

Surface appearance shall be assessed by the Contract Administrator based on visual surveys after the CIREAM mat has been opened to traffic. The finished CIREAM surface shall have a uniformly smooth texture and shall meet the surface appearance requirements of ravelling, segregation and rutting as specified in Table 1 prior to placement of HMA overlay.

335.08.03.02 Surface Tolerance

The surface tolerance of any CIREAM surface shall be such that when tested with a 3 m straight edge placed anywhere on the CIREAM surface, except across the crown, and in any direction on the surface, there shall not be a gap between the bottom of the straight edge and the surface of the CIREAM greater than 6 mm.

335.08.03.03 Compaction

The compaction of the CIREAM mix shall be calculated for each subplot from the bulk relative density determined from slab samples according to LS-306 or ASTM D-6752 and the target density as follows:

Compaction = (bulk relative density of the slab sample / target density) x 100%

where the target density to be used for acceptance purposes shall be calculated for each subplot by averaging the densities of the six (6) compacted specimens produced for indirect tensile strength testing according to LS-297.

Each lot of CIREAM shall be compacted to a minimum mean of 96.0% of the target density established for the mix, with no individual subplot bulk relative density result falling below 95.0% of the target density. CIREAM that is not compacted to the required density shall be deemed rejectable.

335.08.03.04 Tensile Strength of Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength and wet tensile strength.

Samples of CIREAM shall be tested for acceptance purposes according to LS-297.

Dry tensile strength requirements for the lot are met when:

- a) The mean dry tensile strength of the lot is equal to or greater than 225 kPa; and
- b) No individual subplot dry tensile strength is less than 200 kPa.

Wet tensile strength requirements for the lot are met when:

- a) The mean wet tensile strength of the lot is equal to or greater than 100 kPa; and
- b) No individual subplot wet tensile strength is less than 75 kPa.

CIREAM that does not meet the above dry tensile strength and wet tensile strength requirements shall be deemed rejectable.

335.08.03.05 Reclaimed Asphalt Pavement Gradation

If the RAP does not meet the gradation requirements, the Contractor shall submit an action plan of remediation to the Contract Administrator for approval within 2 Business Days after the delivery of the QA testing results.

335.08.04 Repairing and Re-Evaluating

CIREAM that is rejectable based on the Acceptance Criteria subsection shall be repaired according to the requirements specified in Table 1.

Repairs shall be for the full lane width. For repairs due to the surface appearance defects, the minimum repair length shall be sufficient for the repair to be carried out by the recycling train, or by the paving equipment, whichever is applicable. For other repairs based on the lot and subplot acceptance, the minimum length shall follow the Repairing and Re-Evaluating clause of OPSS 313 and to the depth specified in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thicknesses between 40 and 75 mm. The HMA mix type and design used for repairs shall be approved by the Contract Administrator and shall meet the acceptance requirements for the HMA specified elsewhere in the Contract Documents.

All repairs will be re-evaluated and retested according to the Acceptance Criteria subsection.

335.09 MEASUREMENT FOR PAYMENT

335.09.01 Actual Measurement

335.09.01.01 Cold In-Place Recycled Expanded Asphalt Mix

Measurement of CIREAM placed shall be by area in square metres.

335.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

335.10 BASIS OF PAYMENT

335.10.01 Cold In-Place Recycled Expanded Asphalt Mix - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of active filler or other additives to the mix, including any expanded asphalt that is required due to the additives, shall be at no extra cost to the Owner.

HMA required to replace unacceptable CIREAM material shall be at no extra cost to the Owner.

PGAC shall be included in the CIREAM item.

Repair of an unacceptable CIREAM mat shall be carried out at no extra cost to the Owner.

HMA placed in areas inaccessible to the reclaiming equipment shall be included in the CIREAM item.

Repair of areas of CIREAM damaged by traffic shall be completed at no extra cost to the Owner.

Repair, removal, or replacement of an unacceptable trial section shall be completed at no extra cost to the Owner.

TABLE 1
Acceptance Criteria and Repair Requirements for CIREAM

Acceptance Criteria	Defect Type	Severity / Criteria	Acceptable / Rejectable	Repair Requirements
Surface Appearance	Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
	Segregation (Note 1)	Slight to Medium	Acceptable	No action required.
		Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
	Rutting (Note 1)	Very Slight to Slight	Acceptable	No action required.
		Moderate to Severe	Rejectable	Mill 50 mm and replace with an acceptable binder course HMA (Note 2).
		Very Severe	Rejectable	Remove CIREAM to full depth and replace with an acceptable binder course HMA (Note 2).
Surface Tolerance	Non-conformance for surface tolerance as per the Surface Tolerance subsection of the Acceptance Criteria.	> 6 mm based on 3 m straightedge measurement	Rejectable	All deficient areas shall be re-profiled by milling or padded with the same hot mix type to be used in the overlying hot mix lift.
Compaction	Non-conformance for Compaction as per the Compaction subsection of the Acceptance Criteria.	< 96% for Compaction of Lot's Mean; and < 95% for Compaction of Individual Sublot	Rejectable	For rejected sublots, or sublots within the corresponding rejected lot: 1) Recompect the CIREAM mat, if required, with reheating process, or 2) Reprocess with a recycling train (Note 2), or 3) Remove CIREAM material to full depth and replace with an acceptable binder course HMA.
Tensile Strength	Non-conformance for Tensile Strength as per the Tensile Strength of Cold In-place Recycled Expanded Asphalt Mix subsection of the Acceptance Criteria.	For Dry Tensile Strength: < 225 KPa for Lot's Mean; and < 200 KPa for Individual Sublot. For Wet Tensile Strength: < 100 KPa for Lot's Mean; and < 75 KPa for Individual Sublot.	Rejectable	Remove CIREAM to full depth in the lot or sublot represented by the test and replace with an acceptable binder course HMA (Note 2).
Notes: 1) Defect and severity definitions according to SP-027. 2) Reprocessing with a recycling train may be considered as a repair method, upon submission of a proposal by the Contractor and approved by the Contract Administrator.				

Appendix 335-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR MICRO-SURFACING

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336.01 SCOPE

This specification covers the requirements for micro-surfacing.

336.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 710 Pavement Marking

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1003	Aggregates - Hot Mixed Asphalt
OPSS 1103	Emulsified Asphalt
OPSS 1301	Cementing Materials

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

- LS-601 Materials Finer than 75 µm Sieve in Mineral Aggregates by Washing
- LS-602 Sieve Analysis of Aggregates
- LS-609 Petrographic Analysis of Coarse Aggregate
- LS-625 Guidelines for Sampling of Granular Materials

Ontario Traffic Manual (OTM):

Book 7 - Temporary Conditions

SP-024 Manual for Condition Rating of Flexible Pavements

International Slurry Surfacing Association (ISSA)

- TB-100-18 Test Method for Wet Track Abrasion of Slurry Surfaces
- TB-109-18 Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion
- TB-113-17 Trial Mix Procedure for Slurry Seal Design
- TB-114-17 Wet Stripping Test for Cured Slurry Seal Mix
- TB-139-17 Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics
- TB-144-13 Test Method for Classification of Aggregate Filler - Bitumen Compatibility by Schulze-Breuer and Ruck Procedures
- TB-147-08 Test Methods for Measurement of Stability and Resistance to Compaction, Vertical and Lateral Displacement of Multi-layered Fine Aggregate Cold Mixes - Method A

336.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance holes, catch basins, valve chambers, and water valve covers and similar Utility access covers located within the paved portion of the roadway.

Double Application means a scratch coat placed on the existing pavement to form a uniform surface followed by a surface coat in a consistent thickness.

Micro-Surfacing means the application of a pavement surface composed of polymer-modified asphalt emulsion, high quality aggregate, mineral filler, and water.

Rut Filling means a layer of micro-surfacing placed on the existing pavement using a rut-filling box on the longitudinal wheel path rut.

Scratch Coat means a levelling layer of micro-surfacing mixture placed on the existing pavement prior to placing a surface coat.

Siliceous Aggregate means rock aggregate containing or composed of silica (SiO₂) or minerals with silica in the crystal structure as silicate (SiO₄).

Single Application means a single layer of micro-surfacing mixture placed on the existing pavement as a surface coat in a consistent thickness.

Surface Coat means a top layer of micro-surfacing mixture laid on a scratch coat or directly on the existing pavement.

336.04 DESIGN AND SUBMISSION REQUIREMENTS

336.04.01 Design Requirements

336.04.01.01 Mix Design

A laboratory equipped and staffed to carry out mix designs for micro-surfacing shall designate the mix proportions and prepare the job mix formula.

The compatibility of the aggregate and the polymer modified emulsified asphalt shall be confirmed by the laboratory designing the mix.

All component materials used in the mix design shall be representative of the material to be used on the Contract.

The mix design proportions shall be within the following limits.

Residual Asphalt:	6.0 to 11.5% by dry mass of aggregate
Mineral Filler:	0 to 3.0% by dry mass of aggregate

The micro-surfacing mixture shall be designed to carry traffic within one hour of placement.

336.04.02 Submission Requirements

336.04.02.01 Mix Design

Two weeks prior to the start of micro-surfacing, the mix design shall be submitted in writing to the Contract Administrator together with the results of the tests listed in Table 1.

Material for micro-surfacing shall only be placed after the Contract Administrator has issued confirmation in writing. The Contract Administrator shall review and issue the written confirmation within 5 Business Days that the mix design has been submitted and meets the specified requirements.

336.04.02.02 Submission of Test Data

The Contractor shall provide Quality Control (QC) test results of all aggregates and filler used in the Work from a laboratory meeting the requirements of the Laboratory Requirements clause. Test results showing complete conformance with the physical property requirements of this specification shall be provided to the Contract Administrator at the time of submission of the mix design.

QC test results shall be submitted using MTO forms as applicable.

Only aggregate sample test data obtained from stockpiled material to be used in the Work and tested within the past 14 months shall be submitted.

336.04.02.03 Laboratory Requirements

An acceptable laboratory conducting tests for physical properties or consensus properties shall be one that holds a certificate from the Canadian Council of Independent Laboratories (CCIL) as Type D for the applicable test methods and also participates in the annual MTO Proficiency Sample Testing Program.

An acceptable laboratory conducting tests for LS-601 and LS-602 shall be one that holds a valid certificate from CCIL as Type C. Testing for LS-601 and LS-602 shall be conducted by qualified laboratory staff who hold a valid certificate from CCIL in aggregate testing. Testing for LS-609 shall be conducted by a person holding a valid certificate from CCIL showing them qualified in petrographic examination.

Equivalent alternate laboratory and technician certifications or laboratory proficiency sample testing programs may be used to demonstrate similar requirements, provided they are acceptable to the Owner.

336.05 MATERIALS

336.05.01 Polymer Modified Emulsified Asphalt

The emulsified asphalt shall be CQS-1HP according to OPSS 1103.

The polymer modifier shall be a minimum of 3% polymer solids by mass of asphalt cement residue in the emulsion.

The emulsion shall be homogeneous after mixing. To facilitate sampling and testing, the emulsion shall be stable for 14 Days after delivery to the job site. The polymer material shall be milled or blended into the asphalt cement or blended into the emulsifier solution prior to the emulsification process. The addition of polymers or other additives after the manufacture of the polymer modified emulsified asphalt is not permitted.

336.05.02 Aggregates

Aggregates shall be according to OPSS 1001.

Aggregates shall meet the coarse and fine aggregate requirements of Table 2.

Aggregates shall meet the gradation requirements of Table 3.

336.05.03 Mineral Filler

Mineral filler shall be Portland cement Type GU according to OPSS 1301.

336.05.04 Water

The water shall be free from oil, acid, alkali, organic matter, or other deleterious substances.

336.05.05 Mix Additives

Additives shall be compatible with the other components of the micro-surfacing mix.

336.05.06 Tack Coat

Tack coat shall be the same polymer modified emulsified asphalt used in the micro-surfacing mix and diluted to 1 part emulsion to 3 parts water by volume.

336.06 EQUIPMENT

336.06.01 Mixing Equipment

The mixing equipment shall be specifically designed and manufactured to mix and place micro-surfacing mixture. The mixture shall be mixed by an automatic sequenced, self-propelled, continuous flow micro-surfacing mixing machine. The mixing machine shall be capable of accurately delivering and proportioning the aggregate, emulsified asphalt, mineral filler, additives, and water to a revolving multi-blade double shaft mixer and discharging the mixed product in a continuous flow. The mixing equipment shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, additives, and water to maintain an adequate supply to meet mix design proportions.

336.06.02 Proportioning Devices

Individual volume or weight controls for proportioning aggregate, mineral filler, emulsified asphalt, additives, and water to be added to the mix shall be provided and properly marked.

336.06.03 Spreading Equipment

The mix shall be spread uniformly by means of a conventional augured surfacing spreader box attached to the mixing machine and equipped with paddles to agitate and spread the mix evenly throughout the box. A front seal shall be provided to ensure no loss of the mix at the pavement contact point. The rear seal shall act as final strike-off and shall be adjustable. The spreader box and rear strike off shall be designed to ensure that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall be equipped with a suitable means to adjust the box to compensate for variations in the pavement geometry. Rut filling spreader boxes shall be specifically designed for rut filling applications.

The spreading equipment shall be capable of being re-supplied with the micro-surfacing mixture within the working lane to continuously place micro-surfacing for a minimum 2-lane-km distance. The machine shall be equipped to allow the operator to have full control of the forward and reverse speeds during application of the micro-surfacing mixture.

336.06.04 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

336.07 CONSTRUCTION

336.07.01 Operational Constraints

Micro-surfacing mixture shall be placed only when the atmospheric temperature is at least 10 °C and rising and the weather is free of fog or rain and there is no forecast of temperatures below 0 °C within 24 hours from the time of application. The mix proportions shall be adjusted when weather conditions prolong opening to traffic beyond one hour.

Micro-surfacing shall commence no earlier than May 15 and shall be completed no later than September 30.

Traffic, including construction traffic, shall be kept off the freshly placed mixture.

The centreline shall be delineated with short term pavement markings at the end of each Day of micro-surfacing. Short term pavement markings shall be according to OPSS 710.

336.07.02 Trial Area

A trial area 100 m in length and one lane wide shall be placed at the commencement of the micro-surfacing operation to demonstrate the ability to produce a surface in conformance with that meets the requirements of this specification. Within 1 hour of placement, the Contract Administrator shall inspect the Work for acceptance. The trial areas shall be repeated until the micro-surfacing meets the requirements of this specification. The location of the trial area shall be approved by the Contract Administrator.

336.07.03 Surface Preparation

The area to be surfaced shall be thoroughly cleaned using a rotary power broom to remove all sand, dirt, and other debris. Areas inaccessible to a rotary power broom shall be manually cleaned.

Existing crack sealing material shall be removed.

Existing durable pavement markings shall be removed.

Unless specified in the Contract Documents, all pavement surfaces to be micro-surfaced shall be tack coated. Where tack coating is not required, water shall be applied to the pavement surface immediately ahead of the spreader to dampen the pavement surface without allowing any free-standing or free-flowing water.

Surfaces to be tack coated shall be free of standing water and contamination, such as mud, loose aggregate, and debris. Tack coat shall be applied at a rate of 0.25 to 0.40 kg/m² as determined by the Contractor based on the condition of the existing pavement surface. Tack coating shall be allowed to cure sufficiently before micro-surfacing.

All roadway appurtenances within the area of micro-surfacing shall be properly covered and protected immediately prior to micro-surfacing.

336.07.04 Mix Application

Micro-surfacing mixture shall be placed as a scratch and surface coat (double application) or a surface coat only (single application), as specified in the Contract Documents.

Additives may be added to the micro-surfacing mix during construction to provide control of the quick-set properties and to increase adhesion.

A sufficient amount of mixture shall be carried in all parts of the spreader box at all times so that complete coverage is obtained. Water used to spray the spreader box to facilitate spreading shall not harm the mix. Lumping, balling, or unmixed aggregate shall not be permitted in the finished surface. Any oversized aggregate or foreign materials shall be screened from the aggregate prior to delivery to the mixing equipment.

The application rates for a single layer of micro-surfacing mix shall meet the requirements of Table 4.

Ruts of 13 mm or greater in depth shall be filled with micro-surfacing mixture using a rut-filling spreader box prior to micro-surfacing. Ruts greater than 25 mm in depth shall be filled with micro-surfacing mixture applied with two passes of the rut filling spreader box. All rut-filling material shall cure under traffic for at least a 24-hour period before additional material is applied. The minimum width of a rut filling micro-surfacing application shall be 1.5 metres.

When specified in the Contract Documents, micro-surfacing mixture shall be applied as a scratch coat to fill ruts less than 13 mm in depth, cracks and shallow potholes to leave a uniform surface.

336.07.04.01 Handwork

In restricted areas where hand spreading is necessary, adjustments to the mix formula may be made to retard the setting time. The mixture shall be placed along one edge of the surface to be covered and spread uniformly with squeegees or other suitable Hand Tools.

336.07.04.02 Appearance

After micro-surfacing, the surface shall have a uniform texture free from excessive scratch marks, tears, indentations, or other surface irregularities. Tear marks or other surface irregularities in any 12 m² area per lane are considered excessive if there are:

- a) four or more marks $\geq$ 12 mm wide and $\geq$ 100 mm long.
- b) any marks $\geq$ 25 mm wide and $\geq$ 25 mm long.

There shall be no transverse ripples or longitudinal streaks of 6 mm or greater in depth when measured by placing a 3 m straight edge in any direction over the finished surface.

The edges of the micro-surfaced surface shall be finished uniformly, with a neat appearance along the roadway centreline, lane lines, shoulder, pavement edge, and curb lines.

336.07.04.03 Documentation

A summary of the quantity and application rate of micro-surface material placed and a list of the quantities used for each of the mix components (i.e., aggregate, emulsified asphalt, water, mineral filler, and additive) shall be submitted daily to the Contract Administrator.

A summary of the station-to-station limits, quantity, and application rate of the tack coat shall be submitted daily to the Contract Administrator.

336.07.04.04 Joints

The longitudinal and transverse joints shall be neat and uniform in appearance, with no excessive build-up. Longitudinal joints shall be placed on lane lines.

The longitudinal joints in the scratch coat shall be constructed as a butt joint.

The longitudinal joint in the surface course shall have an overlap of 50 to 100 mm.

336.07.05 Clean Up

All areas not to be micro-surfaced, such as shoulders, ditches, and gutters, shall have the micro-surfacing mixture removed on a daily basis.

Appurtenances shall be free of micro-surfacing mixture and left in an operable condition.

336.07.06 Traffic Convoy

Traffic shall be convoyed according to the OTM, Book 7.

The pilot vehicle shall guide one-way traffic through or around construction. The maximum speed of the convoy shall be 30 km/h. Convoying shall be maintained until such time as the micro-surfacing mixture is able to carry traffic without damage.

336.07.07 Repairs

All repairs to address appearance deficiencies described in the Appearance clause shall consist of an additional application of micro-surfacing mixture for the full lane width over the length of deficiency.

The length of repair shall be sufficient to eliminate all appearance deficiencies. If the distance between repair areas is less than 3 m, then the adjacent repairs shall be treated as one repair.

336.07.08 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

336.08 QUALITY ASSURANCE

336.08.01 Sampling and Testing

Sampling shall be conducted by the Contractor according to LS-625. Quality assurance (QA) samples shall be taken from stockpiles of aggregate to be used in the Work. Sampling locations shall be determined by the Contract Administrator.

Duplicate samples shall be obtained and sealed by the Contractor in the presence of the Contract Administrator. One of the duplicate samples shall be randomly selected for testing by the QA laboratory and the remaining sealed sample shall be retained by the QA laboratory for possible referee testing. In the event that the Contractor is unavailable to take the sample, no further material shall be placed in the Work until the QA sample has been taken. Samples shall be of sufficient mass of the material to conduct the necessary gradation and physical property tests.

All QA samples shall be delivered by the Contract Administrator, within 24 hours of sampling.

Notwithstanding the requirements for QA sampling as indicated in this specification, the Owner reserves the right to obtain a QA sample at any time without notice.

336.08.01.01 Acceptance of Aggregate

If the QA test results of the aggregate sample do not meet all the requirements in this specification, the material shall be considered rejectable and shall not be used in the Work.

336.08.01.02 Referee Testing of Aggregate

The Contractor may invoke referee testing by submitting a written request to the Contract Administrator, within 5 Business Days following notification that a sample does not meet the requirements of this specification.

The retained QA aggregates sample shall be used for referee testing.

In the event the referee testing result shows the sample does not meet the requirement of this specification, the Contractor shall be responsible for the cost of the referee testing, including the cost of transporting the samples to the referee laboratory.

336.08.02 Warranty Requirements

336.08.02.01 Warranty Period

The warranty period shall be 24 months from the date of Contract Completion.

336.08.02.02 Distress Survey

A distress survey will be completed by the Owner one year from the date of Contract Completion according to the severity and density definitions provided in SP-024. A second distress survey will be completed a minimum of 45 Days prior to the end of the warranty period. The results of both surveys shall be sent to the Contractor.

If the Owner determines that any distresses found pose a hazard to the travelling public at any time during the warranty period, the Contractor shall be required to make the repairs according to this specification within 2 weeks of being notified to the approval of the Owner.

336.08.02.03 Performance Requirements

At the end of the warranty period, the surface shall be free from any aggregate loss or ravelling that is slight to very severe and from flushing that is moderate to very severe. The density of flushing that is very slight to slight shall not be greater than intermittent.

If the surface does not meet the performance requirements, the applicable repairs or replacement methods specified in Table 5, shall be completed within 30 days. Acceptance of the areas being repaired or replaced shall be at the sole discretion of the Contract Administrator.

The length of repair shall be sufficient to eliminate all surficial defects as described. If the distance between repair areas is less than 3 m, then the adjacent repairs shall be treated as one repair.

336.09 MEASUREMENT FOR PAYMENT

336.09.01 Actual Measurement

336.09.01.01 Micro-Surfacing Type II Micro-Surfacing Type III Modified Micro-Surfacing Type III

Measurement of the micro-surfacing mixture placed shall be by area in square metres.

336.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

336.10 BASIS OF PAYMENT

336.10.01 Micro-Surfacing Type II - Item Micro-Surfacing Type III Modified - Item Micro-Surfacing Type III - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

336.10.02 Trial Area

The accepted trial area shall be paid for at the Contract unit price for micro-surfacing. All costs associated with repairing and replacing unacceptable trial areas shall be at no additional cost to the Owner.

TABLE 1
Mix Design Requirements

Test Method	Description	Requirements
ISSA TB-139	Wet cohesion - @ 30 minutes min. (Set) - @ 60 minutes min. (Traffic)	12 kg-cm minimum 20 kg-cm minimum
ISSA TB-109	Excess asphalt by LWT (load wheel test) sand adhesion	538 g/m ² maximum
ISSA TB-114	Wet stripping	90% minimum
ISSA TB-100	Wet track abrasion loss-one hour soak	538 g/m ² maximum
	Loss-six day soak	807 g/m ² maximum
ISSA TB-147 Method A	Lateral displacement	5% maximum
	Specific gravity after 1000 cycles of 57 kg	2.10 maximum
ISSA TB-144	Classification compatibility by S-B-R test	(AAA, BAA) 11 Grade Points minimum
ISSA TB-113	Mix time @ 25 °C	Controllable to 120 seconds minimum

TABLE 2
Micro-Surfacing Coarse and Fine Aggregates Requirements

Micro-Surfacing Type	Application (Note 1)	Physical Requirements as Specified in OPSS 1003
II	Low Traffic Volume	Superpave 12.5 (Note 2)
II	High Traffic Volume	Superpave 12.5 FC2
III Modified	High Traffic Volume	Superpave 12.5 FC2
III	High Traffic Volume	Superpave 12.5 FC2

Notes:

- 1) Low Traffic Volume: AADT < 2,500 per lane
High Traffic Volume: AADT ≥ 2,500 per lane
- 2) Aggregates meeting the physical requirements of Superpave 12.5 aggregates shall be produced from quarried bedrock consisting of 100% siliceous aggregate determined in accordance with LS-609.

TABLE 3
Gradation Requirements

Percent Passing, LS-602			
MTO Sieve Designation	Micro-Surfacing Type II	Micro-Surfacing Type III Modified	Micro-Surfacing Type III
9.5 mm	100	100	100
6.7 mm	--	95-100	--
4.75 mm	90-100	80-95	70-90
2.36 mm	65-90	50-75	45-70
1.18 mm	45-70	33-55	28-50
600 µm	30-50	25-40	19-34
300 µm	18-30	15-30	12-25
150 µm	10-21	7-20	7-18
75 µm	5-15	5-15	5-15

TABLE 4
Micro-Surfacing Single Layer Application Rates

Micro-Surfacing Type	Application Rate kg/m²
Type II	5 to 11
Type III and Type III Mod	8 to 16

TABLE 5
Micro-Surfacing Repair and Replacement Methods

Surface Defects (Note 1)	Severity	Density	Repair/Replacement Method
Flushing	Very slight to slight	Frequent to throughout	Resurface with one layer of micro-surfacing for a full lane width
	Moderate to very severe	Few to throughout	Removal by milling of all flushed areas for a full lane width and replace with two layers of micro-surfacing.
Aggregate Loss / Ravelling	Slight to moderate	Few to throughout	Resurface with one lift of micro-surfacing for a full lane width.
	Severe to very severe	Few to throughout	Fill in delaminations/potholes with micro-surfacing and resurface with two layers of micro-surfacing.
Note: 1) Surface defect definitions according to SP-024.			



CONSTRUCTION SPECIFICATION FOR SLURRY SEAL

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337.01 SCOPE

This specification covers the requirements for slurry seal and includes all surface preparation, material application, handwork, joints, protection while curing, clean up, and provision for a trial area.

337.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1003	Aggregates - Hot Mix Asphalt
OPSS 1103	Emulsified Asphalt
OPSS 1301	Cementing Materials
OPSS 1302	Water

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS 602 - Sieve Analysis of Aggregates

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions

ASTM International

D 3910-15 Standard Practices for Design, Testing and Construction of Slurry Seal

International Slurry Surfacing Association (ISSA)

TB 106-90	Measurement of Slurry Seal Consistency
TB 109-2005	Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion
TB 114-90	Wet Stripping Test for Cured Slurry Seal Mix
TB 115-90	Determination of Slurry System Compatibility
TB 139-90	Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics

337.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Appurtenances mean maintenance holes, catch basins, valve chambers, and water valve covers and similar Utility access covers located within the paved portion of the roadway.

Slurry Seal means a homogeneous mixture of emulsified asphalt, fine aggregates, water, mineral filler, and, if required, additive. This mixture is applied in a cold fluid state on a prepared bituminous surface.

337.04 DESIGN AND SUBMISSION REQUIREMENTS

337.04.01 Design Requirements

A laboratory that is equipped and staffed to carry out slurry seal mix designs with, as a minimum, a current CCIL Type C Certification or an equivalent laboratory shall designate the mix proportions and prepare the job mix formula.

The compatibility of the aggregate and the emulsified asphalt shall be confirmed by the laboratory designing the mix.

All component materials used in the mix design shall be representative of the material to be used on the Contract.

Slurry seal shall only be placed after the Contract Administrator has issued confirmation in writing that the mix design has been reviewed and meets the specified requirements.

The mix design proportions shall be within the following limits:

Residual Asphalt:

Slurry Seal - Type I	10 to 16% by dry mass of aggregate
Slurry Seal - Type II	7.5 to 13.5% by dry mass of aggregate
Slurry Seal - Type III	6.5 to 12% by dry mass of aggregate

Mineral Filler:

0.5 to 2.0% by dry mass of aggregate

The slurry seal material shall be designed to carry traffic within 4 hours of placement unless specified in the Contract Documents.

337.04.02 Submission Requirements

337.04.02.01 Mix Design

Two weeks prior to the start of the slurry seal operation, the mix design shall be submitted in writing to the Contract Administrator together with the results of the tests listed in Table 1.

337.05 MATERIALS

337.05.01 Emulsified Asphalt

The emulsified asphalt shall be specially designed for slurry seal work and shall meet the requirements of OPSS 1103.

337.05.02 Aggregates

The aggregates shall be according to Table 2 and OPSS 1001. The aggregate shall meet the physical requirements of Superpave 12.5 mix for the traffic category specified in the Contract Documents according to OPSS 1003, except that the maximum absorption for coarse aggregate shall not be more than 1.75%.

337.05.03 Mineral Filler

Mineral filler shall be Portland cement, Type GU, according to OPSS 1301.

337.05.04 Water

The water shall be free of harmful salts and contaminants.

337.05.05 Mix Additives

Additives may be added to the slurry seal mix during construction to provide control of the quick-set properties and to increase adhesion. Additives shall be compatible with the other components of the slurry seal mix.

337.05.06 Tack Coat

Tack coat shall be the same emulsified asphalt used in the mix and diluted to 1 part emulsion to 3 parts water by volume.

337.06 EQUIPMENT

337.06.01 Rotary Power Brooms

Rotary power brooms shall be capable of cleaning gravel, sand, dirt and other debris from the roadway surfaces.

337.06.02 Mixing and Spreading Equipment

Mixing equipment shall be specifically designed and manufactured to mix slurry seal material.

Spreading equipment shall be designed to apply a fine mist of water on the road surface immediately prior to placement of slurry seal.

The spreading equipment shall also have a spreader box and rear strike-off and be designed and operated to ensure that a uniform consistency is achieved and to produce a free flow of material to the rear strike-off. The spreader box shall be equipped with a suitable means to adjust the box to compensate for variations in the pavement geometry. The spreader box shall be capable of spreading slurry in one pass at varying widths up to 4.3 m.

337.06.03 Proportioning Devices

Individual volume or weight controls for proportioning aggregate, mineral filler, emulsified asphalt, additives, and water to be added to the mix shall be provided and properly marked.

337.06.04 Pilot Vehicle

Pilot vehicles used to control traffic shall be according to OTM, Book 7.

337.07 CONSTRUCTION

337.07.01 Operational Constraints

Slurry seal shall be placed only when the atmospheric temperature is at least 10 °C and rising and the weather is free of fog or rain and there is no forecast of temperatures below 0 °C within 24 hours from the time of application.

Slurry seal shall commence no earlier than May 15 and shall be completed no later than September 30.

Traffic, including construction traffic, shall be kept off the freshly placed mixture to prevent damage to the surface.

337.07.02 Trial Area

A trial area 100 m in length and one lane wide shall be placed at the commencement of the slurry seal operation, to demonstrate the ability to produce slurry seal according to this specification. Within 4 hours of placement, the Contract Administrator shall inspect the slurry seal for conformance. The trial area shall be repeated until the slurry sealing meets the requirements of this specification. The location of the trial area shall be approved by the Contract Administrator.

337.07.03 Surface Preparation

The surface upon which slurry seal is placed shall be clean and dry at the time of application. The area to be surfaced shall be thoroughly cleaned using a rotary power broom. Areas inaccessible to the rotary power broom shall be cleaned manually.

Existing durable pavement markings shall be removed except at those locations specified in the Contract Documents.

When specified in the Contract Documents, all existing pavement surfaces to receive slurry seal shall be tack coated. Surfaces to be tack coated shall be free of standing water and contamination, such as mud, loose aggregate, and debris. Tack coat shall be applied at a rate of 0.25 to 0.40 kg/m² as determined by the Contractor based on the condition of the existing pavement surface. Tack coating shall be allowed to cure sufficiently before application of slurry seal.

All roadway appurtenances within the area to receive slurry seal shall be properly covered and protected immediately prior to the placement of the slurry seal.

337.07.04 Mixture Application

Slurry seal shall be placed according to the application rates specified in Table 3.

337.07.05 Handwork

Areas which cannot be reached with the slurry seal spreading equipment shall be surfaced using hand squeegees to provide complete and uniform slurry seal coverage. The area to be hand worked shall be lightly dampened prior to slurry seal placement and the slurry seal applied concurrent with adjacent machine applied slurry seal.

337.07.06 Appearance

Following placement, the slurry seal shall have a uniform texture and consistent appearance, and be free from excessive scratch marks, tears, indentations, or other surface irregularities. Tear marks in any 12 m² area per lane are considered excessive if there are:

- a) Four or more marks ≥ 12 mm wide and ≥ 100 mm long
- b) Any marks ≥ 25 mm wide and ≥ 25 mm long

There shall be no longitudinal ripples, raking, wash-boarding, chatter, or other irregularities that affect the ride quality.

The edges of the slurry seal shall be finished uniformly, with a neat appearance along the roadway centreline, lane lines, shoulder, pavement edge, and curb lines.

337.07.07 Documentation

A summary of the quantity and application rate of slurry seal placed and a list of the quantities used for each of the slurry seal components (i.e., aggregate, emulsified asphalt, mineral filler, and additive) shall be submitted daily to the Contract Administrator.

337.07.08 Joints

The longitudinal and transverse joints shall be neat and uniform in appearance with no excessive build-up. Longitudinal joints shall be placed on lane lines.

The longitudinal joint in the surface course shall have an overlap of 50 to 100 mm.

337.07.09 Clean Up

All areas not to be slurry sealed, such as shoulders, ditches, and gutters, shall have the slurry seal material removed on a daily basis. Appurtenances shall be free of slurry seal and left in operable condition.

337.07.10 Repairs

Damaged slurry sealed surfaces shall be repaired by the Contractor.

Repairs to address appearance deficiencies described in the Appearance subsection shall consist of an additional application of slurry seal for the full lane width over the length of deficiency.

The length of repair shall be sufficient to eliminate all appearance deficiencies. If the distance between repair areas is less than 3 m, these repair areas shall be treated as one continuous repair.

337.07.11 Traffic Control with Moving Vehicles

When specified in the Contract Documents, traffic shall be controlled with moving vehicles according to OTM, Book 7.

The moving vehicles shall guide one-way traffic through or around construction. The maximum speed of the moving vehicles shall be 30 km/h. Traffic control with moving vehicles shall be maintained until such time as the slurry seal is able to carry traffic without damage.

337.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

337.08 QUALITY ASSURANCE

337.08.01 Sampling

The aggregate shall be stockpiled 2 weeks prior to construction for sampling and testing. Samples for gradation testing shall be taken from the stockpile as determined by the Contract Administrator.

337.09 MEASUREMENT FOR PAYMENT

337.09.01 Actual Measurement

337.09.01.01 Slurry Seal - Type I Slurry Seal - Type II Slurry Seal - Type III

Measurement of the slurry seal placed shall be by area in square metres with no deductions for appurtenances.

337.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

337.10**BASIS OF PAYMENT****337.10.01**

Slurry Seal - Type I - Item
Slurry Seal - Type II - Item
Slurry Seal - Type III - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Repair, removal, disposal, and replacement of any damaged or defective slurry seal shall be at no additional cost to the Owner.

The accepted trial area shall be paid for at the tender unit price for slurry seal. All costs associated with unacceptable trial areas shall be borne by the Contractor at no additional cost to the Owner.

TABLE 1
Mix Design Requirements

Test Method	Description	Requirements	
		Minimum	Maximum
ISSA TB-106	Slurry Seal Consistency, cm	2	3
ISSA TB-109	Excess Asphalt, g/m ²	---	540
ISSA TB-114	Wet Stripping, % Retained Coating	90	100
ISSA TB-115	Compatibility	Pass Tests (Note 1)	
ASTM D 3910	Wet Track Abrasion, g/m ²	---	800
ISSA TB-139	Set and Cure Characteristics		
	Set Time	12 kg-cm minimum @ 30 minutes	
	Traffic Time	20 kg-cm or near spin minimum @ 240 minutes or less (Note 2)	
Note:			
1. Mixing tests must pass at the maximum expected air temperature.			
2. Time to carry traffic other than 240 minutes as specified in the Contract Documents.			

TABLE 2
Slurry Seal Aggregate Gradation Requirements, LS-602

MTO Sieve Designation	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
9.5 mm	100	100	100
4.75 mm	100	90 - 100	70 - 100
2.36 mm	90 - 100	65 - 90	45 - 70
1.18 mm	65 - 90	45 - 70	28 - 50
600 µm	40 - 65	30 - 50	19 - 34
300 µm	25 - 42	18 - 30	12 - 25
150 µm	15 - 30	10 - 21	7 - 18
75 µm	10 - 20	5 - 15	5 - 15

TABLE 3
Slurry Seal Application Rates

Slurry Seal Type	Application Rate kg/m²
Type I	4.3 to 6.5
Type II	5.4 to 9.8
Type III	8.1 to 12.0



CONSTRUCTION SPECIFICATION FOR ROUTING AND SEALING CRACKS IN ASPHALT PAVEMENT

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341.01 SCOPE

This specification covers the requirements of sealing cracks and joints with hot-poured rubberized asphalt joint/crack sealant compound in asphalt pavement.

341.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1212 Hot-Poured Rubberized Asphalt Joint/Crack Sealant Compound

Ontario Ministry of Transportation Publications

SP-024 Manual for Condition Rating of Flexible Pavements – Distress Manifestations

341.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Overband means a routed groove or unrouted crack, which is sealed in such a way that the surface of the sealant is approximately 2 to 3 mm above the adjacent asphalt pavement surface at the centerline of the routed groove or unrouted crack and is feathered out to 0 mm, approximately 20 to 30 mm on either side of the routed groove or the edge of the unrouted crack.

Pavement Edge means where the outside edge of the asphalt pavement surface meets the gravel shoulder or concrete barrier.

Routing/Routed means cutting grooves in an asphalt pavement using either a router equipped with carbide cutting wheels or a random crack saw equipped with a series of diamond blades.

Skew Cracks means non-transverse cracks that exist within the lane and may cross pavement edge.

341.04

DESIGN AND SUBMISSION REQUIREMENTS

341.04.01

Submission Requirements

The following shall be submitted to the Contract Administrator at least 5 Business Days prior to the placement of sealant compound:

- a) The following sealant compound information obtained from the manufacturer for every batch/lot of sealant compound which is likely to be used on the Contract:
 - i) The batch number/lot or designation;
 - ii) The size of the batch/lot;
 - iii) Application recommendations;
 - iv) Recommended heating time and temperature;
 - v) Allowable storage time and temperature after initial heating;
 - vi) Allowable reheating criteria;
 - vii) Recommendations for continuous overnight heating, if the manufacturer allows such heating;
 - viii) Application temperature range.
- b) One copy of at least one set of test results that have been conducted for each batch of hot-poured rubberized asphalt joint/crack sealant compound used on the Contract. The testing shall be carried out according to OPSS 1212 by a certified Canadian Council of Independent Laboratories (CCIL) laboratory that is independent of both the manufacturer and the Contractor.

341.05

MATERIALS

341.05.01

Sealant Compound

The sealant compound shall be a hot poured rubberized asphalt sealant compound according to OPSS 1212.

341.05.02

Limestone Screenings

Limestone screenings used for dusting sealant shall have 100 percent passing the 1.18 mm sieve and not greater than 25 percent passing the 0.075 sieve. Other blotting materials may be used with written approval from the Contract Administrator.

341.06 EQUIPMENT

341.06.01 Routers and Random Crack Saws

All equipment used for routing shall consist of well-maintained mechanical routers or random crack saws capable of continually creating well-defined right-angled grooves with centrelines which are approximately coincident with the centerlines of their associated cracks to the tolerances stated within this specification. Such capability shall be successfully demonstrated to the Contract Administrator's satisfaction prior to its use.

341.06.02 Heating Kettle

The heating kettle for the sealant compound shall be a double boiler oil transfer type with built in agitator and equipped with calibrated thermometers to measure the temperature of both the heat transfer oil and the sealant compound. The heating kettle shall be equipped with a spigot.

The heating kettle shall have automatic thermometric controls used to prevent the overheating of the sealant compound.

341.06.03 Hot-Compressed Air Lance

The hot-compressed air lance shall have an air discharge temperature of approximately 500° C and an air exit velocity of at least 1000 metres per second.

341.06.04 Air Compressor

The air compressor used to supply the hot-compressed air lance shall be equipped with oil and moisture filters and providing a minimum pressure of 700 kPa at a minimum air volume of 4.25 cubic metres per minute (150 cubic feet per minute).

341.07 CONSTRUCTION

341.07.01 General

Routing and/or sealing shall not be carried out when the pavement is damp or wet, when water is migrating up into the routs or when the pavement surface temperature is greater than 50° C.

The conditions under which cracks shall be routed and sealed or sealed without routing, are specified elsewhere in the Contract Documents and based on the average widths of the cracks at the time that the work is done.

341.07.02 Crack Routing

Under no circumstances shall more cracks be routed during the day than can be sealed prior to shutting down operations each Day.

In addition, the routing operation shall not be so far ahead of the cleaning operation that dirt and debris left on the road is creating clouds of dust which is obscuring driver vision in adjacent traffic.

Cracks shall not be routed in locations where the centerlines of two or more parallel or sub-parallel cracks are within 75 mm of one another or the cracks are associated with alligator or map cracking as described in SP-024.

All transverse and skewed cracks shall be routed to within 25 mm of the pavement edge.

The corners of all routed grooves shall be right-angled with no more than 10° of deviation from one corner to the other and with its centreline no more than 4 mm from the centreline of its associated crack.

Any portion of a crack that meanders outside of the cross section of a routed groove shall be considered unacceptable for payment purposes.

When it cannot be demonstrated to the satisfaction of the Contract Administrator that the specified dimensions and shape of the routed groove can be maintained, then the equipment being used shall be adjusted and/or replaced so that the shape and dimensions of the routed groove meet all specified tolerances. All carbide cutters in the router's cutting head shall be replaced at the completion of 2500 linear metres of routing. The Contract Administrator shall be notified prior to the correction of all equipment used for routing.

Two or more cracks shall not be joined up by routing through pavement that is not cracked and under no circumstances shall grooves be cut in areas where a crack does not exist.

341.07.03 Sealant Preparation

The sealant compound shall be slowly melted with constant agitation until it is in a lump-free, free-flowing state, within the application temperature range recommended by the manufacturer for application.

Temperature gauges for both the heating oil and sealant compound on the kettle melter shall be properly calibrated at all times.

The Contract Administrator shall be informed at least 24 hours prior to the charging of the kettle with sealant compound. The initial charge of sealant shall be placed in an empty kettle at the work site in the presence of the Contract Administrator.

341.07.04 Cleaning and Drying Routed Grooves and Cracks and Removal of Debris

Immediately prior to placing the sealant compound, all routed grooves, all unrouted cracks and the surface of the asphalt 50 mm on either side of the grooves and unrouted cracks where an overband is to be constructed, shall be cleaned and dried using a hot compressed air lance. The use of a hot compressed air lance shall not result in the charring or burning of the asphalt surface.

Hot compressed air shall be applied to ensure that all moisture and loose debris have been removed and fractured aggregate surfaces have been scaled from all routed grooves or unrouted cracks.

Before applying sealant compound, all loose debris from the routing and cleaning operation shall be completely removed from the adjacent asphalt roadway.

341.07.05 Placing Sealant Compound

341.07.05.01 General

After each routed or unrouted crack has been cleaned and dried, hot-poured rubberized asphalt sealant compound shall be uniformly placed without the formation of entrapped air, using either a manual pouring cone filled from a spigot located on the heating kettle itself or by using a hose and wand fitted with the proper sized shoe which allows the sealant compound to be pumped directly from the heating kettle into the routed or unrouted crack. Sealant compound shall only be placed if the pavement temperature at the surface is less than or equal to 50° C.

341.07.05.02 On Surfaces to Receive an Asphalt Overlay

For pavements which are being covered with an asphalt overlay all routed and unrouted cracks shall be immediately filled after cleaning and drying with sealant compound as specified in the Contract Documents.

For all existing pavements that are not being covered with an asphalt overlay, all routed and unrouted transverse or skewed cracks as well as any unrouted longitudinal cracks within 150 mm of the pavement edge shall be immediately filled with sealant compound after cleaning and drying so that upon complete cooling, the sealant compound forms a well-defined overband as specified in the Contract Documents.

All routed longitudinal cracks shall be immediately filled with sealant compound after cleaning and drying so that upon complete cooling, the sealant compound is at or slightly above the adjacent asphalt pavement surface, as specified in the Contract Documents.

Where an overband is being constructed, a rubber or plastic squeegee with its bottom edge trimmed slightly larger than the specified dimensions of the overband shall be used to strike off the sealant compound after it is poured into the routed or unrouted transverse or skewed crack.

For routed or unrouted transverse or skewed cracks, the sealant compound shall be struck off by starting from the end of the routed groove or unrouted crack closest to the pavement edge and working towards the center of the road.

Upon complete cooling of the sealant to the ambient temperature, the minimum elevation of the sealant compound shall, in all cases, shall be at or above the adjacent asphalt pavement surface as specified in the Contract Documents. If, during the application the sealant compound is contracting such that this requirement is not likely to be met, then sealant compound shall be applied as many times as is necessary to meet this requirement, before being dusted.

Before leaving the site at the end of each day, the heating kettle shall be completely drained of any remaining sealant compound. However, if a situation arises and the work has to stop before the sealant has been completely used, then the Contract Administrator may require that all remaining sealant be drained from the kettle. In this case, the Contract Administrator shall be informed when the kettle is being drained to allow the Contract Administrator sufficient opportunity to witness it.

Under no circumstances shall the sealant compound be heated continuously overnight without providing the Contract Administrator with a written declaration from the manufacturer clearly stating under what conditions this can be safely done without causing degradation of the sealant. If this written declaration has not been provided to the Contract Administrator and the heating kettle is not completely empty at the beginning of any Day, then the Contract Administrator may require that the heating kettle be completely drained and the wasted sealant compound be replaced before continuing work on the Contract.

At least once each hour, the temperature of the sealant compound shall be measured in the presence of the Contract Administrator using a calibrated thermometer and recorded along with the date and time of the measurement. The temperature record shall be made available to the Contract Administrator upon request.

If, at any time the Contract Administrator finds that the temperature of the sealant compound is not within the manufacturer's recommended range, then, at the discretion of the Contract Administrator, sealant compound that was placed in the roadway since the last acceptable temperature that was verified by the Contract Administrator shall either be removed, repaired or, in lieu of repairs, the affected sealed cracks shall receive a payment adjustment as specified in the Basis of Payment section. If the sealant has been overheated, then any sealant compound remaining in the heating kettle shall be rejected, and drained out and replaced with acceptable material. All rejected sealant compound shall be removed from the Working Area.

Sealant compound damaged by construction operation and any damage caused by the lane being opened to traffic before the sealant has sufficiently cooled, shall be removed and replaced.

341.07.06 Sealant Dusting For Cracks/Routs Treated in Pavements Not Being Covered by an Asphalt Overlay

Where traffic is to be maintained during crack sealing, the surface of the sealant shall be dusted with limestone screenings prior to allowing any traffic, including construction vehicles, on the sealed cracks. Portland cement shall not be used.

At all locations, the sealant compound shall be dusted only after it has cooled so that the final elevation of the sealant compound is at or slightly above the pavement surface as specified in the Contract Documents and, a skin has formed on the sealant which is tacky enough to allow the dust to stick to it.

341.07.07 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

341.08 QUALITY ASSURANCE

341.08.01 Sampling and Testing Sealant Compound

341.08.01.01 Unheated (as Delivered) Sealant Compound

When requested by the Contract Administrator, the Contractor shall provide samples of batches of sealant compound used on the Contract. Each sample shall be approximately 4 litres in volume. All samples of unheated sealant compound shall be placed in security bags, sealed with security seals in the presence of the Contract Administrator, and delivered in a suitable box, clearly marked with the sampling identification information, as specified elsewhere in the Contract Documents, along with the following additional information:

- a) The designated trade name and designation # of the compound;
- b) The manufacturer;
- c) The manufacturer's batch number; and
- d) The size of the applicable batch.

Samples shall be delivered to the following address:

Bituminous Section
Ontario Ministry of Transportation
Room 15,
145 Sir William Hearst Avenue
Downsview, Ontario M3M 0B6

341.08.01.02 Samples during Sealant Placement

The Contractor at the direction of and in the presence of the Contract Administrator shall take samples of hot-poured rubberized asphalt joint/crack sealant compound directly from the heating kettle, while the sealant compound is being placed,. A minimum of either three samples at points when approximately 1/4, 1/2, and 3/4 of the tender quantity number of linear metres has been placed or a minimum of one sample for each 25,000 linear metres placed, whichever is greater, shall be taken. Additional samples shall be taken when requested by the Contract Administrator.

Each sample shall be placed in a triple-tight single metal container (e.g. paint can) with a wire handle and with a minimum volume of 4 litres. The side and top of each metal container shall be clearly marked with the following information:

- a) Contract number;
- b) Designated trade name and designation # of the compound;
- c) Manufacturer;
- d) Manufacturer's batch number; and
- e) The point in the Contract at which the sample was taken, e.g., the percentage of the work completed.

An accompanying tag shall also be firmly affixed to the wire handle of the metal container showing all of the sampling identification information listed above, all other sampling information specified elsewhere in the Contract Documents as well as the following additional information:

- a) The station and offset in the roadway where the sample was taken;
- b) The temperature of the sealant compound when the sample was taken; and the
- c) Weather conditions (ambient temperature and precipitation).

The samples shall be delivered to the following address:

Bituminous Section
Ontario Ministry of Transportation
Room 15,
145 Sir William Hearst Avenue
Downsview, Ontario, M3M 0B6

341.08.02 Deficiencies and Repairs during Construction

If any of the deficiencies listed under various categories in Table 1 are found during construction, then, at the discretion of the Contract Administrator, the sealed crack or routed groove shall be repaired by the Contractor as specified or, in lieu of repairs, a payment adjustment shall be applied as specified in the Basis of Payment section.

A repair proposal shall be submitted to the Contract Administrator for all repairs. Repairs shall not commence until approval of the proposal has been received from the Contract Administrator.

Any materials, equipment or procedures used in the repair or replacement of routing and sealing shall be the same as those specified for the original work.

341.09 MEASUREMENT FOR PAYMENT

341.09.01 Actual Measurement

Where a crack is being routed and sealed, measurement for payment shall be in linear metres along the sealed crack, but excluding any portions of the sealed crack where the crack migrates away from the routed groove.

Where a crack is being sealed without routing, measurement for payment shall be in linear metres along the sealed crack.

Separate measurements shall be made for:

- a) Cracks that are routed and sealed with no deficiencies (i.e. L1);

- b) Cracks that are routed and sealed that are deficient, as specified in Table 1, but are left unrepaired (i.e. L2);
- c) Cracks that are sealed without routing and with no deficiencies (i.e. L3); and
- d) Cracks that are sealed without routing that are deficient, as specified in Table 1, but are left unrepaired (i.e. L4).

341.09.02 Plan Quantity

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

341.10 BASIS OF PAYMENT

The removal, disposal, and/or replacement of any sealant, according to the Contract Documents, shall be at no additional cost to the Owner.

341.10.01 Routing and Sealing Cracks in Asphalt Pavement – Item

Payment at the Contract price for routing and sealing cracks shall be full compensation for all labour, Equipment and Material required to do the work. No additional payment shall be made for overruns in sealant compound quantity.

341.10.01.01 Payment Adjustment

When the Contract Administrator allows a payment adjustment in lieu of repairs for a routed and sealed crack which exhibits one or more of the deficiencies listed in Table 1, then a payment reduction of 50% of the Contract price shall be applied for each linear metre exhibiting such deficiencies.

Payment for routed and sealed cracks shall be made in accordance with the following equation:

$$(1) \quad \text{Payment} = \text{Contract Price} \times (L1 + 0.5 \times L2)$$

Where: Contract Price = the Contract price for this tender item

L1 = the total length in linear metres of the measured cracks that are routed and sealed with no deficiencies;

L2 = the total length in linear metres of measured cracks that are routed and sealed but are deficient, as specified in Table 1 and are left unrepaired.

341.10.02 Sealing Cracks in Asphalt Pavement– Item

Payment at the Contract price for sealing cracks without routing shall be full compensation for all labour, Equipment and Material required to do the work. No additional payment shall be made for overruns in sealant compound quantity.

341.10.02.01 Payment Adjustment

When the Contract Administrator allows a payment adjustment in lieu of repairs for a crack that is sealed without routing and exhibits one or more of the deficiencies listed in Table 1, then a payment reduction of 50% of the Contract price shall be applied for each linear metre exhibiting such deficiencies.

Payment for cracks that are sealed without routing shall be made in accordance with the following equation:

(2) $\text{Payment} = \text{Contract Price} \times (\text{L3} + 0.5 \times \text{L4})$

Where: Contract Price = the Contract price for this tender item

L3 = the total length in linear metres of the measured cracks that are sealed without routing and have no deficiencies;

L4 = the total length in linear metres of measured cracks that are sealed without routing but are deficient, as specified in Table 1 and are left unrepaired.

Table 1
Deficiencies and Repairs during Construction

Categories	Deficiencies	Repairs
Routed Groove	a) Two intersecting sides deviating by more than 10° from a right-angle. b) Its centerline more than 4 mm from the centerline of its associated crack. c) A width less than 36 mm or more than 44 mm. d) A depth less than 10 mm or more than 12 mm, when the groove is in a pavement not being covered by an asphalt overlay. e) A depth less than 15 mm or more than 19 mm, when the groove is in a pavement that is being covered with an asphalt overlay.	Remove sealant and reroute groove to no more than 50 mm wide, clean and then seal. or Re-route to no more than 50 mm wide, clean, and then re-seal.
Sealant Compound Material Used	a) Does not meet the material quality requirements specified in the Contract Documents. b) Contains: i. imbedded foreign material (other than limestone screenings) ii. entrained bubbles c) Has debonded or pulled away from the routed, unrouted sealed crack d) Has been excessively heated.	Complete removal and replacement of the sealant compound and pickup and disposal of any debonded or pulled away sealant compound. Note: If removal of the sealant damages the rout or deficiencies are identified with the rout cross section, the Contract Administrator may instruct that the crack be re-routed.
Pavement not being covered with an asphalt overlay after Sealing.	Upon complete cooling: a) Sealant compound is no longer above the pavement surface when an overband is specified. b) Sealant compound has subsided by more than 1 mm below the adjacent pavement surface when an overband is not specified.	The method of repair for unacceptable contraction of the sealant compound below the elevation of the pavement surface within an unrouted or routed sealed crack shall be at the direction of the Contract Administrator and, depending upon the condition of the sealant compound, may involve either: a) Washing and cleaning the existing sealant compound of debris from the top of the rout with clean water using a low-pressure washer and then topping-up with sealant compound when completely dry; or b) Complete removal and replacement of the sealant compound.
Pavement being covered with an asphalt overlay after Sealing.	a) Upon complete cooling, subsided to more than 7 mm below the existing pavement surface.	



CONSTRUCTION SPECIFICATION FOR THE GRINDING OF CENTRELINE AND SHOULDER RUMBLE STRIPS IN ASPHALT

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APPENDICES

342 -A	Commentary

342.01 SCOPE

This specification covers the requirements for the installation of centreline rumble strips (CRS) into the surface course of asphalt pavement, and the grinding of shoulder rumble strips (SRS) into the surface course of fully or partially paved asphalt shoulders.

342.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

342.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

342.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 313	Hot Mix Asphalt – End Result
OPSS 510	Removal
OPSS 710	Pavement Marking

342.06 EQUIPMENT

The construction equipment shall employ a rotary type cutting head capable of installing rumble strips with a smooth surface to the lines and dimensions as specified in the Contract Documents.

342.07 CONSTRUCTION

342.07.01 General

Centreline rumble strips (CRS) shall be installed at the centreline of the highway as specified in the Contract Documents.

Shoulder rumble strips (SRS) shall be installed at the partially paved asphalt shoulder or fully paved asphalt shoulder as specified in the Contract Documents.

The pavement surface shall be cleaned and all debris shall be disposed of as specified elsewhere in the Contract Documents.

342.07.02 Placement

Centreline rumble strips and SRS shall not be placed within 200 mm of routed and filled transverse joints.

Centreline rumble strips shall be installed prior to the final pavement markings being placed.

Shoulder rumble strips shall be installed after the final pavement markings have been placed. Any damage to the final pavement markings shall be repaired according to OPSS 710.

Where SRS are installed in conjunction with a bicycle buffer zone, the SRS shall be installed prior to the placement of the outer pavement marking edge line.

342.07.03 Tolerances

Tolerances for the width and depth of each rumble strip groove shall be as specified in the Contract Documents. If any one of these tolerances is exceeded in more than two grooves within a one metre length section, the section shall be rejected.

Rejected sections shall be repaired or assessed a payment reduction as directed by the Contract Administrator.

Rejected sections shall be repaired by partial depth asphalt removal according to OPSS 510, replacement of the hot mix asphalt according to OPSS 313, the reinstallation of rumble strips according to this specification, and reinstatement of damaged pavement markings according to OPSS 710. The depth of the partial depth removal shall be 50 mm and the width shall be 500 mm centred over the rumble strip. However, when this will result in a narrow remaining width of asphalt pavement on either side that is less than 300 mm, the removal width shall be extended to include the narrow width of asphalt pavement.

342.09 MEASUREMENT FOR PAYMENT

342.09.01 Actual Measurement

342.09.01.01 Shoulder Rumble Strips - Asphalt Centreline Rumble Strips – Asphalt Shoulder Rumble Strips for Bicycle Buffer Zone - Asphalt

Measurement of rumble strips shall be by horizontal length in metres in which the CRS or SRS have been placed.

342.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

342.10 BASIS OF PAYMENT

**342.10.01 Shoulder Rumble Strips - Asphalt – Item
Centreline Rumble Strips- Asphalt - Item
Shoulder Rumble Strips for Bicycle Buffer Zone – Asphalt - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Appendix 342-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONCRETE PAVEMENT AND CONCRETE BASE

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350.01 SCOPE

This specification covers the requirements for the construction of concrete pavement and concrete base.

350.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 366	Repairing Concrete Pavement and Concrete Base
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base
OPSS 904	Concrete Structures
OPSS 919	Formwork and Falsework
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1302	Water
OPSS 1306	Burlap
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

OPSS 1441 Load Transfer Assemblies
OPSS 1442 Epoxy Coated Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-100	Method of Rounding-off Data and Other Numbers
LS-101	Procedures for Calculating Percent within Limits
LS-296	Method of Test for Calibrating, Correlating, and Conducting Surface Smoothness Measurements Using an Inertial Profiler
LS-410	Method of Test for Compressive Strength of Concrete Cores
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
LS-433	Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
LS-450	Method of Test for Determination of Concrete Pavement Thickness Using Drilled Core Specimens

MTO Forms:

PH-CC-433-A Concrete Mix Submission Form A

CSA Standards

A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing*
*[Part of A23.1-19/A23.2-19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

C171-20	Sheet Materials for Curing Concrete
E3013/E3013M-22	Evaluating Concrete Pavement Dowel Bar Alignment Using Magnetic Pulse Induction

Other

Environmental Protection Act, R.S.O 1990, E.19

350.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Concrete Base means a rigid pavement structure, which is overlaid with asphaltic concrete, and includes concrete shoulders when present.

Concrete Pavement means a rigid pavement structure with an exposed concrete surface, and includes concrete shoulders when present.

Cold Weather means those conditions when the ambient air temperature is at or below 5 °C. It is also considered to exist when the ambient air temperature is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Effluent means liquid waste that is a direct result of concrete grinding, grooving and sawcutting. Effluent includes any stormwater, or surface drainage that becomes mixed with this material.

Environmental Compliance Approval (ECA) means as interpreted by Section 2.1 of the Ontario Environmental Protection Act.

Grout Retention Disk means a plastic disk that provides a barrier that prevents dowel adhesive from escaping from a dowel hole or tie bar hole before it has hardened.

Horizontal Alignment means the deviation of the dowel bar from true parallel alignment from the edge of the concrete pavement or concrete base, measured over the entire length of the dowel bar.

Horizontal Side Shift means the location of the dowel bar relative to the planned location from the concrete pavement or concrete base edge, nearest longitudinal joint, or nearest parallel dowel bar.

Hot Weather means those conditions when the ambient air temperature is at or above 28 °C. It is also considered to exist when the ambient air temperature is at or is likely to rise above 28 °C within 24 hours after concrete placement. Temperature refers to shade temperature.

International Roughness Index (IRI) means a specific mathematical transform of a true profile in which a low pass filter (usually consisting of a moving average with a 250 mm base length) followed by a “Quarter Car Filter” are applied to the true profile then the absolute values of the vertical vibration of the “Quarter Car Filter” are accumulated and divided by the subplot length. It is expressed in units of m/km.

Load Transfer Device means a metal support, or dowel basket, that holds a dowel in place ahead of paving operations.

Longitudinal Side Shift means the longitudinal translation of the dowel bar relative to its planned location perpendicular to the concrete pavement or concrete base edge.

MPI Device means a magnetic pulse induction (MPI) equipment meeting the requirements of ASTM E3013 and specifically developed for measuring dowel bar position and alignment in concrete pavements and concrete bases.

Mean Roughness Index (MRI) means the number calculated by averaging the IRI values from the two-wheel path profiles.

Panel means a section of concrete pavement or concrete base bounded by the nearest longitudinal and transverse joints.

Percent Within Limits (PWL) means an estimate of the percentage of the lot population that is within the specified limits, determined by using the mean and standard deviation of the lot according to LS-101.

Vertical Alignment means the deviation of the dowel bar from true parallel alignment from the surface of the concrete pavement or concrete base, measured over the entire length of the dowel bar.

350.04 DESIGN AND SUBMISSION REQUIREMENTS

350.04.01 Design Requirements

350.04.01.01 Concrete Mix Designs

The concrete mix shall be designed to provide adequate strength and durability for the intended use and to meet the requirements specified in the Contract Documents.

350.04.02 Submission Requirements

350.04.02.01 Concrete Mix Design

Concrete mix design(s) submissions shall be according to OPSS 1350.

350.04.02.02 Curing Compound

Curing compound submissions shall be according to OPSS 904.

350.04.02.03 Temperature Control Plans

350.04.02.03.01 Cold Weather

A temperature control plan shall be submitted according to the Temperature Control Plans clause of OPSS 904 for concrete paving operations that require curing during cold weather.

350.04.02.03.02 Hot Weather

For concrete paving operations subject to hot weather, a description of the methods to be used to control the temperatures of the concrete and underlying base shall be submitted to the Contract Administrator 7 Days prior to placement.

350.04.02.04 Temperature Records

For concrete paving operations that require curing during cold weather, temperature records shall be submitted according to the Submission of Temperature Records clause of OPSS 904.

350.04.02.05 Effluent Management

A written agreement from the operator of the receiving site or property owner selected to accept the effluent, shall be submitted to the Contract Administrator a minimum of 14 Days prior to commencement of the effluent producing work.

At the completion of the work, a copy of a release signed by the same receiving site operator or property owner shall be submitted to the Contract Administrator.

A copy of the Contractor's ECA for a waste management system shall be submitted to the Contract Administrator prior to the commencement of any work that will generate effluent.

350.05 MATERIALS

350.05.01 Bond Breaker

Bond breaker shall be RC-250, Tectyl 506, or an alternative type of material acceptable to the Owner.

Dowel bars and load transfer devices shall be shop coated with bond breaker, except for dowels which are installed into existing concrete.

350.05.02 Burlap

Burlap shall be according to OPSS 1306.

350.05.03 Concrete

Concrete and concrete materials shall be according to OPSS 1350 with the exception that the maximum allowable proportion by mass of the total cementing material for slag shall be 30%.

The minimum specified 28-Day compressive strength shall be 35 MPa.

350.05.04 Curing Compound

Curing compound shall be according to OPSS 1315.

350.05.05 Epoxy Adhesives

Epoxy resins dowel adhesives used for dowel and tie bars shall be from the MTO DSM approved for horizontal applications and mixed in the nozzle (cartridge). Cementitious grouts shall not be permitted for this application.

350.05.06 Expansion Joint Filler

Expansion joint filler shall be according to OPSS 1308.

350.05.07 Forms

Forms shall be according to OPSS 919.

350.05.08 Moisture Vapour Barrier

The moisture vapour barrier shall be a white opaque polyethylene film according to ASTM C171 and at least 100 µm thick.

350.05.09 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's list of acceptable concrete patching materials. The list of proprietary patching materials may be obtained from the Contract Administrator.

350.05.10 Tie Bars, Dowel Bars and Load Transfer Devices

Tie bars and dowel bars shall be according to OPSS 1440. Tie bars and dowel bars shall be epoxy coated according to OPSS 1442. Load transfer devices shall be according to OPSS 1441.

350.05.11 Water

Water used for curing and pre-soaking of burlap shall be according to OPSS 1302.

350.06 EQUIPMENT**350.06.01 Air Compressor**

The compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free from oil and other contaminants.

350.06.02 Batching Plant and Delivery Equipment

The batching plant shall be according to the Batching Plant subsection of OPSS 1350. Delivery equipment shall be according to the Delivery Equipment subsection of OPSS 1350.

350.06.03 Diamond Grinder

When a diamond grinder is used, it shall be power-driven, self-propelled equipment specifically designed to grind and texture concrete surfaces. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall have the capability to adjust the depth, slope, and cross-fall to ensure that concrete is removed to the desired dimensions and uniformly feathered and textured across the width and length of the repair area.

350.06.04 Effluent Collection Systems

The diamond grinding and grooving machines shall be equipped with a vacuum system that is capable of removing all standing effluent, leaving the roadway in a clean, near dry condition after each pass. Effluent shall not be permitted to encroach into open lanes, enter into closed drainage systems or surrounding areas.

350.06.05 Gang Drill

The gang drill shall consist of not less than three independently powered pneumatic drills. Drilling shall not damage adjacent concrete.

350.06.06 Grooving Machines

Grooving machines shall have circular diamond-tipped blades, mounted on a multi-blade arbor, and shall be self-propelled and specifically designed to groove concrete pavement. The grooving machine shall have a depth control device capable of detecting variations in the concrete pavement surface and automatically adjust the cutting head height to maintain the specified groove depth. The grooving machine shall have alignment control devices.

At the beginning of each work shift, all grooving machines shall be equipped with a full complement of grooving blades capable of cutting grooves of the specified width, depth, and spacing.

350.06.07 Hand Finishing Equipment

Floats used to finish concrete shall be made of magnesium.

350.06.08 Sawcutting Equipment

The sawcutting equipment shall be self-propelled, guided, and capable of sawcutting the joints to the dimensions specified in the Contract Documents. The sawcutting equipment shall be capable of cutting the joints without causing spalling or damage to the adjacent concrete.

The sawcutting equipment for longitudinal joints shall have guided wheels, which run along each longitudinal vertical face of the concrete pavement or concrete base.

The saw shall be equipped with a diamond blade.

350.06.09 Slip-Form Paving Equipment with Automatic Dowel Bar Inserter (DBI)

When a DBI is used, the equipment shall be capable of:

- a) Controlling insertion of the dowel bars and tie bars to achieve the required depth, alignment and spacing;
- b) Automatically marking the centre of the dowel bars for the joint cutting operation, by applying a mark adjacent to the concrete on both sides of the slip-form paver using spray paint or other permanent and visible marking; and
- c) Consolidating the concrete around the automatically-inserted dowel bars and tie bars.

350.06.10 Straight Edge

Straight edges shall be commercially made of metal and 3 m long.

350.06.11 Thermocouples and Dataloggers

Thermocouples and associated instrumentation shall:

- a) Have a combined accuracy of ± 1.5 °C;
- b) Record temperatures at hourly intervals or less; and
- c) Display the temperature.

350.07 CONSTRUCTION

350.07.01 General

The Contract Administrator shall be notified in writing of the intent to place the concrete pavement or concrete base 7 Days prior to the commencement of the concrete paving operation.

Concrete pavement and concrete base shall be constructed true to grade, cross-section and to the dimensions as specified in the Contract Documents.

The concrete pavement and concrete base shall be protected from damage. Traffic, other than foot traffic and rubber-tired sawing equipment, shall not be permitted on the concrete until it has attained a compressive strength of 20 MPa.

Shouldering operations and construction of adjacent lanes may commence once the concrete has attained a compressive strength of 20 MPa. Shoulders shall be as specified in the Contract Documents.

350.07.02 Production of Concrete

Production of concrete shall be according to the General, Temperature Control, Mixing Time and Mixing Rate, and Delivery subsections of OPSS 1350.

350.07.03 Placing of Concrete

350.07.03.01 General

Immediately ahead of the concrete placing operation, the underlying material shall be wetted by means of a uniform spray of water sufficient to wet the underlying material thoroughly without leaving standing water.

The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation.

Concrete shall be placed within 1.5 m of its final position. Concrete shall not be dropped from more than 1.5 m above the underlying material. Concrete shall not be placed more than 10 m ahead of the concrete paving equipment.

Concrete shall be placed at a steady rate, such that a monolithic concrete is obtained without the formation of cold joints.

When there is an interruption in placing concrete greater than 20 minutes, the surface of the concrete where curing has not been applied, and concrete placed ahead of the concrete paving equipment shall be covered with wet burlap. The Contract Administrator shall be notified immediately of any interruption resulting in a cold joint. A proposal for remedial action shall be submitted to the Contract Administrator for approval.

Any excess concrete beyond the concrete pavement or concrete base edge shall be removed immediately.

350.07.03.02 Concrete Placing Restrictions

No concrete shall be placed until all curing material, including cold weather protection material when required, has been delivered to the site.

Concrete shall only be placed when the ambient air temperature is 1 °C and rising, and is less than 32 °C.

All surfaces against which concrete is to be placed shall be free of:

- a) Standing water;
- b) Ice and snow; and
- c) Debris.

Concrete shall not be placed against any material which is at a temperature above 35 °C, nor against any material whose temperature is below 5 °C.

Concrete shall not be placed on or against frozen ground. De-icing chemicals shall not be used.

Fresh concrete shall be protected from contact with rain or snow and concrete shall not be placed during rain or snowfall.

350.07.04 Consolidation

For slip-form pavers, the concrete shall be consolidated by vibrators of sufficient number, spacing and frequency to provide uniform consolidation to the entire concrete pavement or concrete base width and depth. The vibrators shall not operate while the paver is stopped.

Concrete shall be thoroughly consolidated against and along the face of all forms and into the face of previously placed concrete. The vibrators shall not come in contact with the base, subbase, underlying material, forms, tie bars, dowel bars or load transfer devices.

For fixed-form placement, hand-held vibrators shall be used to supplement consolidation adjacent to and along the full length of the form. They shall also be inserted at regularly spaced intervals along both sides of load transfer devices, when used.

350.07.05 Finishing

When a slip-form paver is used, hand finishing is not required but is permitted to address localized areas of open texturing, undulations, projections, or ridges.

No water or other materials shall be applied to the concrete surface or the finishing tools to aid in the finishing.

When fixed forms are being used, or where concrete is being placed against an existing concrete pavement or concrete base, the edge of the concrete surface shall be finished with an edging tool having a radius of not more than 6 mm before surface texturing.

350.07.06 Initial Texturing of Concrete Pavement or Concrete Base Surface

The plastic surface of the concrete shall receive an initial texturing immediately after finishing and before the application of curing on the concrete. The initial texturing shall be performed by dragging burlap longitudinally to produce a uniform textured surface. The burlap shall be kept in a clean condition and free from tears and encrusted mortar. It shall be kept damp but shall not add excessive water to the concrete surface.

350.07.07 Curing

For slip-form placement, curing shall be applied immediately after initial texturing of the concrete surface, and within 15 minutes of concrete being formed by the paver. For fixed-form placement, curing shall be applied immediately after initial texturing of the concrete surface.

The curing period shall be a minimum of 7 Days for concrete cured with curing compound and for concrete subject to cold weather. For all other concrete, the curing period shall be a minimum of 4 Days.

Concrete pavement and concrete base shall be cured using one of the following methods, according to the applicable clauses of OPSS 904:

- a) Curing with Curing Compound clause; or
- b) Curing with Burlap and Water clause.

Formed surfaces shall require no additional curing where the formwork is left in place for the minimum specified curing period. If formwork is removed during the curing period, formed surfaces shall be cured using one of the methods listed above.

When curing compound is used, it shall not be applied to joint faces against which joint sealing compound will be placed or, to concrete surfaces to which concrete or mortar is to be bonded.

Curing compound used on the surface of a concrete base shall be removed completely prior to the application of tack coat and overlaying with asphalt pavement. The method of removal shall be by abrasive blast cleaning according to OPSS 929, and it shall not result in any damage to the concrete surface. The removal process shall meet all environmental constraints specified in the Contract Documents.

350.07.08 Cold Weather Protection

350.07.08.01 General

During cold weather, the temperature of the concrete shall be monitored and controlled for a minimum period of 7 Days to ensure that the concrete temperature does not fall below 15 °C for the first 3 Days of curing and then 10 °C for the following 4 Days. The monitoring shall commence at the start of the concrete placing operation.

The cold weather protection system shall be designed for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required. For cold weather conditions, concrete shall be protected according to the Concrete Subject to Cold Weather clause in OPSS 904. The conditions shall be monitored, and the protection system shall be modified as required.

Cold weather protection may be removed for sawcutting of joints; however, when removed no concrete shall be left unprotected for more than 1 hour and no more than 25 linear metres of concrete shall be exposed at any one time.

350.07.08.02 Monitoring and Control of Temperature

During cold weather, records of monitoring and control of the concrete and ambient air temperature shall be submitted to the Contract Administrator.

For each Day's placement of concrete, thermocouples or sensors shall be embedded within 5 mm of the concrete surface in a minimum of four locations distributed throughout the placed concrete, as directed by the Contract Administrator. At least one additional thermocouple or sensor shall be installed to measure ambient air temperature above the surface of the concrete and outside of the specified cold weather protection.

The recording of concrete temperatures shall begin at the start of concrete placement. The temperature shall be recorded automatically at intervals no greater than 15 minutes. The thermocouples and instrumentation shall be left in place and temperatures recorded until the end of the temperature monitoring period.

Concrete and ambient air temperature readings shall be monitored and verified on site every 6 hours or more frequently as required for the first 3 Days, and every 12 hours or more frequently as required for the remainder of the temperature monitoring period. All necessary action shall be taken to maintain the temperature within the specified limits.

The Contract Administrator shall be provided physical and digital access to verify temperature readings.

350.07.08.03 Submission of Temperature Records

At the end of each Day during the temperature monitoring period, datalogger temperature records for all of the thermocouples and sensors and a record of any actions taken to maintain control of temperature shall be submitted to the Contract Administrator. At the end of the temperature monitoring period, the complete temperature records for all of the thermocouples and sensors, including graphical plots of temperature versus time, shall be submitted to the Contract Administrator.

350.07.09 Joints

350.07.09.01 General

Joints shall be of the type and at the locations specified in the Contract Documents.

Transverse joints in new concrete pavement shall be at the same locations and continuous with transverse joints in the existing adjacent concrete pavement.

350.07.09.02 Longitudinal and Transverse Joints

For concrete pavement and concrete base, there shall be no reservoir cut and a backer rod shall not be used.

For concrete pavement, the dimensions of the longitudinal and transverse joints shall be as specified in the Contract Documents for full depth joint filling without reservoir cut.

For concrete base, the dimension of the joint shall be as specified in the Contract Documents.

350.07.09.03 Construction Joints

Transverse construction joints shall be made at the end of each Day's production or when an interruption greater than 20 minutes occurs in the concrete paving operation. Construction joints shall be located at a transverse contraction joint or expansion joint location.

350.07.09.04 Tie Bars and Dowel Bars

350.07.09.04.01 General

Prior to placement of concrete or the installation of tie bars or dowel bars, bars which are loose, broken, cracked or otherwise damaged shall be removed and replaced.

350.07.09.04.02 Protection of Tie Bars and Dowel Bars

Unprotected on-site storage shall not exceed 30 Days and total on-site storage time shall not exceed 120 Days. When protection is required, bars shall be covered with opaque polyethylene sheeting. For stacked bundles, the protective covering shall be draped over the sides of the bundles and around the perimeter of the stack. The covering shall be secured, with provisions for air circulation around the bars to prevent condensation under the protective covering.

The bars shall be stored clear of the ground on timbers or other suitable protective cribbing spaced to prevent sags in the bundles. Stacks of bundles of straight bars shall have blocking to prevent contact between the layers of bundles.

350.07.09.04.03 Repair of Tie Bars and Dowel Bars

Bars with coating damage less than 1% of the surface area of the bar shall be repaired. Bars with coating damage greater than 1% of the surface area of the bar shall not be used.

Repairs to damaged epoxy coating shall be according to OPSS 1442. Repairs shall not be performed when the temperature of the bar or the ambient air is 5 °C or less, or when moisture is present on the bar. All repairs to the coating of bars shall be completed at least 24 hours before permission to place concrete is given. Repairs should be performed immediately after the damage occurs and shall be done before rusting begins. If any rust is present, it shall be completely removed before the patching material is applied. Repaired dowel bars shall be coated with a bond-breaker.

350.07.09.04.04 Installation of Tie Bars in Plastic Concrete

Tie bars at longitudinal joints shall be installed as specified in the Contract Documents. Tie bars may be installed in the plastic concrete using an inserter or by means of tie bar baskets. Tie bars shall not be manually inserted into the plastic concrete.

Tie bars shall be installed within a tolerance of ± 15 mm from the specified depth. Tie bars shall not be placed within 600 mm of a transverse joint.

Tie bars shall be installed in the plastic concrete so that voids are not created around the bar.

350.07.09.04.05 Installation of Dowel Bars in Plastic Concrete

Dowel bars at transverse joints shall be installed as specified in the Contract Documents. Dowel bars may be installed in the plastic concrete using a DBI or by means of load transfer devices. Dowel bars shall not be manually inserted into the plastic concrete.

When load transfer devices are used, they shall be placed a minimum of 100 m in advance of the concrete placing operation. Load transfer devices shall be prevented from moving, by the use of stakes placed on both sides of the load transfer device. A minimum of three stakes shall be uniformly spaced on each side of the load transfer device for each lane, to prevent movement during the concrete paving operation. The spacer wire shall be cut in two places and the mid-section removed after staking the load transfer device in position. The section of spacer wire removed shall be a minimum of 300 mm in length.

Dowel bars shall be placed parallel to the longitudinal axis (horizontal alignment) and horizontal plane (vertical alignment) of the concrete pavement or concrete base within a tolerance of ± 15 mm along the length of the dowel bar.

The location of the centre of the dowel bars shall be precisely marked to permit joint forming or cutting operations directly over the centre of the dowel bars. Transverse joints shall be sawcut within a tolerance of ± 50 mm from the center of the dowel bars (longitudinal side shift).

Dowel bars shall be placed mid-depth of the concrete pavement or concrete base within the following tolerances:

- a) For a specified concrete pavement or concrete base thickness of < 215 mm:
 - i. lower limit = - 6 mm,
 - ii. upper limit = + 6 mm.
- b) For a specified concrete pavement or concrete base thickness from 215 to 229 mm:
 - i. lower limit = - 12 mm,
 - ii. upper limit = + 15 mm.
- c) For a specified concrete pavement or concrete base thickness of 230 mm or greater:
 - i. lower limit = - 15 mm,
 - ii. upper limit = + 25 mm.

350.07.09.04.06 Installation of Tie Bars and Dowel Bars in Hardened Concrete

When tie bars and dowel bars are installed in hardened concrete, they shall be at the locations and within the tolerances specified in the Installation of Tie Bars in Plastic Concrete and Installation of Dowel Bars in Plastic Concrete clauses as applicable.

Tie bars and dowel bars shall be installed in hardened concrete by drilling holes into the existing concrete using a gang drill. For concrete that is less than 7 Days of age, prior to drilling, cylinders according to the Testing for Early Strength subsection of OPSS 904 shall be prepared to demonstrate that the concrete has reached a minimum compressive strength of 20 MPa. The diameter of the drill hole shall be no more than 5 mm larger than the diameter of the dowel or tie bar. Prior to installing the dowel bar or tie bar, the inside surface of each drill hole shall be wire brushed and then cleaned using compressed air. The dowel or tie bar shall be secured into the existing concrete with an epoxy adhesive. The epoxy adhesive shall be injected into the back of the cleaned drill hole and the dowel or tie bar, with grout retention disks attached, shall be inserted to completely encase the bars with epoxy adhesive for the full depth of the hole.

To replace damaged tie bars, a hole offset 75 mm horizontally from the rejected bar shall be drilled and a replacement bar shall be installed. Damaged tie bars shall be cut flush with the concrete surface.

For dowel bars only (not tie bars), the free end of the dowel bars and the exposed vertical concrete face along the transverse joint shall be coated with bond breaker immediately prior to placing concrete.

Holes that have been started but not completed shall be cleaned and filled with a proprietary patching material.

350.07.09.05 Sawcutting, Cleaning and Sealing of Joints in Concrete Pavement

Concrete pavement joints shall be sealed. Sealing of joints may be done prior to, or after final texturing of the concrete pavement. Sawcutting, cleaning, and sealing of joints for concrete pavement shall be according to OPSS 369, with the addition that samples of hot poured rubberized joint sealing compound shall be required for quality assurance testing by the Owner.

A 4-litre sample shall be taken from the heating and mixing kettle at the beginning, middle and the end of the process of joint sealing compound installation for each calendar year and shall be provided to the Contract Administrator for testing by the Owner. Upon request, a more frequent sampling of the joint sealing compound shall be carried out for quality assurance testing by the Owner.

Joints shall be sealed prior to opening to traffic. Joints that will be open to traffic may be sealed temporarily, subject to approval by the Owner. A proposal to temporarily seal joints shall be submitted to the Contract Administrator, for acceptance.

350.07.09.06 Sawcutting and Cleaning of Joints in Concrete Base

Concrete base joints shall not be sealed. Sawcutting and cleaning of joints for concrete base shall be according to OPSS 369.

350.07.10 Optional Diamond Grinding to Improve Surface Tolerance and Smoothness

Diamond grinding, to improve concrete pavement surface tolerance and smoothness prior to Owner acceptance testing, may be completed at the Contractor's option. The optional diamond grinding shall be completed prior to final texturing of the concrete pavement.

When this option is selected, a written proposal, according to the Repairs subsection, shall be submitted to the Contract Administrator at least 5 Business Days prior to commencing the diamond grinding. The proposal shall list the diamond grinding locations by subplot(s), station limits, and include the length of each location. Where the distance between individual locations within the same lane is less than 100 m, these locations shall be specifically identified in the proposal along with the length between the two locations.

The optional diamond grinding shall not commence until written permission to proceed has been received from the Contract Administrator.

The optional diamond grinding shall be deemed to be a repair.

350.07.11 Final Texturing of Concrete Pavement Surface

350.07.11.01 Trial Section

The ability to texture the concrete pavement surface according to the requirements of this specification by grooving shall be demonstrated by means of a 500 m single lane trial section. The location of the trial section shall be selected by the Contract Administrator.

The Contract Administrator shall give permission to proceed with the final texturing on the Contract when it has been demonstrated to the satisfaction of the Contract Administrator that the trial section meets the requirements of this specification.

The Contract Administrator may require additional trial section(s) to be constructed, at no additional cost to the Owner, using alternate means as required, until it has been demonstrated that the requirements of this specification have been met.

350.07.11.02 Final Texturing of Concrete Pavement

Concrete pavements shall receive a final texturing by grooving. Concrete base shall not receive a final texturing. Final texturing shall be done after the curing period and, if applicable, the cold weather protection period, is complete. The concrete pavement surface shall be grooved with a grooving machine longitudinally. Longitudinally grooved areas shall be straight and run parallel to the longitudinal axis of the concrete pavement, begin and end at lines radial to the concrete pavement center line and shall be centered within the lane width, or as specified in the Contract Documents.

The concrete pavement shall be grooved to the full width of the lane under construction with no grooves cut within 150 mm and no closer than 50 mm of longitudinal joints.

Grooves shall be:

- a) Cut 2.5 mm in width, with a tolerance of plus 1.5 mm.
- b) Cut between 3.0 and 6.0 mm in depth, except over inductive loop detectors where they shall be cut between 1.5 and 3.0 mm in depth.
- c) Spaced 19 mm centre-to-centre with a tolerance of plus or minus 2.5 mm.

Grooving that results in ravelling, aggregate fractures, spalls, or disturbance to the transverse or longitudinal joints, shall not be permitted and shall be controlled or corrected immediately as the work progresses.

If a single grooving blade on any individual grooving machine becomes incapable of cutting a groove within the specified tolerances, work shall be permitted to continue for the remainder of the work shift and the groove shall not be required to be recut. Should two or more grooving blades on any individual grooving machine become incapable of cutting grooves within the specified tolerances, operations shall cease with this machine until repairs to the equipment are completed.

The Contract Administrator shall immediately be notified in writing if any of the defects or conditions listed in the Acceptance of Concrete Surface Texturing subsection are present in the work and shall include the extent of the defects and an explanation of the cause. A proposal for the remedial work for the above defects and conditions shall be submitted to the Contract Administrator for review. Repairs shall not proceed until approval of the proposal has been received from the Contract Administrator. Repairs shall be at no additional cost to the Owner.

350.07.12 Surface Tolerance

The surface of the concrete shall be such that when tested with a 3 m long straight edge placed in any location and direction, including the edge of concrete pavement or concrete base and joints, except across the crown or drainage gutters, there shall not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the concrete pavement.

For concrete base, the tolerance relative to a 3 m straight edge shall be maximum 6 mm.

The surface of the concrete shall join flush with adjacent concrete pavement or concrete base.

Diamond grinding, according to the Repairs clause, shall be carried out to ensure the concrete surface meets these requirements.

350.07.13 Material Sampling and Testing

350.07.13.01 Sampling of Water, Admixtures, Limestone Filler and Cementing Materials

Sampling of water, admixtures, limestone filler and cementing materials shall be according to Sampling of Water, Admixtures, Limestone Filler and Cementing Materials clause in OPSS 1350.

350.07.13.02**Sampling and Testing of Plastic Concrete**

Sampling, testing, acceptance, adjustments, visual acceptance, and submission of results for plastic concrete shall be according to the following clauses in OPSS 1350 with the exception that after satisfactory control has been established, testing shall be carried out on one load of concrete in every five loads:

- a) Testing of Plastic Concrete;
- b) Frequency of Testing Slump, Air Content and Temperature;
- c) Acceptance and Field Adjustment of Plastic Concrete;
- d) Visual Acceptance of Plastic Concrete;
- e) Within-Batch Uniformity of Plastic Concrete;
- f) Submission of Plastic Concrete Test Results.

350.07.13.03**Sampling for Acceptance Testing of Thickness, 28-Day Compressive Strength, Air Void System Parameters, Rapid Chloride Permeability and Acceptance of Joint Sealing****350.07.13.03.01****General**

Core samples shall be removed from the concrete pavement or concrete base at locations identified by the Contract Administrator for acceptance testing of thickness, 28-Day compressive strength, air void system parameters and rapid chloride permeability.

The lot and subplot size and number of cores per subplot shall be according to the Quality Assurance section.

After sealing operations are complete, the Contract Administrator may require that additional cores, up to two cores per subplot, be taken at joint locations to evaluate the acceptability of the joint cleaning and sealing. If the samples show that the joint cleaning and sealing is not according to this specification, additional cores may be required at no addition cost to the Owner.

350.07.13.03.02**Coring**

Core samples shall be obtained for acceptance testing. Coring shall be carried out according to CSA A23.2-14C. The cores shall be 100 mm in diameter and shall be drilled through the full depth of concrete pavement or concrete base, perpendicular to the surface of the concrete. No core shall be taken within 500 mm of any joint or edge of slab.

Removal of five cores per subplot for testing of 28-Day compressive strength, air void system and rapid chloride permeability shall be carried out when the concrete is 7 to 10 Days of age. The Contract Administrator shall randomly select a location for coring within the subplot and three cores for acceptance testing of 28-Day compressive strength shall be removed from a single panel of concrete pavement or concrete base. Cores for testing of air void system parameters and rapid chloride permeability shall be taken from a panel of concrete pavement or concrete base adjacent to the panel from which the cores for compressive strength testing were taken.

Core samples for measurement of thickness shall be taken after completion of any repairs and of final texturing. A single core shall be removed from each subplot for thickness measurement at a location randomly selected by the Contract Administrator.

Each core shall be marked legibly with durable ink immediately after removal with the following:

- a) The Contract number;
- b) Component type (concrete pavement or concrete base);

- c) Lot number;
- d) Sublot number;
- e) Exact location of each individual core;
- f) Date of concrete placement (i.e., yyyy-mm-dd);
- g) Date of extraction.

Each core shall be placed in a plastic bag and sealed to prevent loss of moisture, before they are placed in a security bag in the presence of the Contract Administrator. The cores, a transmittal form, and the MTO form PH-CC-433-A, Concrete Mix Design Form A of the concrete mix design for the concrete pavement or concrete base shall all be submitted to the Contract Administrator.

Core holes shall be filled according to OPSS 1350.

350.07.14 Preparation for Measurement of Position and Alignment of Dowel Bars

350.07.14.01 Joint Cut-Out Procedure

Joint cut-outs shall be carried out by the Contractor for evaluation of dowel bar position and alignment by the Contract Administrator. The joint cut-out measurement shall be according to the Quality Assurance section. The Contract Administrator shall select the transverse joint to be evaluated.

At the selected joint, the concrete shall be removed by chipping hammer to a depth exposing the full length of all the dowel bars across the entire joint. The concrete shall be removed without disturbing the dowel bars.

After the selected joint has been measured and evaluated by the Contract Administrator, the joint shall be removed and replaced with a full depth concrete repair, 2 m in length, according to OPSS 366.

350.07.14.02 Preparation for Measurement of Position and Alignment of Dowel Bars

The Contract Administrator shall be notified in writing when the concrete pavement or concrete base is ready for measurement by the Owner. Lot size, measurement and acceptance of position and alignment of dowel bars using the MPI device shall be according to the Quality Assurance section.

Provisions shall be made for access to the site for acceptance testing of position and alignment of dowel bars.

The area to be measured shall be free of loose stone, debris, and obstructions.

After the measurements by the MPI device are completed, all areas to be repaired shall be marked on the concrete surface at the direction of the Contract Administrator and prior to the commencement of any corrective work.

350.07.15 Preparation for Surface Smoothness Measurement

The Contract Administrator shall be notified in writing when the concrete pavement or concrete base is ready for surface smoothness acceptance testing. Surface smoothness acceptance testing shall be carried out after final texturing has been completed.

Provisions shall be made for access to the site for surface smoothness acceptance testing.

The surface to be tested shall be clear of any loose stone, debris, and obstructions which could affect the measurement. The subplot number and station shall be clearly marked at the beginning of each subplot in a way that remains visible to the smoothness measuring operator until the final measurements are completed and accepted.

When reflectors are used for quality assurance or referee measurements, reflectors shall be obtained from the profiler operator and placed on the left/right shoulder or the highway median at the beginning and end of each profile run as required by the profiler operator. After smoothness measurements are completed each Day, the reflectors shall be removed and returned to the profiler operator.

When global position system-distance measuring instrument (GPS-DMI) technology is used for quality assurance or referee measurements, the profiler operator shall collect static GPS coordinates while stopped on the shoulder. Traffic protection for the collection of static GPS coordinates shall be provided.

After the measurements are analyzed, all areas to be repaired due to rejectable sublots or incidents of localized roughness or both, shall be marked on the concrete surface at the direction of the Contract Administrator and prior to the commencement of any corrective work.

350.07.16 Repairs

350.07.16.01 Surface Tolerance and Surface Smoothness Deficiencies

A repair proposal shall be submitted to the Contract Administrator at least 5 Business Days prior to carrying out any surface tolerance or surface smoothness related repairs. The proposal shall contain the following:

- a) Sublot;
- b) Repair locations including the appropriate stations;
- c) Length of each repair area;
- d) Distance between the ends of the repair areas on the same lane that are within 100 m of each other;
- e) Detailed description of deficiency.

Repairs shall not begin until written permission to proceed has been received from the Contract Administrator.

Diamond grinding shall be the only method of repair acceptable for correction of surface tolerance and surface smoothness deficiencies including incidents of localized roughness.

Repairs by diamond grinding shall be completed prior to opening the concrete pavement or concrete base to traffic. Diamond grinding shall be performed parallel to the lane with each pass overlapping the previous one by up to 25 mm. There shall not be more than 3 mm of elevation difference between adjacent lanes and the concrete pavement or concrete base cross slope shall be maintained throughout the repaired area. After repair, the concrete pavement or concrete base shall be of a uniform texture.

The maximum depth of removal of concrete by diamond grinding shall not exceed 10 mm. The minimum width of all repairs shall be the width of the lane being repaired.

Repaired areas that do not meet the texturing requirements of this specification shall be re-textured according to the requirements of this specification.

350.07.16.02 Crack Repairs

If any cracks are found in the concrete pavement or concrete base, a proposal for remedial work shall be submitted to the Contract Administrator for review. Crack repairs shall not proceed until approval of the proposal has been received from the Contract Administrator.

350.07.17 Management of Effluent

350.07.17.01 General

Effluent shall be captured and managed as specified in the Contract Documents.

The requirements of this specification do not relieve the Contractor of obligations imposed by the Contractor's ECA for a waste management system.

All approvals, releases, and agreements, and conditions that are required for the management of effluent shall be obtained prior to the commencement of the effluent producing work.
Effluent shall be transported to one of the following receiving sites:

- a) A waste disposal site with an ECA for a waste disposal site valid for liquid industrial waste class 146 (L);
- b) A waste processing facility with an ECA for a waste disposal site (processing) valid for liquid industrial waste class 146 (L).

For each shipment of effluent from the construction area to any certified receiving site:

- a) The carrier shall have an ECA for a waste management system valid for liquid industrial waste class 146 (L), and shall comply with the Environmental Compliance Approval clause;
- b) The Contractor shall present, on behalf of the carrier, a Regulation 347 Form 1 manifest for "Part A" to be completed by the Contract Administrator; and
- c) The Contract Administrator shall be notified a minimum of 2 weeks prior to the first shipment and a minimum of 24 hours prior to each subsequent shipment requiring the manifest.

Responsibilities of certified carriers shall include, but not be limited to, the following:

- a) Transportation of waste materials produced by the work according to the ECA; and
- b) Waste materials including, but not restricted to, manifesting of liquid industrial waste.

350.07.17.02 Environmental Compliance Approval

The Contractor's ECA for a waste management system and the receiver's ECA for a waste disposal site shall be valid for all of the following:

- a) The entire period of the work;
- b) The entire area within the limits of the work and the entire haul route;
- c) The equipment to be utilized; and
- d) Waste classification 146 (L).

350.07.18 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

350.08 QUALITY ASSURANCE

350.08.01 Acceptance of Concrete Pavement and Concrete Base

Concrete pavement and concrete base shall be acceptable if the requirements of this specification are met, including:

- a) Thickness;
- b) 28-Day compressive strength;
- c) Air void system in hardened concrete;

- d) Rapid chloride permeability;
- e) Position and alignment of dowel bars;
- f) Position of tie bars;
- g) Texturing;
- h) Curing;
- i) Control of temperature;
- j) Surface smoothness;
- k) Surface tolerance; and
- l) There are no visible defects detected by inspection according to the Field Inspection subsection.

Unacceptable lots and sublots shall be rejected. Concrete from rejected lots and sublots shall be removed and replaced.

The area to be removed shall be bounded by the nearest adjacent transverse joints, longitudinal joint and outside edge of concrete pavement or concrete base, so that there shall be no additional joints.

Concrete pavement or concrete base that has been replaced shall be evaluated for acceptance on the same basis as the original lots and sublots.

350.08.02 Field Inspection

The Contract Administrator shall inspect the work during production and shall reject all or a portion of the work based on the presence of one or more of the following defects:

- a) Insufficient depth of sawcut of joints;
- b) Ravelling or damaging the concrete surface adjacent to the sawcut joints;
- c) Joints that have not been cleaned and prepared according to this specification, prior to sealing;
- d) Joints that have not been sealed according to this specification;
- e) Cracks;
- f) Voids or honeycombing;
- g) Tie bars and dowel bars not meeting the specified lengths or diameters;
- h) Loose tie bars;
- i) Cut or otherwise damaged tie bars or dowel bars;
- j) Excessive bleeding or segregation of the concrete;
- k) Presence of effluent that has not been removed according to this specification.

After sealing operations are complete, the Contract Administrator shall inspect any cores taken at joint locations to evaluate the acceptability of the joint cleaning and sealing. The Contract Administrator shall reject all or a portion of the work if the samples show that the joint cleaning and sealing is not according to this specification.

350.08.03 Acceptance of 28-Day Compressive Strength, Air Void System Parameters, Rapid Chloride Permeability and Thickness

350.08.03.01 General

Acceptance of 28-Day compressive strength, air void system parameters, rapid chloride permeability and thickness shall be based on testing of cores removed from the hardened concrete. Acceptance of 28-Day compressive strength and thickness shall be on a lot basis. Acceptance of air void system parameters and rapid chloride permeability shall be on a subplot basis.

350.08.03.02 Lot Size

A lot shall consist of the total quantity of concrete pavement or concrete base of the same specified thickness and specified 28-Day compressive strength. For lots less than or equal to 50,000 m², each lot shall be divided into sublots of approximately 1,000 m². A minimum of three sublots are required for each lot. For lots greater than 50,000 m², the lot shall be divided into sublots of approximately 2,000 m².

A total of six cores shall be removed from each subplot:

- a) Three cores from each subplot for determination of the 28-Day compressive strength;
- b) One core for determination of air void system parameters;
- c) One core for determination of rapid chloride permeability;
- d) One core for determination of thickness.

350.08.03.03 Acceptance Testing

350.08.03.03.01 28-Day Compressive Strength Testing

Testing of 28-Day compressive strength shall be according to LS-410, with the exception that determination of concrete pavement thickness is not required. The 28-Day compressive strength of a subplot shall be the average of the set of three cores for the subplot, rounded to one decimal place.

350.08.03.03.02 Air Void System in Hardened Concrete

One half of one core representing the subplot shall be tested for air void system parameters to determine the acceptability of concrete. The core shall be tested according to LS-432. The other half of the core shall be retained by the Owner for audit purposes.

350.08.03.03.03 Rapid Chloride Permeability

The core taken for rapid chloride permeability shall be tested according to LS-433. Acceptance testing shall be carried out at 28 to 32 Days. Two 50 mm long samples shall be cut from the core representing the subplot for rapid chloride permeability and tested to determine the acceptability of the concrete within the subplot.

350.08.03.03.04 Thickness Testing

The concrete pavement or concrete base thickness for each subplot shall be determined based on the length of the core removed from each subplot for thickness testing, when measured according to LS-450.

350.08.03.04 Basis of Acceptance

350.08.03.04.01 28-Day Compressive Strength

Acceptance of concrete pavement or concrete base 28-Day compressive strength for each lot shall be based on the mean and standard deviation of the measurements for compressive strength of all sublots contained in the lot.

The Contract Administrator shall calculate the mean and standard deviation of the results and calculate the percent within limits (PWL) according to LS-101. For calculation of PWL, the lower limit for 28-Day compressive strength is the specified minimum 28-Day compressive strength.

If the lot PWL is greater than or equal to 90%, the lot is acceptable. If the lot PWL is greater than 95%, the lot shall be accepted with a bonus. If the lot PWL is less than 90% and greater than or equal to 50%, the lot is accepted with a payment adjustment according to the Basis of Payment section. If the lot PWL is less than 50%, the lot shall be rejected.

Notwithstanding the overall PWL, if the compressive strength of a subplot is less than 60% of the specified compressive strength, the subplot shall be rejected.

350.08.03.04.02 Air Void System in Hardened Concrete

For a subplot to be considered acceptable, the core representing the subplot shall have an air content of 3.0% or more and a spacing factor of 0.230 mm or less. Acceptable sublots shall be subject to full payment or a bonus payment. Calculation of the bonus shall be according to the Basis of Payment section.

Sublots with an air content of less than 3.0% or a spacing factor greater than 0.230 mm and but less than or equal to 0.260 mm shall be considered unacceptable but, at the discretion of the Owner, may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated based on individual sublots and applied according to the Basis of Payment section.

Sublots with a spacing factor greater than 0.260 mm shall be rejected.

350.08.03.04.03 Rapid Chloride Permeability

Sublots with rapid chloride permeability less than or equal to 2500 coulombs shall be considered acceptable. Sublots with a rapid chloride permeability result greater than 2500 coulombs and less than or equal to 3500 coulombs shall be considered unacceptable but, at the discretion of the Owner, may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated based on individual sublots and applied according to the Basis of Payment section.

Sublots with rapid chloride permeability results exceeding 3500 coulombs shall be rejected.

350.08.03.04.04 Thickness

Acceptance of concrete pavement or concrete base thickness for each lot shall be based on the mean and standard deviation of the measurements for thickness of all sublots contained in the lot.

The Contract Administrator shall calculate the mean and standard deviation of the results and calculate the PWL according to LS-101. For calculation of PWL, the lower limit for thickness is the specified thickness minus 5 mm.

If the lot PWL is greater than or equal to 90%, the lot is acceptable. If the lot PWL is greater than 95%, the lot shall be accepted with a bonus. If the lot PWL is less than 90% and greater than or equal to 50%, the lot is accepted with a payment adjustment according to the Basis of Payment section. If the lot PWL is less than 50%, the lot shall be rejected.

Notwithstanding the overall PWL, if the thickness of a subplot is less than 60% of the specified concrete pavement or concrete base thickness, the subplot shall be rejected.

350.08.03.05 Referee Testing

350.08.03.05.01 General

Referee testing for a subplot may only be invoked by the Contractor within 3 Business Days of receiving the test results for that subplot.

Referee testing shall be carried out according to the Acceptance Testing clause.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor as they become available.

350.08.03.05.02 28-Day Compressive Strength

Referee testing of 28-Day compressive strength for a subplot shall be carried out on a new set of three cores removed within 24 hours of invoking the referee testing. Cores for referee testing for each disputed subplot shall be taken in the presence of the Contract Administrator at a location no more than 1 m from the location that each of the disputed acceptance cores were removed. The core size and core extraction shall be according to the Coring clause.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed and the acceptance test result shall be used in the determination of acceptance and payment for the concrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed and the acceptance test result shall be disregarded and not used in the determination of acceptance and payment.

The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cores, expressed to one decimal place.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost. When acceptance results are eliminated from the analysis as a result of the referee process, the concrete shall be assessed based on the available strength results for the lot.

350.08.03.05.03 Air Void System in Hardened Concrete

Referee testing for air voids shall be carried out on the same half of the core sample that was tested for acceptance. When the referee testing is invoked, the sample representing the subplot shall be referee tested and the acceptance test results discarded. The subplot referee test results shall replace the acceptance test result in the acceptance requirements of this specification.

When the referee results indicate that the refereed subplot is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed subplot is not acceptable, the Contractor shall be charged the cost of the air void system referee testing.

350.08.03.05.04 Rapid Chloride Permeability

Referee testing of rapid chloride permeability of a subplot shall be done on a new core removed within 24 hours of invoking the referee testing. Cores for referee testing for each disputed subplot shall be taken in the presence of the Contract Administrator at a location no more than 1 m from the location from which the disputed acceptance core was removed. The core size, core extraction, and filling shall be according to the Coring clause.

When the referee result is greater than the acceptance test result or no more than 500 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the subplot is more than 500 coulombs below the acceptance test result, the acceptance test result is then not confirmed and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

350.08.03.05.05 Thickness

Referee testing of thickness for a subplot shall be done on the same core that was used for acceptance testing of thickness.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed and the acceptance test result shall be used in the determination of acceptance and payment for the concrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed and the acceptance test result shall be disregarded and not used in the determination of acceptance and payment.

The confirmation value for confirming the acceptance test result shall be 5.0 mm.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

When acceptance results are eliminated from the analysis as a result of the referee process, the concrete shall be assessed based on the available thickness results for the lot.

350.08.04 Acceptance of Position and Alignment of Dowel Bars

350.08.04.01 General

All testing shall be carried out by the Owner. Test results shall be forwarded to the Contractor as they become available.

Acceptance testing of position and alignment of dowel bars shall be carried out upon completion of construction of the concrete pavement or concrete base or as portions of the work are completed.

The Contract Administrator shall arrange for acceptance testing after:

- a) Written notification that the concrete pavement or concrete base is ready for acceptance testing is received; and
- b) The Contract Administrator is satisfied that the concrete pavement or concrete base is free of loose stone, debris, and obstructions.

The Contract Administrator shall provide 48 hours notice of when the dowel bar position and alignment measurements shall begin. When weather conditions are unsuitable for testing according to the equipment manufacturer's recommendations, testing shall be suspended and shall resume only when conditions are acceptable for testing.

350.08.04.02 Lot Size

The total quantity of concrete pavement or concrete base on the Contract shall be divided into lots, with each lot containing all the transverse joints with dowel bars placed by the same method (load transfer devices or automatic dowel bar inserter). Each transverse joint shall represent a subplot.

350.08.04.03 Measurement and Acceptance

One joint for every 10 sublots or a minimum of 10 joints shall be randomly selected by the Contract Administrator and dowel position and alignment shall be measured for that joint.

Measurement of dowel position and alignment using MPI device shall be according to ASTM E3013.

Verification of the MPI device result by means of a joint cut-out, shall be done on a joint from the first subplot for each method of placement (load transfer devices or automatic dowel bar inserter) and shall be carried out once per year for multi-year Contracts. The procedure for joint cut-outs shall be according to the Joint Cut-Out Procedure clause. The Contract Administrator shall inspect the joint and measure and record the depth, horizontal and longitudinal side shift, vertical and horizontal alignment of all the dowel bars and compare to the measurements obtained using the MPI device to verify accuracy.

Acceptance of the dowel bar position and alignment for the lot shall be based on the mean and standard deviation of the lot MPI device measurements for vertical alignment, horizontal alignment, longitudinal side shift and depth. The dowel bar closest to the longitudinal joint shall be removed from the analysis due to possible interference of the tie bar. All MPI device measurements for vertical alignment, horizontal alignment and longitudinal side shift shall be converted to positive values prior to calculating the mean and standard deviation. The Contract Administrator shall calculate the PWL for each criterion according to LS-101. For calculation of PWL, the upper limit and lower limits for each attribute are as specified in Table 1.

If the lot PWL is greater than or equal to 90%, the lot is acceptable for the criteria. If the lot PWL is less than 90% and greater than or equal to 50%, the lot is accepted for the criteria with a payment adjustment defined in the Basis of Payment section. If the lot PWL is less than 50%, the lot shall be rejected.

In addition, any subplot which contains an individual dowel bar which exceeds any of the criteria identified in Table 2 for vertical alignment, horizontal alignment, horizontal side shift, longitudinal side shift and depth, is rejectable and shall be removed and replaced. The Owner shall scan joints on either side of the unacceptable subplot, until five consecutive joints on each side are found with no rejectable bars. Any joints with rejectable bars shall be removed and replaced, according to OPSS 366. The area of concrete to be removed shall be according to the Acceptance of Concrete Pavement and Concrete Base subsection.

350.08.04.04 Referee Testing

350.08.04.04.01 General

For each measurement taken by the Owner, a written request for referee testing, no more than 3 Business Days after receiving the test results may be made. Each request shall identify the subplot(s) for referee testing.

Referee testing of dowel position and alignment shall be done using the MPI device according to ASTM E3013.

Referee testing shall be done by the Owner. Up to two representatives can witness the referee testing. Referee test results shall be forwarded to the Contractor as they become available.

350.08.04.04.02 Referee Testing Cost

When the referee result for a subplot confirms the acceptance test result, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

350.08.05 Acceptance of Concrete Surface Texturing

The Contract Administrator shall select, inspect, and measure grooving areas for acceptance. The Contract Administrator shall reject all or a portion of the work based on the presence of one or more of the defects identified below that fall within either one of the conditions in Table 3:

- a) Width of grooves less than 2.5 mm or greater than 4.0 mm;
- b) Depth of grooves less than 3 mm or greater than 6 mm, except over inductive loop detectors where the depth shall be between 1.5 and 3.0 mm; and
- c) Distances between centres of grooves less than or greater than 19 mm $\pm$ 2.5 mm.

350.08.06 Acceptance of Surface Smoothness

350.08.06.01 General

Lot acceptance for surface smoothness of concrete pavement or concrete base shall be based on measurements of MRI and incident(s) of localized roughness. All acceptance testing of surface smoothness shall be performed by the Owner. Test results shall be forwarded to the Contractor as they become available.

Requirements for smoothness apply regardless of whether the concrete pavement or concrete base is constructed adjacent to existing concrete pavement or concrete base, respectively, except as provided for in the Acceptance of Surface Smoothness, Lot Size clause, bullet d).

Acceptance testing of surface smoothness shall be done upon completion of construction of the concrete pavement or concrete base, or as portions of the work are completed.

The Contract Administrator shall arrange for acceptance testing after:

- a) Final texturing has been completed;
- b) Written notification that the concrete pavement or concrete base is ready for acceptance testing is received; and
- c) The Contract Administrator is satisfied that the concrete pavement or concrete base is free of loose stone, debris, and obstructions.

The Contract Administrator shall provide 48 hours notice of when the surface smoothness measurements will begin. When the weather conditions are unsuitable for testing, according to the equipment manufacturer's recommendations, the testing shall be suspended and resumed only when the conditions are acceptable.

350.08.06.02 Lot Size

A lot shall consist of the total quantity of concrete pavement or concrete base. Each lot shall be divided into approximately 100 m single lane sublots. When the last subplot is less than 50 m in length, it shall be added to the previous subplot.

The Owner shall measure all through lane concrete surfaces with the following exceptions:

- a) Where the posted speed is 60 km/hour or less;
- b) Lanes less than 400 m in length;
- c) Shoulders;
- d) Within the first or last 10 m length of the new concrete pavement or concrete base section where the new concrete pavement or concrete base abuts against an existing asphalt or concrete pavement where the Contractor is not responsible for the adjoining surface;
- e) Bridge decks and within 10 m of bridge deck expansion joints or approach slabs.

350.08.06.03 Measurement and Acceptance of Surface Smoothness

Smoothness measurement of the surface of the concrete pavement or concrete base, and incidents of localized roughness shall be measured according to LS-296, using an inertial profiler. The inertial profiler shall do three runs of any pavement section. The surface smoothness of each subplot shall be determined by calculating the MRI.

For concrete pavement, a subplot's smoothness shall be acceptable if the average MRI is less than or equal to 1.000 m/km. If the subplot's MRI is greater than 1.000 m/km but less than or equal to 1.250 m/km, the subplot is accepted with a payment adjustment according to the Basis of Payment section or may be repaired by diamond grinding. If the subplot's MRI is greater than 1.250 m/km, the subplot is unacceptable and shall be repaired by diamond grinding or removed and replaced.

For concrete base, a subplot's smoothness shall be acceptable if the average MRI is less than or equal to 1.200 m/km. If the subplot's MRI is greater than 1.200 m/km but less than or equal to 1.500 m/km, the subplot is accepted with a payment adjustment according to the Basis of Payment section or may be repaired by diamond grinding. If the subplot's MRI is greater than 1.500 m/km, the subplot is unacceptable and shall be repaired by diamond grinding or removed and replaced.

In addition, for concrete pavement or concrete base, incidents of localized roughness of less than 2.400 m/km are acceptable. Incidents of localized roughness between 2.400 m/km and 3.499 m/km are accepted with a payment adjustment or may be repaired by diamond grinding. Incidents of localized roughness greater than or equal to 3.500 m/km are unacceptable and shall be repaired by diamond grinding or removed and replaced.

350.08.06.04 Referee Testing

350.08.06.04.01 General

Referee testing for a subplot may only be invoked within 5 Business Days of receiving the test results for that subplot with a written request to the Contract Administrator.

The referee inertial profiler shall be designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor as they become available.

All sublots that are requested for referee testing shall be re-measured, according to LS-296 within 21 Business Days of the Contract Administrator receiving the written request for referee testing. The disposition of all of the re-measured sublots and all incident(s) of localized roughness that are located within those sublots shall be based on the referee measurements and the results shall be binding on both the Contractor and the Owner.

350.08.06.04.02 Referee Testing Cost

If referee testing is invoked and the MRI for the sublots tested in that request is either higher or less than 10% lower than the MRI determined from the original MRI measurements taken by the quality assurance inertial profiler for those sublots, then the Contractor shall be charged the cost of the referee testing, otherwise, the Owner shall bear the cost.

350.08.07 Acceptance of Repairs

350.08.07.01 General

At the discretion of the Contract Administrator, where defects or deficiencies have been repaired by either standard methods or by Contractor proposal, the Contract Administrator shall:

- a) Conduct a visual inspection or other measures;
- b) Request additional coring when required; or
- c) Conduct any other testing deemed necessary to assess the effectiveness of the repairs.

All repaired or replaced areas shall be measured by the Owner to ensure they meet the requirements of this specification.

350.08.07.02 Acceptance of Repair of Surface Tolerance and Surface Smoothness Deficiencies

The Contractor shall inform the Contract Administrator, in writing, when the repaired sublots are ready for acceptance re-measurement by the Owner. Sublots repaired by diamond grinding to correct deficiencies or as chosen by the Contractor, or areas that have been removed and replaced, shall be re-measured for surface smoothness.

A repaired subplot shall be evaluated for acceptance according to the Acceptance of Surface Smoothness clause and Acceptance of Concrete Surface Texturing subsection.

Grooving in areas that have been diamond ground after final texturing shall be re-evaluated for acceptance according to the Acceptance of Concrete Surface Texturing subsection.

The Contractor shall be responsible for the cost of re-measurement of repaired sublots.

350.08.08 Scaling Warranty

350.08.08.01 General

The Contractor shall warrant that throughout and at the end of the warranty period, there shall be no medium or severe scaling of the concrete pavement surface and light scaling shall not exceed 20% of the concrete pavement surface. Visual inspection and assessment of severity of scaling shall be according to Figures 1-6. Panels with medium or severe scaling shall be removed and replaced. For panels with light scaling greater than 20%, a repair proposal shall be submitted to the Owner for approval.

350.08.08.02 Warranty Period

The warranty period shall begin on the date of the Certificate of Substantial Performance and shall continue for 3 years.

350.08.08.03 Distress Survey

The Owner may carry out a survey at any time during the warranty period. Severity and extent of surface scaling shall be evaluated according to the requirements of this specification.

Survey results shall be sent to the Contractor at least 60 Days prior to the end of the warranty.

350.09 MEASUREMENT FOR PAYMENT

350.09.01 Actual Measurement

**350.09.01.01 Concrete Pavement
Concrete Base**

Measurement of concrete pavement or concrete base shall be the surface area placed in square metres.

350.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

350.10 BASIS OF PAYMENT

**350.10.01 Concrete Pavement - Item
Concrete Base - Item**

350.10.01.01 General

Payment at the Contract price for the above tender item(s) shall be full compensation for all labour, equipment and material required to do the work subject to payment adjustments.

Payment shall not be made for diamond grinding, other repairs and areas removed and replaced as detailed in this specification.

350.10.01.02 Combined Payment Factor for 28-Day Compressive Strength, Air Void System Parameters, Rapid Chloride Permeability and Thickness

350.10.01.02.01 General

The total combined payment factor (PF_{TC}) for 28-Day compressive strength, air void system parameters, rapid chloride permeability and thickness shall be calculated using the following formula:

$$PF_{TC} = (PF_{strength} + PF_{AVS} + PF_{RCP} + PF_{thickness}) - 3$$

Where:

$PF_{strength}$ = Payment factor for 28-Day compressive strength
 PF_{AVS} = Payment factor for air void system parameters
 PF_{RCP} = Payment factor for rapid chloride permeability
 $PF_{thickness}$ = Payment factor for thickness

The sum of $PF_{strength}$, PF_{AVS} , PF_{RCP} , and $PF_{thickness}$, shall be as calculated, but shall not be less than 3.8.

The combined payment factor 28-Day compressive strength, air void system parameters, rapid chloride permeability and thickness shall be rounded to three decimal places, according to LS-100.

350.10.01.02.02 Payment Factors for Thickness and 28-Day Compressive Strength

The payment factors for thickness ($PF_{thickness}$) and 28-Day compressive strength ($PF_{strength}$) shall be determined according to Table 4.

350.10.01.02.03 Payment Factor for Air Void System Parameters

The payment factor for air void system parameters (PF_{AVS}) for the entire lot shall be the average of the individual payment factors for all measured sublots within the lot.

The individual payment factors for each acceptable subplot and each unacceptable subplot that the Owner has permitted to remain in the Work shall be determined by the Contract Administrator according to Table 5. For the purpose of calculating the individual payment factors for each subplot, the Contract Administrator shall round-off spacing factor test data to two decimal places and air content test data to one decimal place according to LS-100.

350.10.01.02.04 Payment Factor for Rapid Chloride Permeability

The payment factor for rapid chloride permeability (PF_{RCP}) for the entire lot shall be the average of the individual payment factors for all measured sublots within the lot. The Contract Administrator shall round the payment factors for each subplot and lot to two decimal places according to LS-100.

The individual payment factor for each acceptable subplot shall be 1.00.

The individual payment factor for each unacceptable subplot that the Owner has permitted to remain in the Work shall be determined by the Contract Administrator as follows:

$$\text{Sublot Payment Factor} = 1.00 - \frac{C - 2500}{2000}$$

Where:

C = Rapid chloride permeability of the sublot (coulombs)

350.10.01.03 Payment Factor and Payment Adjustments for Surface Smoothness

350.10.01.03.01 Mean Roughness Index

A sublot's payment factor for smoothness shall be based on the initial quality assurance measurements unless that sublot has been repaired by diamond grinding or the initial quality assurance MRI has been substituted as a result of referee testing. Where a sublot has been repaired by diamond grinding, the subsequent measurements taken after the repair shall be used in the calculation for the payment adjustment to that sublot. No sublot that has been repaired by diamond grinding for any reason shall receive a payment factor greater than 1.000. The Contractor's optional diamond grinding according to the Optional Diamond Grinding to Improve Surface Tolerance and Smoothness subsection shall be deemed to be a repair and shall not receive a payment factor greater than 1.000.

For concrete pavement, any sublot with an initial MRI measurement for the three runs that is greater than 1.000 m/km but less than or equal to 1.250 m/km, the Contractor may either accept the inclusion of its payment factor in the calculation for the lot or choose to repair at least a portion of the sublot by diamond grinding.

For concrete pavement, the individual payment factors for each sublot shall be determined by the Contract Administrator by substituting the MRI's into the applicable formulae shown in Table 6 and rounding to three decimal places, according to LS-100.

For concrete pavement, the payment factor for the entire lot ($PF_{\text{smoothness}}$) shall be the lesser of the following:

- a) The average of the individual payment factors for all measured sublots of concrete pavement within the lot, rounded to three decimal places, according to LS-100; or
- b) 1.020.

For concrete base, any sublot with an initial MRI measurement for the three runs that is greater than 1.200 m/km but less than or equal to 1.500 m/km, the Contractor may either accept the inclusion of its payment factor in the calculation for the lot or choose to repair at least a portion of the sublot by diamond grinding.

For concrete base, the individual payment factors for each sublot shall be determined by the Contract Administrator by substituting the MRI's into the applicable formulae shown in Table 7 and rounding to three decimal places, according to LS-100.

For concrete base, the payment factor for the entire lot ($PF_{\text{smoothness}}$) shall be the lesser of the following:

- a) The average of the individual payment factors for all measured sublots of concrete base within the lot, rounded to three decimal places, according to LS-100, or
- b) 1.000.

350.10.01.03.02 Incident(s) of Localized Roughness

The Contractor shall either be given payment adjustments or be required to repair all incidents of localized roughness according to Table 8. Where two or more incidents of localized roughness are found to be within 2 m of one another and they are left unrepaired, the localized roughness at those locations shall be treated as a single incident of localized roughness. The MRI of that single incident of localized roughness shall be the MRI for all the individual incidents of localized roughness within that 2 m for assessment of payment adjustment.

The surface smoothness payment adjustment for any subplot which includes any unrepaired incidents of localized roughness shall be unaffected by any payment adjustment given for such incidents of localized roughness.

350.10.01.04 Payment Factor for Position and Alignment of Dowel Bars

The payment factor for position and alignment of dowel bars shall be calculated using the following formula:

$$PF_{dowel\ bars} = PF_{horizontal} + PF_{vertical} + PF_{sideshift} + PF_{depth} - 3$$

Where:

- PF_{horizontal} = Payment factor for horizontal alignment
- PF_{vertical} = Payment factor for vertical alignment
- PF_{sideshift} = Payment factor for longitudinal side shift
- PF_{depth} = Payment factor for depth

The payment factors of the dowel bars for horizontal and vertical alignment, longitudinal side shift and depth shall each be calculated using the equations in Table 9, rounded to three decimal places, according to LS-100.

350.10.01.05 Payment Adjustment

The payment factors (PF_{TC}, PF_{smoothness}, and PF_{dowel bars}) shall be used to calculate the overall payment adjustment(s) for thickness, strength, AVS, RCP, surface smoothness, and position and alignment of dowel bars. If applicable, the overall maximum bonus shall be as calculated below except it shall not exceed 5.00% for concrete pavement and 3.00% for concrete base.

The payment adjustment shall be calculated by the Contract Administrator using the following formula:

$$Payment\ Adjustment = Lot\ Size \times T \times \left((PF_{TC} + PF_{smoothness} + PF_{dowel\ bars}) - 2 \right) - 1$$

Where:

- Lot Size = Total quantity of concrete pavement or concrete base having the same specified thickness, the same specified 28-Day compressive strength, and having dowel bars placed by the same method, in m².
- T = Tender Unit Price in \$/m²
- PF_{smoothness} = the payment factor for smoothness for the lot

The sum of PF_{TC}, PF_{smoothness}, and PF_{dowel bars} shall be as calculated, but not less than 2.2.

When the total quantity of concrete pavement or concrete base for the Contract is covered by one lot, a single payment adjustment shall be calculated according to the formula above.

When the total quantity of concrete pavement or concrete base for the Contract is divided into more than one lot due to different specified thickness, specified 28-Day compressive strength, or dowel bar placement method, the Contract Administrator shall calculate multiple payment adjustments.

Table 10 illustrates how lot size is determined for each payment adjustment and which payment factors are input into the calculation.

TABLE 1
Limits for Position and Alignment of Dowel Bars

Attribute	Lower Limit (mm)	Upper Limit (mm)
Horizontal alignment (mm)	Not Applicable	15
Vertical alignment (mm)	Not Applicable	15
Longitudinal Side Shift (mm)	Not Applicable	50
Depth Tolerance (for specified concrete pavement or concrete base thickness):		
< 215 mm	Mid-depth - 6	Mid-depth + 6
215 to 229 mm	Mid-depth - 12	Mid-depth + 15
≥ 230 mm	Mid-depth - 15	Mid-depth + 25

TABLE 2
Rejection Criteria for Position and Alignment of Dowel Bars

Attribute	Lower Limit (mm)	Upper Limit (mm)
Horizontal alignment (mm)	-38	38
Vertical alignment (mm)	-38	38
Horizontal or Longitudinal Side Shift (mm)	-75	75
Depth (for specified concrete pavement or concrete base thickness):		
< 215 mm	Mid-depth - 10	Mid-depth + 10
215 to 229 mm	Mid-depth - 18	Mid-depth + 23
230 to 259 mm	Mid-depth - 25	Mid-depth + 35
≥ 260 mm	Mid-depth - 25	Mid-depth + 40

TABLE 3
Grooving Rejection Condition

Number of Grooves in One Pass	Continuous Length Greater Than
> 1/3	20 m
> 2/3	10 m

TABLE 4
Payment Factors for Strength and Thickness

PWL	Payment Factor (PF)
PWL > 95	PF = 1.00 + [0.001(PWL-95)]
90 ≤ PWL ≤ 95	PF = 1.00
50 ≤ PWL < 90	PF = 0.55 + 0.005 PWL

TABLE 5
Payment Factor per Sublot for Air Void System Parameters of Hardened Concrete

Spacing Factor, mm	Air Content, %																				
	≤1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	≥3.0
<0.200	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95	0.95	1.02
0.200	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95	0.95	1.01
0.210	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95	0.95	1.01
0.220	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95	0.95	1.01
0.230	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95	0.95	1.00
0.240	0.50	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95	0.95
0.250	0.48	0.50	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93	0.95
0.260	0.45	0.48	0.50	0.52	0.55	0.57	0.59	0.62	0.64	0.67	0.69	0.71	0.74	0.76	0.79	0.81	0.83	0.86	0.88	0.90	0.93
Notes:																					
A. Thick line between 0.230 and 0.240 mm spacing factor indicates maximum acceptable spacing factor.																					
B. Thick line between 2.9 and 3.0% air content indicates minimum acceptable air content.																					
C. Shaded cells indicate acceptable air void system parameters.																					

TABLE 6
Sublot Payment Factors Based on MRI for Concrete Pavement

MRI (m/km)	Sublot Payment Factors
≤ 0.500	1.200 (subject to Note 1)
> 0.500 to 0.650	1.867 - (1.333 x MRI) (subject to Note 1)
> 0.650 to 1.000	1.000
> 1.000 to 1.250	2.200 - (1.200 x MRI)
Notes:	
1. The payment factor shall not exceed 1.000 for subsequent MRI measurements which are taken after repairs by diamond grinding regardless of the reason for the repairs.	

TABLE 7
Sublot Payment Factors Based on MRI for Concrete Base

MRI (m/km)	Sublot Payment Factors
≤ 1.200	1.000
> 1.200 to 1.500	$2.200 - (\text{MRI})$

TABLE 8
Payment Adjustments and Repairs for Incidents of Localized Roughness

MRI (m/km)	Payment Adjustment
2.400 to 3.499	The Contractor shall receive a payment reduction of \$3,000 for each incident of localized roughness located in multi-lane freeways, and \$2,500 for each incident of localized roughness located in all other Highway types. Repairs shall be allowed for any incident of localized roughness in this range. If the repair removes the incident of localized roughness, then the payment adjustment for that incident of localized roughness shall be waived.
≥ 3.500	All incidents of localized roughness in this range shall be repaired.

TABLE 9
Payment Factors for Position and Alignment of Dowel Bars

PWL	PF
$90 \leq \text{PWL} \leq 100$	$\text{PF} = 1.00$
$50 \leq \text{PWL} < 90$	$\text{PF} = 0.55 + 0.005\text{PWL}$

TABLE 10
Illustrative Examples of How to Determine Lot Size for Payment Adjustments

Case A: When all concrete pavement or concrete base has the same specified thickness, specified strength, and dowel bar placement method. Total quantity of concrete pavement or concrete base on Contract = 100,000 m²
Lot Size for Strength, AVS, RCP & Thickness Lot 1 = 100,000 m² (PF_{TC 1}) Lot Size for Smoothness Lot 1 = 100,000 m² (PF_{smoothness 1}) Lot Size for Dowel Bars Lot 1 = 100,000 m² (PF_{dowel bars 1})
Lot Size for Payment Adjustment = 100,000 m² Payment Adjustment = 100,000 m² x T x [(PF_{TC 1} + PF_{smoothness 1} + PF_{dowel bars 1}) - 2] - 1]
Case B: When all concrete pavement or concrete base has the same specified thickness, specified strength, but different dowel bar placement methods. Total quantity of concrete pavement or concrete base on Contract = 100,000 m²
Lot Size for Strength, AVS, RCP & Thickness Lot 1 = 100,000 m² (PF_{TC 1}) Lot Size for Smoothness Lot 1 = 100,000 m² (PF_{smoothness 1}) Lot Size for Dowel Bars Lot 1 = 75,000 m² (PF_{dowel bars 1}) Lot Size for Dowel Bars Lot 2 = 25,000 m² (PF_{dowel bars 2})
Lot Size for Payment Adjustment 1 = 75,000 m² Payment Adjustment 1 = 75,000 m² x T x [(PF_{TC 1} + PF_{smoothness 1} + PF_{dowel bars 1}) - 2] - 1]
Lot Size for Payment Adjustment 2 = 25,000 m² Payment Adjustment 2 = 25,000 m² x T x [(PF_{TC 1} + PF_{smoothness 1} + PF_{dowel bars 2}) - 2] - 1]
Case C: When concrete pavement or concrete base is divided into different lots due to specified thickness, specified strength, and dowel bar placement method. Total quantity of concrete pavement or concrete base on Contract = 100,000 m²
Lot Size for Strength, AVS, RCP & Thickness Lot 1 = 40,000 m² (PF_{TC 1}) Lot Size for Strength, AVS, RCP & Thickness Lot 2 = 60,000 m² (PF_{TC 2}) Lot Size for Smoothness Lot 1 = 100,000 m² (PF_{smoothness 1}) Lot Size for Dowel Bars Lot 1 = 75,000 m² (PF_{dowel bars 1}) Lot Size for Dowel Bars Lot 2 = 25,000 m² (PF_{dowel bars 2})
Lot Size for Payment Adjustment 1 = 40,000 m² Payment Adjustment 1 = 40,000 m² x T x [(PF_{TC 1} + PF_{smoothness 1} + PF_{dowel bars 1}) - 2] - 1]
Lot Size for Payment Adjustment 2 = 35,000 m² Payment Adjustment 2 = 35,000 m² x T x [(PF_{TC 2} + PF_{smoothness 1} + PF_{dowel bars 1}) - 2] - 1]
Lot Size for Payment Adjustment 3 = 25,000 m² Payment Adjustment 3 = 25,000 m² x T x [(PF_{TC 2} + PF_{smoothness 1} + PF_{dowel bars 2}) - 2] - 1]

FIGURE 1
Example of Light Scaling



FIGURE 2
Example of Light Scaling



FIGURE 3
Example of Medium Scaling



FIGURE 4
Example of Medium Scaling



FIGURE 5
Example of Severe Scaling



FIGURE 6
Example of Severe Scaling





CONSTRUCTION SPECIFICATION FOR CONCRETE SIDEWALK

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351.01	SCOPE

This specification covers the requirements for the construction of concrete sidewalks, including ramps.

351.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 314	Untreated Granular, Subbase, Base, Surface, Shoulder and Stockpiling
OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1308	Joint Filler in Concrete
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-450 Method of Test for Determination of Concrete Pavement Thickness Using Drilled Core Specimens

MTO Forms:

PH-CC-433A Concrete Mix Design Submission Form A

ASTM International

A48/48M-22 Gray Iron Castings

C171-20 Sheet Materials for Curing Concrete

C1028-07e1 Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method

CSA Standards

A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing*

* [Part of A23.1-19/A23.2-19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

351.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cold Weather means those conditions when the ambient air temperature is at or below 5 °C. It is also considered to exist when the ambient air temperature is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Sidewalk Bay means the area between two transverse joints, regardless of the type of joint.

351.04 DESIGN AND SUBMISSION REQUIREMENTS

351.04.01 Design Requirements

351.04.01.01 Concrete Mix Designs

The concrete mix used for the sidewalk shall be designed to provide adequate strength and durability and to meet the requirements specified in the Contract Documents.

351.04.02 Submission Requirements

351.04.02.01 Concrete Mix Designs

Concrete mix design(s) submissions shall be according to OPSS 1350.

351.04.02.02 Tactile Walking Surface Indicator Plates

At least 1 week prior to the installation of the tactile walking surface indicator (TWSI) plates, a copy of the Working Drawings shall be submitted to the Contract Administrator.

In addition, the following shall be submitted with the Working Drawings:

- a) The manufacturer's installation instructions.

- b) When requested by the Contract Administrator, a certificate from the manufacturer for the tactile walking surface indicator plates that confirms the product was manufactured and met the test requirements according to the Contract Documents. The certificate shall include test results from an independent testing laboratory currently accredited by the Standards Council of Canada.

351.05 MATERIALS

351.05.01 Concrete

Concrete and concrete materials shall be according to OPSS 1350 with the following addition:

- a) The minimum specified 28-Day compressive strength shall be 30 MPa, or as specified in the Contract Documents.

351.05.02 Expansion Joint Material

Expansion joint filler material shall be asphalt impregnated fibreboard having a minimum of 12 mm thickness and shall be according to OPSS 1308, Type A.

351.05.03 Granular Base

Granular base shall be according to OPSS 1010.

351.05.04 Subgrade Moisture Vapour Barrier

Subgrade moisture vapour barrier shall be according to ASTM C171.

351.05.05 Tactile Walking Surface Indicator Plates

The TWSI plates shall be:

- a) As specified in the Contract Documents.
- b) Cast iron, Gray in colour.
- c) New.
- d) According to ASTM A48, Class 30 or 35B.
- e) Bare and not coated with paint or other coating substances.
- f) Sound, free from pouring faults, cracks, blowholes, and other defects.

The top of the truncated domes and the field between the truncated domes shall have a wet and dry static coefficient of friction of 0.8 according to ASTM C1028.

The initials or trademark of the manufacturer, year of manufacture, and country of manufacture shall be distinctly cast and legible in raised letters on the top side of each plate.

351.06 EQUIPMENT

351.06.01 Formwork

Formwork shall be according to OPSS 919.

351.06.02 Hand Finishing Equipment and Joint Tools

Floats and joint tools shall be made of magnesium. Magnesium bull floats shall be commercially made.

351.06.03 Slip Forming

The equipment used for slip forming shall have automatic horizontal and vertical alignment controls, and shall be used in conjunction with a minimum of one stringline.

351.06.04 Straight Edges

Straight edges shall be according to OPSS 904.

351.07 CONSTRUCTION

351.07.01 General

Concrete sidewalk shall be constructed at the locations and to the dimensions specified in the Contract Documents.

351.07.02 Excavation and Embankment Construction

Excavation and embankment construction shall be according to OPSS 206.

351.07.03 Subgrade

When the subgrade is prepared for granular base, the finished subgrade surface shall be within a 15 mm deviation measured at any point on a 3 m long straight edge.

When the subgrade is prepared for sidewalk, the finished subgrade surface shall be within a 12 mm deviation from the specified grade and cross-section, with the surface being within a 10 mm deviation measured at any point on a 3 m long straight edge.

351.07.04 Granular Base

Placement of granular base material shall be according to OPSS 314.

When a granular base is prepared for sidewalk, the finished granular surface shall be within a 12 mm deviation from the specified grade and cross-section, with the surface being within a 10 mm deviation measured at any point on a 3 m long straight edge.

351.07.05 Compaction

Compaction of subgrade and granular base shall be according to OPSS 501.

351.07.06 Preparation Work

Prior to placing concrete on:

- a) subgrade, the subgrade shall be wetted down, except where clays occur.
- b) granular base, the granular immediately ahead of the concrete placing operation shall be wetted down thoroughly.

The wetting down shall be carried out without leaving standing water.

Alternatively, a subgrade moisture vapour barrier may be placed to completely cover the subgrade under the sidewalk. Adjacent strips shall be lapped 100 mm minimum and ends shall be lapped 300 mm minimum.

351.07.07 Form Setting

Throughout their entire length, forms shall be set true to the lines, grades, and thickness specified in the Contract Documents and in direct contact with the subgrade or granular base.

351.07.08 Utility Isolation in Sidewalk

The required Utility isolations shall be constructed in the concrete sidewalk to the details and locations specified in the Contract Documents.

351.07.09 Placing of Concrete

Placing of concrete shall be according to the Placing of Concrete, General clause and Concrete Placing Restrictions clause of OPSS 904.

Any excess concrete beyond the sidewalk edge shall be removed.

Concrete shall be placed at a steady rate, such that a monolithic concrete is obtained without the formation of cold joints. When there is an interruption in placing concrete greater than 20 minutes, the surface of the concrete where curing has not been applied shall be covered with wet burlap. The Contract Administrator shall be notified immediately of any interruption resulting in a cold joint. A proposal for remedial action shall be submitted to the Contract Administrator for approval.

351.07.10 Tactile Walking Surface Indicator Plate Installation

A set of two TWSI plates shall be set into plastic concrete at each concrete sidewalk ramp as specified in the Contract Documents and according to the plate manufacturer's installation instructions.

Plates shall be cleaned after installation.

351.07.11 Consolidation

Consolidation of concrete shall be according to OPSS 904.

351.07.12 Concrete Finishing

Concrete finishing shall be according to OPSS 904.

The concrete sidewalk shall be given a broomed texture after finishing with a float.

The concrete adjacent to all formwork and joints shall be finished with a tool that produces a 5 mm rounded edge and a smooth, horizontal surface with a maximum width of 50 mm. All tooling shall be uniform and straight and shall be depressed to a maximum of 1 mm below the adjacent surface. Any ridges along the tooled marks shall be removed.

351.07.13 Joints

351.07.13.01 General

Longitudinal and transverse joints shall be constructed of the type and at the locations specified in the Contract Documents.

351.07.13.02 Dummy Joints

Dummy joints shall be hand formed using a 5 mm radius dummy joint tool.

351.07.13.03 Contraction Joints

Contraction joints shall be placed at every third dummy joint and shall be sawcut or formed to a depth that is one quarter the thickness of the sidewalk.

When sawcutting is used, sawcutting shall be carried out as soon as the joint can be sawcut without ravelling the joint or damaging the concrete surface, and prior to any cracks developing.

Sawcut joints shall be cleaned. Cleaning of joints shall remove all sawcut slurry, grinding and grooving effluent, if applicable, and any other debris from the joint. Cleaning of joints shall consist of flushing the joints with water in one direction to remove slurry, effluent, and debris. Additional methods of cleaning the joints may be required and shall be approved by the Contract Administrator.

When the sidewalk width is 2.5 m or greater, a longitudinal contraction joint shall be sawn or formed at a maximum spacing interval of 1.5 m. Longitudinal contraction joints shall be constructed with equal spacing between joints and from joints to the sidewalk edges.

351.07.13.04 Expansion Joints

Expansion joints shall be constructed to the full depth of the slab.

Expansion joints shall be filled with expansion joint material and shall be clean and dry at the time of construction.

Expansion joints shall be constructed where the sidewalk abuts a rigid object or changes direction.

351.07.14 Identification Stamp

The concrete sidewalk shall be clearly and legibly marked with an approved stamp at each end of the work, every 20 m and all other places as directed by the Contract Administrator. The stamp shall be centered on the sidewalk bay next to and parallel to transverse joint. The stamp shall identify the Contractor's name and the year of construction.

351.07.15 Curing

Concrete curing shall be according to OPSS 904.

351.07.16 Concrete Subject to Cold Weather

For concrete subject to cold weather during the curing period, the protection of concrete shall be according to OPSS 904.

351.07.17 Protection of Sidewalk

Vehicular traffic shall be restricted from crossing the sidewalk after the concrete has been placed for a minimum period of 3 Days or until the concrete has reached 75% of the specified 28-Day compressive strength.

351.07.18 Surface Tolerance

Formed and unformed surfaces shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete. When the straight edge is placed across a construction joint, the gap between the straight edge and the surface of the concrete shall not be greater than 3 mm.

351.07.19 Tactile Walking Surface Indicator Plate Tolerances

Tolerances for the tactile walking surface indicator plates shall be as specified in the Contract Documents. If the TWSI plates are not within the specified tolerances, the plates shall be rejected. Rejected plates shall be removed and replaced as directed by the Contract Administrator.

351.07.20 Material Sampling for Thickness

Core samples shall be obtained for acceptance testing of sidewalk thickness. Cores shall be taken when the concrete is a minimum of 7 Days of age. The Contract Administrator shall randomly select one core from each lot. Coring shall be carried out according to CSA A23.2-14C. The cores shall be 100 mm in diameter and shall be drilled through the full depth of the sidewalk, perpendicular to the concrete surface.

Each core shall be marked legibly with durable ink immediately after removal with the following:

- a) Contract number.
- b) Lot number.
- c) Exact location of each individual core.
- d) Date of concrete placement (ie. yyyy-mm-dd).
- e) Date of extraction.

The cores, a transmittal form, and MTO form PH-CC-433A, Concrete Mix Design Submission Form A shall be submitted to the Contract Administrator. Filling of Core Holes shall be according to OPSS 1350.

One core shall be removed per lot for testing of thickness by the Owner. The core shall be taken at a random location specified by the Contract Administrator. Coring shall be carried out according to CSA A23.2-14C. The core shall be 100 mm in diameter and shall be drilled through the complete depth of concrete sidewalk. The Contract number, lot number and exact location of the core shall be marked legibly on the core with durable ink. The core shall be given to the Contract Administrator along with Form A of the concrete mix design.

351.07.21 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

351.08 QUALITY ASSURANCE

351.08.01 Acceptance

The concrete sidewalk shall be acceptable if all requirements of this specification are met, including requirements for:

- a) 28-Day compressive strength.
- b) Air void system parameters.
- c) Thickness.
- d) Surface tolerance.
- e) There are no defects detected by field inspection according to the Field Inspection subsection.

Acceptance for 28-Day compressive strength and air void system parameters shall be according to OPSS 1350.

Unacceptable lots shall be deemed rejectable. Concrete from unacceptable lots shall be removed and replaced at the Contractor's expense.

The replacement concrete sidewalk for lots that have been removed and replaced shall be evaluated for acceptance on the same basis as the original lots.

351.08.02 Field Inspection

The Contract Administrator shall inspect the work and shall reject all or a portion of the work based on the presence of one or more of the following defects:

- a) Cracks.
- b) Voids, or
- c) Honeycombing.
- d) Surface tolerance not meeting the requirements of this specification.

351.08.03 Acceptance of Thickness

351.08.03.01 Acceptance Testing

The lot size for testing of thickness shall be 500 lineal metres of sidewalk. The sidewalk thickness for each lot shall be determined based on the length of the core removed from each lot for thickness testing. Testing of thickness shall be according to LS-450.

Concrete thickness for a lot shall be considered acceptable when the thickness of the core is not more than 8 mm shorter than the specified thickness.

Unacceptable lots shall be removed and replaced.

The Contractor may submit an alternative in writing for the Owner's consideration for unacceptable concrete.

351.08.03.02 Referee Testing

Referee testing for a lot may only be invoked by the Contractor within 5 Business Days of receiving the test results for that lot.

Referee testing of thickness for a lot shall be done on the same core that was used for acceptance testing of thickness. Referee testing of thickness shall be according to LS-450.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed, and the acceptance test results shall be used in the determination of acceptance of the concrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded and not used in the determination of acceptance.

The confirmation value for confirming the acceptance test result shall be 5.0 mm.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

351.09 MEASUREMENT FOR PAYMENT

351.09.01 Actual Measurement

351.09.01.01 Concrete Sidewalk

Measurement of concrete sidewalk shall be by area in square metres.

351.09.01.02 Tactile Walking Surface Indicators for Concrete Sidewalk Ramps

For measurement purposes a count shall be made for each set of TWSI plates installed at each concrete sidewalk ramp. A set shall consist of two TWSI plates.

351.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

351.10 BASIS OF PAYMENT

351.10.01 Concrete Sidewalk - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Repair or removal and replacement of an unacceptable sidewalk bay shall be completed at no extra cost to the Owner.

351.10.02 Tactile Walking Surface Indicators for Concrete Sidewalk Ramps - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

351.10.03 Excavation

Payment for excavation shall be under the tender item Earth Excavation, Grading or Rock Excavation, Grading according to OPSS 206.

No payment shall be made for appurtenances adjusted by the Utility company.

351.10.05 Granular Material

Granular materials required for the work shall be paid for at the Contract price for the appropriate granular tender item.



CONSTRUCTION SPECIFICATION FOR THE INSTALLATION OF INTERLOCKING CONCRETE PAVERS

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355.01 SCOPE

This specification covers the requirements for the installation of interlocking concrete pavers for pavements, sidewalks, boulevards, and medians. The work includes the grading, placement of subsurface drainage, subbase, base, bedding sand, joint sand, edge restraints, and interlocking concrete pavers. This specification applies to both manual and mechanical installations.

355.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 313	Hot Mix Asphalt
OPSS 314	Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 405	Pipe Subdrains
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates – Concrete
OPSS 1004	Aggregates – Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1860	Geotextiles

CSA Standards

A231.2:19	Precast Concrete Pavers

355.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Bedding Sand means a layer of uncompacted sand that is screeded smooth prior to placement of the concrete pavers.

Concrete Paver means a precast concrete paving product.

Edge Restraint means a curb, edging, building, or other appurtenance that is intended to confine the bedding sand and concrete pavers so that the concrete pavers do not spread and lose interlock.

Joint Sand means a fine, dry sand used to fill the joint space and interlock the concrete pavers.

355.04 DESIGN AND SUBMISSION REQUIREMENTS

355.04.01 Submission Requirements

Laboratory test results indicating compliance to material requirements and a full-size sample of each type of concrete paver shall be submitted to the Contract Administrator at least 10 Business Days prior to commencement of paver installation.

355.05 MATERIALS

355.05.01 Granular Subbase

The granular subbase material shall be Granular B according to OPSS 1010.

355.05.02 Granular Base

The granular base material shall be Granular A according to OPSS 1010.

355.05.03 Bedding and Joint Sand

Bedding sand shall meet the requirements of concrete sand as specified in OPSS 1002, except that the percent passing the 75 µm sieve shall be less than 1%.

Joint sand shall be dry and meet the gradation requirements of mortar sand according to OPSS 1004 and the physical requirements according to OPSS 1002.

The bedding and joint sand shall be free of organics and deleterious soluble salts or other contaminants.

355.05.04 Concrete Pavers

Concrete pavers shall be according to CSA-A231.2 Concrete paver size, shape, colour, thickness, and texture shall be as specified in the Contract Documents.

Mechanically installed concrete pavers shall have integral spacer nibs on all vertical faces to control joint spacing.

355.05.05 Edge Restraints

Edge restraints shall be as specified in the Contract Documents.

355.05.06 Geotextile

Geotextile shall be non-woven, Class 1, according to OPSS 1860 with an FOS of 60 to 120 µm.

355.06 EQUIPMENT

355.06.01 Compaction

Concrete pavers shall be set into the bedding sand using a high frequency, low amplitude, mechanical flatplate vibratory compactor having a plate area sufficient to cover a minimum of 12 concrete pavers. The compactor shall transmit an effective force of not less than 22kN per square metre of plate area. The frequency of vibration shall be within the range of 75 to 90Hz.

Pneumatic-tired roller shall have a gross weight of 10 tonnes.

355.07 CONSTRUCTION

355.07.01 Subgrade Preparation

Preparation of the subgrade shall be according to OPSS 206.

355.07.02 Subbase and Base

When the interlocking concrete pavers are being placed on:

- a) Granular base, the base and subbase layers shall be constructed according to OPSS 314.
- b) Concrete base, the base layer shall be constructed according to OPSS 350.
- c) Asphalt base, the base layer shall be constructed according to OPSS 313.

Layer depths of subbase and base shall be as specified in the Contract Documents

Both granular subbase and base shall be compacted according to OPSS 501.

355.07.03 Subsurface Drainage

Subsurface drainage shall be as specified in the Contract Documents. Subdrains shall be constructed according to OPSS 405.

Geotextile shall be installed at all drain locations between the bedding sand and the drain surface extending 100 mm beyond the drain in all directions.

355.07.04 Bedding Sand

355.07.04.01 Placement

The bedding sand shall be placed loose, in a uniform layer with sufficient depth to achieve the final compacted thickness of 20 to 30 mm.

355.07.04.02 Screeding

The bedding sand shall be screeded in a loose condition and protected against compaction prior to placement of the concrete pavers.

355.07.05 Edge Restraint

Edge restraints shall be provided along the perimeter of all concrete paver installations.

355.07.06 Laying Pattern

Concrete pavers shall be installed in the pattern specified in the Contract Documents. Cutting of the concrete pavers, the use of infill concrete, and discontinuities in pattern shall only be allowed along the outer pavement boundaries and adjacent to drains, maintenance holes, edge restraints, and other appurtenances. Where partial concrete pavers are required, they shall be sawcut. No less than one-third of a concrete paver shall be used in pavement subjected to vehicular traffic.

355.07.07 Placement

Concrete pavers shall be placed uniformly to achieve normal joint spacing of 2 to 5 mm between adjacent concrete pavers and such that all joints are aligned.

Concrete pavers shall only be placed on loose moist bedding sand.

355.07.08 Compaction

355.07.08.01 Initial Compaction

After placement, compactive effort shall be applied to the concrete pavers to achieve compaction of the bedding sand and to achieve proper grade. At least three passes of a plate compactor shall be made across the surface of the concrete pavers.

355.07.08.02 Joint Sand Compaction

After initial compaction, dry joint sand shall be uniformly spread over the concrete pavers and swept to fill in the joints. At least two passes of a plate compactor shall be applied to the surface while simultaneously sweeping the sand into the joints. Joints shall be completely filled at the completion of compaction. Excess sand shall then be removed from the pavement surface by sweeping.

355.07.08.03 Final Compaction

On pavements subject to vehicular traffic, final compaction shall be achieved by not less than 10 passes of a pneumatic-tired roller.

355.07.09 Surface Tolerance

The surface of the concrete pavers is to be such that when tested with a 3 m long straightedge placed in any direction on the surface, except across the crown or drainage gutters, the gap between the bottom of the straightedge and the surface of the concrete pavers shall be 10 mm or less.

355.07.10 Removal of Unacceptable Concrete Pavers

All loose concrete pavers and concrete pavers that do not meet the surface tolerance shall be removed and reinstalled.

All pavers broken during the initial compaction shall be removed and replaced prior to the placement of the joint sand and joint sand compaction.

All damaged concrete pavers shall be removed and replaced.

355.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

355.09 MEASUREMENT FOR PAYMENT

355.09.01 Actual Measurement

355.09.01.01 Interlocking Concrete Pavers

Measurement shall be made for the area of concrete pavers placed in square metres without deduction for maintenance hole covers, Utility poles, and other appurtenances.

355.09.02 Plan Quantity

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

355.10 BASIS OF PAYMENT

355.10.01 Interlocking Concrete Pavers-Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

Removal and reinstallation of loose concrete pavers or concrete pavers not meeting surface tolerances shall be at no extra cost to the Owner.

Removal and replacement of damaged concrete pavers shall be at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR REPAIRING RIGID PAVEMENT WITH PRECAST CONCRETE SLABS

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363.01 SCOPE

This specification covers the requirements for repairing rigid pavement with precast concrete slabs using either the Fort Miller Super-Slab[®] Method or the Michigan Method. The work may include both continuous and intermittent slab repairs.

363.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

363.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

363.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 360	Full Depth Repair of Concrete Pavement or Base
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base
OPSS 510	Removal
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1441	Load Transfer Assemblies

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-602 Sieve Analysis of Aggregates

LS-619 Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

LS-704 Plastic Limit and Plasticity Index of Soils

MTO Materials Engineering and Research Report:

MERO-019 Falling Weight Deflectometer (FWD) Testing Guideline (ISBN 0-7794-8720-6 Print)

CSA Standards

A23.1/23.2-04 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

A3000-03 Cementitious Materials Compendium

A3004-C2 Test Method for Determination of Compressive Strengths [Part of CAN/CSA A3000-03, Cementitious Materials Compendium]

ASTM International

C 939-02 Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)

363.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bedding Grout means a thin non-structural grout pumped into the grout distribution system that is cast in the bottom of the Fort Miller Super-Slab® Method to fill voids beneath the slabs to provide uniform support to the slab.

Cement Treated Base means granular base material stabilized with Portland cement.

Continuous Precast Concrete Slab Repair means the continuous replacement of multiple consecutive slabs of concrete pavement with inter-connecting precast concrete slabs.

Diamond Grinding means altering the profile and texture of a concrete pavement surface by using grinding equipment that employs diamond tip blades.

Intermittent Precast Concrete Pavement Slab Repair means a 2 to 4.5 m long repair carried out using a single precast slab.

363.04 DESIGN AND SUBMISSION REQUIREMENTS

363.04.01 Submission Requirements

363.04.01.01 Precast Concrete Pavement Slab Repair Plan

At least 2 weeks prior to the start of the work, details on the method of the following operations shall be submitted to the Contract Administrator:

- a) Fabrication, transportation, and installation of each precast concrete slab repair method.
- b) Removal of existing concrete (i.e., sawcutting, removal, equipment, and disposal).

- c) Removal of hot mix asphalt repair.
- d) Base preparation.
- e) Precast slab placement.
- f) Grouting (i.e., equipment to be used for mixing and installing).

363.04.01.02 Precast Concrete Mix Design

The precast concrete mix design shall be submitted to the Contract Administrator at least 2 weeks prior to the start of the work.

Documentation shall be included with the submission of the mix design that demonstrates the proposed mix design and materials meet the requirements of this specification, including the air void system in the hardened concrete and the minimum specified 28-Day compressive strength.

All supporting test data shall not be more than 12 months old at the time the concrete mix design is submitted to the Contract Administrator.

363.04.01.03 Flowable Fill Mix Design - Michigan Method

When flowable fill is used as a levelling material, a concrete mix design for flowable fill shall be submitted to the Contract Administrator at least 2 weeks prior to the start of the work. Trial batch documentation shall also be submitted to the Contract Administrator for review a minimum of 7 Days prior to placement.

363.04.01.04 Proprietary Concrete Repair Material (PCRM) - Product Details

At least 7 Days prior to commencement of the work, the name of the PCRM selected for use and the manufacturer's specifications and recommendations for placement shall be submitted to the Contract Administrator. The submission shall also include documentation verifying the suitability of the product for the application and evidence of successful performance in a similar application. The PCRM and supporting information provided shall be acceptable to the Owner.

363.04.01.05 Chipping Hammer

At least one week prior to commencement of the work, a copy of the manufacturer's published specifications on the chipping hammers to be used shall be submitted to the Contract Administrator.

363.05 MATERIALS

363.05.01 Precast Concrete Slabs

363.05.01.01 General

The minimum compressive strength of concrete at 28 Days shall be 30 MPa. Testing of the concrete compressive strength shall be carried out according to CSA A23.2.

The air void parameters of the hardened concrete shall be a minimum air content of 3% and a maximum spacing factor of 0.230 mm.

Concrete shall meet the requirements of the materials section of OPSS 350 and OPSS 1350 with the following exceptions and additions:

- a) Concrete aggregates shall be according to OPSS 1002.
- b) The nominal maximum size of coarse aggregate shall be 19 mm.

363.05.01.02 Finishing

Finishing of precast concrete slabs shall be according to OPSS 350.

363.05.01.03 Texturing of Surface

Texturing of the precast concrete slab surface shall be according to OPSS 350 except that manual devices may be used to provide the required tined texture.

363.05.01.04 Dimensions

Precast concrete slabs shall be full lane width and length of 2 to 4.5 m. Prior to fabrication, the concrete thickness at each repair location shall be determined. Slabs may be cast a maximum of 15 mm thinner than the existing concrete to be repaired to accommodate the bedding material.

363.05.02 Fine Aggregate for Base Preparation - Fort Miller Super-Slab® Method

Fine aggregate for base preparation shall be 100% crushed fine aggregate with a plasticity index of 0% according to LS-704 and a maximum micro-Deval abrasion loss of 35 according to LS-619. Fine aggregate means that portion of aggregate material passing the 4.75 mm sieve when tested according to LS-602.

363.05.03 Flowable Fill - Michigan Method

Flowable fill shall consist of a mixture of Portland cement, coarse and fine aggregate, fly ash, and water, and may contain air entraining admixture or ground granulated blast furnace slag or both.

Portland cement shall be Type GU cement according to CSA A3000.

Fly ash shall be according to CSA A3000.

Coarse and fine aggregate shall meet the requirements of OPSS 1002 and shall have a maximum aggregate size of 12.5 mm.

The compressive strength of the flowable fill mixture shall not be less than 0.5 MPa or greater than 1.0 MPa at 28 Days.

If an air entraining admixture is used, then the air content of the flowable fill shall not exceed 35% of the flowable fill volume.

363.05.04 Bedding Grout - Fort Miller Super-Slab® Method

Bedding grout shall be a mixture of cement, water, and plasticizing admixture. The grout mixture shall have a flow rate of 17 to 22 seconds as measured by ASTM C 939 to ensure fluidity. The compressive strength of the bedding grout shall be a minimum of 2.0 MPa at 12 hours.

363.05.05 Tie Bars and Dowel Bars

Tie bars shall be according to OPSS 1440. Dowel bars shall be according to OPSS 1441.

363.05.06 Expansion Caps for Dowel Bars

Caps shall be tight-fitting and made of compressible, non-absorptive, closed cell polyethylene that will allow approximately 6 mm movement at the end of the dowel bar.

363.05.07 Bond Breaker

Dowel bars shall be coated with RC-250, Tectyl 506, or an approved equivalent.

363.05.08 Proprietary Concrete Repair Material (PCRM)

The PCRM selected shall be suitable for the application.

The minimum compressive strength of the PCRM at 28 Days shall be 30 MPa.

The PCRM for use in the dowel grout of the Fort Miller Super-Slab[®] Method shall be capable of being pumped into the inverted dovetail slots.

363.05.09 Epoxy Adhesives

Epoxy adhesives shall be from the Owner's approved product list and shall be of the type intended for horizontal dowel application and mixed in the cartridge nozzle.

363.05.10 Joint Materials

The joint sealant material shall be according to OPSS 369.

363.05.11 Water

Water shall be according to OPSS 1302.

363.06 EQUIPMENT

363.06.01 Screeding Device for Base Preparation

The screeding device used for fine grading for base preparation shall be laser or otherwise mechanically controlled and shall be capable of fine grading fully compacted fine aggregate or flowable fill to a tolerance of 3 mm.

363.06.02 Gang Drill

The gang drill shall consist of not less than three independently powered pneumatic drills.

363.06.03 Chipping Hammer

Chipping hammers shall be hand held and have a maximum weight of 9.0 kg prior to any handle modification, where applicable, and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and parts or model number engraved on them by the manufacturer. All information shall be clearly legible. The manufacturer's published specifications shall be the sole basis for determining weight and piston stroke.

363.06.04 Gang Saw

The gang saw shall have gang-mounted diamond saw blades and shall be capable of cutting at least 3 parallel slots simultaneously at a slot spacing of 300 mm within a tolerance of 3 mm.

363.06.05 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free from oil and other contaminants.

363.06.06 Consolidating Equipment

Internal vibrators used to consolidate the PCRM in the dowel bar slots shall have a maximum diameter of 25 mm and shall have a resilient covering that will not damage the epoxy coated reinforcement during use.

363.06.07 Hand Finishing Equipment

Hand finishing equipment shall be according to OPSS 904.

363.06.08 Straight Edges

Straight edges shall be according to OPSS 904.

363.07 CONSTRUCTION

363.07.01 General

Precast concrete pavement slab repairs shall be carried out at the locations identified in the Contract Documents. The work may include both continuous and intermittent slab repairs.

Acceptable methods of intermittent slab repair are the Fort Miller Super-Slab[®] Method and the Michigan Method, as modified by the requirements of this specification.

Acceptable methods of continuous slab repair are the Fort Miller Super-Slab[®] Method as modified by the requirements of this specification, or an alternative continuous precast method with demonstrated and documented good field performance under similar conditions, such as precast, prestressed concrete.

363.07.01.01 Fort Miller Super-Slab[®] Method

In the Fort Miller Super-Slab[®] Method, the work shall consist of fabricating precast concrete pavement slab repairs (i.e., Super-Slab[®]), sawcutting and removing the existing concrete pavement, repairing and compacting the existing subbase, as necessary, placing and grading fine aggregate base material, inserting and securing dowel bars and tie bars, placing precast slabs, installing PCRM in inverted dovetail slots, installing bedding grout beneath the slabs, and sealing of joints.

363.07.01.02 Michigan Method

In the Michigan Method, the work shall consist of fabricating precast concrete pavement slab repairs with dowel bars, sawcutting and removing the existing concrete pavement, constructing dowel bar slots, placing of flowable fill levelling material, placing precast slabs, installing PCRM in dowel bar slots, and sealing of joints.

363.07.01.03**Trial Slab Repair**

Prior to carrying out the precast concrete pavement slab repair, the ability to successfully carry out the slab repair according to this specification shall be demonstrated to the Contract Administrator by placing a trial repair slab within the Contract limits.

In lieu of a trial slab repair, the Contract Administrator may accept evidence demonstrating the ability to successfully conduct the slab repair with the same equipment, placing crew, and methodology to meet the Contract requirements for conducting the slab repair on any Contract within the last 12 months.

The trial slab repair shall be conducted on both the intermittent slab and continuous slab. The location of the trial slab repair shall be proposed to the Contract Administrator for approval. The Contract Administrator shall be given a minimum of 48 hours notice prior to the trial slab repair.

The Contract Administrator shall allow the slab repair work to continue based on an acceptable visual assessment of the trial. When the slab repair is rejected by visual assessment, additional trial slab repairs shall be performed until the slab repair meets the requirements of this specification.

Unacceptable trial repair slabs shall be repaired, removed, or reinstalled, as required.

363.07.02**Operational Constraints**

Perimeter sawcutting of the removal area shall not be carried out more than 1 week in advance of the expected date of repair.

Bedding grout and dowel grout shall be carried out as soon as possible after the installation of the precast concrete pavement slab.

The temperature of the flowable fill mixture used for the Michigan Method, as manufactured and delivered, shall be at least 10 °C. Placement of flowable fill shall not be allowed if the anticipated air temperature will be 2 °C or less in the 24 hour period following proposed placement.

The PCRM shall not be placed when the air temperature is outside the manufacturer's recommended temperature range or is likely to fall or rise outside the range throughout the duration of the material placing operation. Prior to placing the PCRM, it shall be demonstrated to the Contract Administrator that the existing concrete temperature in the repair area meets the manufacturer's requirements by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

Construction vehicles, equipment, or traffic shall not be permitted to travel on the precast repair until the PCRM has attained a minimum compressive strength of 20 MPa.

Each repair location shall be completed within the time period specified in the Contract Documents. If the repair is not progressing at a rate that will permit the full restoration of traffic within the allowable time period, appropriate measures acceptable to the Contract Administrator shall be undertaken to allow opening of the road to traffic. Full depth precast concrete slab repairs shall replace the above temporary work during the next scheduled closure.

363.07.03**Removals**

A template shall be used to precisely delineate the limits of the areas to be repaired within a tolerance of 12 mm. Repairs shall be the full width of the lane and full depth of concrete or hot mix asphalt repair.

Concrete removal shall be carried out according to OPSS 510. The outer limits of the removal area shall be sawcut full depth and shall not be overcut by more than 250 mm into the adjacent concrete that is to remain in place. Overcuts shall be filled with a proprietary product acceptable to the Owner.

Concrete removal shall be by lift-out method. Removals shall be carried out without damaging the adjacent concrete pavement or asphalt shoulder or disturbing the underlying base. Heavy breaking equipment such as hoe rams shall not be used in the removal operation. The concrete pavement shall not be broken in place.

If the adjacent concrete is damaged or cracked due to the removal procedure, the damaged concrete shall be repaired according to OPSS 360. Asphalt surfaces damaged during the removal process shall be repaired. A proposal for repairs shall be provided to the Contract Administrator for approval.

363.07.04 Base Preparation

363.07.04.01 General

Levelling material shall be either a flowable fill for the Michigan Method or fine aggregate for the Fort Miller Super-Slab[®] Method meeting the requirements of this specification.

Micro-grinding of the existing cement treated base is recommended if minor adjustment for the base level is required.

363.07.04.02 Flowable Fill - Michigan Method

The batching equipment shall have devices designed to measure the specified quantities of each component material and mixing shall be of sufficient duration to ensure uniform consistency of the mixture. Water content shall be maintained so that compressive strengths are achieved and a uniform, flowable mixture is developed that is essentially self-levelling when placed.

363.07.04.03 Fine Aggregate - Fort Miller Super-Slab[®] Method

Fine aggregate shall be compacted then fine graded using a screeding device capable of grading the fully compacted bedding material to the required tolerance.

363.07.05 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905.

363.07.06 Dowel Bar Installation - Michigan Method

363.07.06.01 Sawcutting Dowel Bar Slots

Slots shall be created using gang saws. The slots shall be 65 mm wide by 450 mm long and to a maximum depth to allow the dowel bar to be placed at mid-slab depth with 12 mm cover under the bar. The slots shall be parallel to the centreline of the roadway with a maximum tolerance of 3 mm from a parallel line.

Equipment shall not cause damage to the existing pavement. All slurry from the sawcutting operation shall be removed from the slot and pavement. Over-cutting dowel bar slots is not permitted.

363.07.06.02 Concrete Removal in Dowel Bar Slots

Chipping hammers shall be used to remove concrete within the slots. Concrete shall be removed to ensure the bottom of the slot is level and in such a manner as to prevent damage to the concrete remaining in place. If the concrete removal operation causes damage to the adjacent concrete pavement, corrective action shall be taken immediately.

If during the removal process the adjacent concrete is damaged due to the removal operation, the damaged concrete shall be repaired as a partial depth repair according to OPSS 360.

The chipping hammers shall not be permitted to break through the concrete. In the event of a break through or if a crack develops within a slot, the repair shall be treated as a full depth repair and the entire joint within the lane shall be removed and replaced with a 2 m full depth concrete repair according to OPSS 360.

363.07.06.03 Slot Cleaning

All concrete surfaces within the slot shall be solid, free from loose or unsound fragments. All concrete surfaces shall be abrasive blast cleaned according to OPSS 929 and all dust and loose material shall be removed from the prepared surface by using compressed air.

363.07.06.04 Placing the PCRM in Dowel Bar Slots - Michigan Method

All concrete surfaces within the slot shall be in accordance with manufacturer's requirements. Care shall be taken to prevent standing water in the slot. Prior to placing the PCRM, all excess water shall be removed with compressed air.

The treatment of the concrete surfaces within the slot with a bonding agent, if required by the manufacturer, and the mixing, placing, finishing, and curing of the PCRM shall be done according to the manufacturer's recommendations. A metering or measuring device shall be used to establish the correct amount of mixing water. All batches of PCRM shall be consistent.

PCRM shall not be spilled onto the adjacent concrete surface when placing in slots. The PCRM shall be vibrated to consolidate the material into the slot and around the dowel bar.

The PCRM shall be finished flush with the surface of the concrete and all excess material removed immediately. Hand finishing shall be minimized to prevent overworking of the repair. The PCRM shall be cured according to the manufacturer's recommendations.

363.07.07 Dowel Bar and Tie Bar Installation - Fort Miller Super-Slab® Method

Gang drills shall be used to drill holes in the existing concrete for insertion of dowel bars. The diameter of the drill holes shall be no more than 5 mm larger than the diameter of the dowel bars or tie bars. Drill holes shall be thoroughly cleaned by air blowing from the back of the drill hole outwards. Drilling equipment shall be used in a manner to ensure adjacent pavement is not damaged.

Dowel bars and tie bars shall be secured into the existing concrete with an epoxy adhesive. The epoxy adhesive shall be injected into the back of the cleaned drill hole and the dowel bar or tie bar with grout retention disks attached, and shall be inserted to ensure the bars are completely encased with epoxy adhesive for the full depth of the hole. Tie bars and dowel bars shall be installed as specified in the Contract Documents. Tie bars are only required for continuous repairs.

363.07.08 Slab Installation - Fort Miller Super-Slab® Method

Slabs shall be guided into position during installation using guide bars inserted in bedding grout port holes to align slabs during setting. The use of pry bars or wedges in joints for alignment purposes shall not be permitted.

The vertical differential between adjacent slabs shall be less than 6 mm. If the vertical differential is greater than 6 mm, the slab shall be removed, the base re-graded, and the slab reset until the differential is less than 6 mm prior moving on to the next slab.

If slabs are to be opened to traffic before they are grouted, incompressible shims shall be placed at approximate ¼ points in both the transverse and longitudinal joints to maintain horizontal alignment of the new precast slabs until they are grouted.

If un-grouted slabs are vertically displaced so that the vertical differential is greater than 6 mm as described above, the slab shall be removed, the base re-graded, and the slab reset prior to grouting, or the surface shall be brought to the required tolerance by grinding as required by this specification.

363.07.09 Placing the Dowel Grout and Bedding Grout - Fort Miller Super-Slab® Method

Foam grout dams shall be installed at the open ends of the transverse joint to be grouted to prevent dowel grout from escaping during the installation. Dowel grout shall be mixed in strict accordance with the instructions provided by the manufacturer. The volume of water shall be measured accurately for each batch by weighing the batch water or by using calibrated pails that are perforated at a level to ensure the correct amount of water is mixed with each bag of grout. Dowel grout shall be pumped in the back port of each dowel slot until it comes out the second port in the same slot. Foot shall be placed over the second port and pumping shall be continued until the grout flows along the joint to the next slot. The same procedure shall be repeated for the back port of the next slot. The grout level in previously filled ports shall be continually monitored. Grout shall be added, as necessary, to keep the grout level in the ports even with the top of the slab and in the joints above the top of the slots.

Bedding grout shall be placed after the dowel grout has been installed. Bedding grout shall be mixed in strict accordance with the instructions provided by the manufacturer of the viscosity-reducing admixture. Bedding grout shall be pumped in the lowest port of the slab until it comes out the corresponding port at the other end of the slab. While filling the remaining ports in the slab, the grout level shall be continually monitored in previously filled ports and grout added, as required, to keep the grout level in the ports even with the top of the slab. This will maintain a safe and adequate head pressure on the bedding grout until all voids under the slab are filled.

Before the bedding grout fully sets, the top 50 mm of bedding grout in each port shall be removed and replaced with PCRM. The PCRM in all ports shall be finished flush and matching with the surface of the concrete and all excess material removed immediately.

363.07.10 Tolerances

363.07.10.01 Dowel Bar and Tie Bar Tolerances

Dowel bars shall be installed mid-depth of the concrete slab in a plane with the pavement surface and parallel to the centreline of the road. Tie bars shall be installed mid-depth of the concrete slab in a plane with the pavement surface and perpendicular to the longitudinal lane edge sawcut face. The tolerance for the alignment of dowel bars and tie bars shall be ± 15 mm along the length of the bar in both the vertical and horizontal planes of the pavement and parallel to the direction of traffic.

363.07.10.02 Surface Tolerances

The surface of the precast concrete slab repair shall join flush with the existing concrete pavement. Surface tolerance of intermittent repair slabs shall be so that when tested with a 3 m long straight edge placed in the longitudinal direction there shall not be a gap greater than 6 mm between the bottom of the straight edge and the surface of the pavement. Surface tolerance of continuous slabs shall be so that the gap is not greater than 6 mm when the straight edge is placed in any location and direction, including the edge of pavement, except across the crown or drainage gutters.

363.07.11 Joint Sealing

All longitudinal and transverse joints shall be sealed according to OPSS 369.

363.07.12 Sampling and Testing

363.07.12.01 General

All samples, including those handled by a commercial carrier shall be accompanied by a sample data sheet and any additional documents as specified elsewhere in the Contract Documents. When not specified or not included on the sample data sheet, samples shall be delivered with a transmittal form identifying the following information:

- a) Contract Number.
- b) Name of Contractor, name of contact person and telephone numbers.
- c) Name of Contract Administrator, and telephone numbers.
- d) Quantity and type of sample. When a sample consists of more than one item, each item shall be individually identified.
- e) Date sampled.
- f) Date shipped.
- g) Sample, lot, and subplot number.
- h) Sample location.

363.07.12.02 Compressive Strength of Concrete in Precast Slab

Concrete test cylinders shall be cast, cured, handled, and delivered for 28-Day compressive strength testing according to OPSS 1350 based on 1 set of 2 cylinders taken for each batch of concrete.

363.07.12.03 Compressive Strength of Flowable Fill

The compressive strength of the flowable fill shall be determined by casting cylinders. Two sets of two standard 150 x 300 mm cylinders to represent a day's placement shall be cast, cured, and delivered. Cylinders for testing the 3-Day and 28-Day compressive strengths shall be stored and cured according to OPSS 1350, then transported to a quality assurance (QA) laboratory designated by the Owner in the Contract Documents. Testing for 28-Day compressive strength shall be conducted according to OPSS 1350, except that specimens shall be air cured in their moulds until they are to be tested.

363.07.12.04 Compressive Strength of Proprietary Concrete Repair Materials and Bedding Grout

Samples of PCRM shall be taken from the mixer in the field for the determination of the early strength and 28-Day compressive strength. The PCRM shall be moulded into cubes according to CAN/CSA A3004-C2.

Cubes shall be prepared on-site from the PCRM to be used to fill the slots. For the 28-Day compressive strength, the PCRM shall be sampled once for every 4 hours of production or a minimum of once per day, whichever is greatest. One set of six cubes shall be made from each sample of PCRM.

Additional cubes for determination of early strength shall be prepared. One set of six cubes shall be made for the final repair area of each closure. These cubes shall be tested to verify that the PCRM in the repair area has attained a compressive strength of 20 MPa. These test results shall be communicated immediately to the Contract Administrator prior to opening to traffic.

The timing of testing and frequency of testing of the early strength cubes shall be determined when the PCRM has attained a minimum compressive strength of 20 MPa.

The specimens shall be stored at a temperature between 15 °C and 25 °C and shall not be moved prior to demoulding. The specimens shall be demoulded and transported to the QA laboratory designated by the Owner within 24 hours $\pm$ 4 hours. The samples shall be transported in a sealed white opaque plastic bag containing at least 250 ml of water and maintained at a temperature between 15 °C and 25 °C.

363.07.12.05 Falling Weight Deflectometer Testing

Falling weight deflectometer (FWD) testing shall be carried out on the approach and leave joints of each precast slab to determine the load transfer efficiency across the transverse joints. FWD testing, equipment calibration, and reporting shall be according to MERO-019 using the Load Transfer test with a Detailed Project Level data collection scenario and a JCP Test Plan configuration.

363.07.13 Repair or Removal of Unacceptable Concrete

Precast concrete pavement slabs that arrive on the job site cracked, honeycombed, or showing any other visually detectable deficiencies shall be rejected and not used in the work.

Precast concrete pavement slabs that do not meet the surface tolerance requirements shall be removed and replaced, or corrected by diamond grinding.

Concrete pavement adjacent to precast concrete slab repair, damaged or displaced during installation of the precast repair shall be removed and replaced with new concrete as specified.

363.07.14 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

363.08 QUALITY ASSURANCE

363.08.01 Inspection

Prior to installation and with notification, access shall be provided to the Contract Administrator to inspect the precast concrete pavement slabs to ensure that they are properly textured and crack-free without any honeycombing or other visually detectable deficiencies.

363.08.02 Acceptance or Rejection

Prior to opening to traffic, access shall be provided to the Contract Administrator to inspect the precast concrete slab repairs to determine if the completed work contains:

- a) Cracking or spalling.
- b) Ungrouted saw over-cuts from the removal process.
- c) Rocking of precast concrete pavement slab.
- d) Precast concrete pavement slab that does not meet surface tolerance.

Precast concrete pavement slab repairs shall be rejected based on the presence of one or more of the defects identified above or one or more of the following conditions:

- a) FWD testing results indicate a load transfer efficiency of less than 70%.
- b) Compressive strength of the precast slab less than 30 MPa at 28 Days.
- c) Air content of the hardened concrete in the precast slab is less than 3% or spacing factor is greater than 0.230 mm.

A detailed remedial plan shall be submitted to the Contract Administrator for approval to address identified deficiencies.

363.09 MEASUREMENT FOR PAYMENT

363.09.01 Actual Measurement

363.09.01.01 Precast Concrete Slab Repair

Measurement of the precast concrete slab repair placed shall be by area in square metres. The total area shall be calculated to the nearest 0.1 m².

363.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

363.10 BASIS OF PAYMENT

363.10.01 Precast Concrete Slab Repair - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Measures taken to permit full restoration of traffic within the allowable time period shall be at no additional cost to the Owner.

Precast concrete pavement slabs that do not meet surface tolerance requirements shall be either removed and replaced or repaired by diamond grinding at no additional cost to the Owner.

Precast concrete pavement slabs rejected by the Contract Administrator shall be removed and replaced with new concrete as specified elsewhere in the Contract Documents at no additional cost to the Owner.

Concrete adjacent to and damaged by the removal process shall be cut back full depth to sound concrete and replaced at no additional cost to the Owner.

Asphalt surfaces damaged during the removal process shall be repaired at no additional cost to the Owner.

Full-depth repairs required as a result of chipping hammers breaking through the concrete or a crack developing as a result of chipping operations shall be carried out at no additional cost to the Owner.

Appendix 363-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
CROSS-STITCHING LONGITUDINAL CRACKS IN
CONCRETE PAVEMENT AND CONCRETE BASE**

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365-A	Commentary

365.01	SCOPE

This specification covers the requirements for cross-stitching longitudinal cracks in concrete pavement and concrete base.

365.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

365.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

365.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 369 Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base

Ontario Provincial Standard Specifications, Material

OPSS 1440 Steel Reinforcement for Concrete
OPSS 1442 Epoxy Coated Reinforcing Steel Bars for Concrete

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

365.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cross-Stitching means tying together concrete pavement or concrete base across a longitudinal crack using deformed tie bars epoxied into holes drilled at an angle across the crack. This prevents horizontal and vertical movement of the concrete crack and migration of the adjacent slabs.

365.05 MATERIALS

365.05.01 Tie Bars

Tie bars shall be deformed tie bars according to OPSS 1440 and as specified in the Contract Documents. Tie bars shall be epoxy coated according to OPSS 1442.

365.05.02 Epoxy Adhesive

Epoxy adhesive shall be of the type specified for horizontal dowel application and mixed in the cartridge. Epoxy adhesive shall be supplied from a source on the ministry DSM.

365.06 EQUIPMENT

365.06.01 Drill

A hydraulic or pneumatic drill shall be used to drill holes in the concrete pavement or concrete base. The drill shall be frame mounted and capable of drilling at a 35 or 45 degree angle to the horizontal. Drilling equipment shall be used in a manner to ensure adjacent concrete is not damaged.

365.06.02 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free from oil and other contaminants.

365.07 CONSTRUCTION

365.07.01 Tie Bar Installation

Tie bars shall be installed as specified in the Contract Documents at locations identified by the Contract Administrator. A minimum of two deformed tie bars shall be cross-stitched through a single longitudinal crack.

Holes for the tie bars shall be drilled at an angle to the horizontal, alternating across opposite sides of the crack to produce a cross-stitching pattern. The diameter of the drill hole shall be no more than 5 mm larger than the diameter of the tie bar. Drill holes shall be located such that the tie bar intersects the longitudinal crack at approximately mid-depth of the concrete slab. Drill holes shall not exit the bottom of the concrete slab and shall be installed within the following tolerances:

- a) Drilling angle: $\pm 1^\circ$
- b) Drill hole depth: ± 5 mm
- c) Drill hole diameter: ± 1 mm
- d) Drill hole offset from longitudinal crack: ± 5 mm

Prior to tie bar installation, drill holes shall be thoroughly cleaned with compressed air by inserting the compressor nozzle for the full length of the drilled hole.

The tie bars shall be secured into the existing concrete with epoxy adhesive. The epoxy adhesive shall be injected into the cleaned drill hole from the bottom of the hole outward. The tie bars shall be inserted to ensure the bars are completely encased with epoxy adhesive for the full depth of the drill hole. Excess epoxy shall be removed from the surface of the pavement.

365.07.02 Sealing of Longitudinal Cracks

Upon completion of tie bar installation the longitudinal crack shall be sealed according to OPSS 369.

365.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

365.08 QUALITY ASSURANCE

365.08.01 Inspection

The Contractor shall allow the Contract Administrator to inspect all drill holes prior to placing the tie bars to ensure they meet the requirements of the Contract Documents.

365.08.02 Rejection

Drill holes identified by the Contract Administrator as not meeting the requirements of the Contract Documents shall be filled with epoxy and abandoned.

365.09 MEASUREMENT OF PAYMENT

365.09.01 Actual Measurement

365.09.01.01 Cross-Stitching Longitudinal Cracks in Concrete Pavement and Concrete Base

For measurement purposes, a count shall be made of the number of cross-stitching tie bars installed.

365.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

365.10 BASIS OF PAYMENT

365.10.01 Cross-Stitching Longitudinal Cracks in Concrete Pavement and Concrete Base - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Drill holes not within the specified tolerances shall be filled with epoxy and abandoned at no additional cost to the Owner.

365.10.02 Sealing of Longitudinal Cracks

Payment for the sealing of longitudinal cracks shall be according to OPSS 369.

Appendix 365-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR REPAIRING CONCRETE PAVEMENT AND CONCRETE BASE

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366.01 SCOPE

This specification covers the requirements for full depth and partial depth repairs of concrete pavement and concrete base using conventional concrete repairs, high early strength concrete repairs, and fast-track concrete repairs (full depth repair only).

366.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 320	Open Graded Drainage Layer
OPSS 350	Concrete Pavement and Concrete Base
OPSS 369	Sealing or Resealing of Joints and Cracks in Concrete Pavement and Concrete Base
OPSS 904	Concrete Structures
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Materials

OPSS 1002	Aggregates - Concrete
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade and Backfill Material
OPSS 1301	Cementing Materials

OPSS 1302	Water
OPSS 1306	Burlap
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1441	Load Transfer Assemblies
OPSS 1442	Epoxy Coated Reinforcing Steel Bars for Concrete

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-410	Method of Test for Compressive Strength of Drilled Cores
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
LS-435	Method of Test for Linear Shrinkage of Concrete
LS-449	Method of Test for Load Transfer Test of Concrete Pavement Using a Falling Weight Deflectometer

CSA Standards

A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens*
A23.2-9C	Strength of Cylindrical Concrete Specimens*
A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing*
	*[Part of A23.1-19/A23.2-19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

C171-20	Sheet Materials for Curing Concrete

366.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Autogenous Cylinders means cylinders used for estimating compressive strength of concrete in the repair areas when high early strength or fast-track concrete is used. These cylinders are stored in insulated curing containers in which the elevated curing temperature is obtained from heat of hydration of the cement.

Cold Weather means as defined in OPSS 350.

Conventional Concrete Repair means a concrete pavement or concrete base repair process excluding high early strength concrete repairs or fast-track concrete repairs.

Diamond Grinding means altering the profile and texture of a concrete surface by utilizing grinding equipment that employs diamond tipped blades.

Fast-track Concrete Repair means a process in which a section of concrete pavement or concrete base is closed to traffic, concrete is removed and repairs are completed, and the section is re-opened to traffic within a specified time period of 24 hours or less.

Full Depth Repair means a repair area in the concrete pavement or concrete base which is the full thickness of the existing concrete pavement or concrete base.

High Early Strength Concrete Repair means a process in which a section of concrete pavement or concrete base is closed to traffic, concrete is removed, and concrete repairs are completed and the section re-opened to traffic within 72 hours or within the timeframe specified in the Contract Documents.

Horizontal Alignment means as defined in OPSS 350.

Horizontal Side Shift means as defined in OPSS 350.

Hot Weather means as defined in OPSS 350.

Longitudinal Side Shift means as defined in OPSS 350.

Partial Depth Repair means a repair area in the concrete pavement or concrete base which has a minimum depth of 50 mm to a maximum depth of one-third the thickness of the existing concrete pavement or concrete base.

Staged Repair means a repair area which cannot be repaired in one complete operation due to traffic or construction sequence requirements and must be completed in separate stages.

Vertical Alignment means as defined in OPSS 350.

366.04 DESIGN AND SUBMISSION REQUIREMENTS

366.04.01 Design Requirements

366.04.01.01 Concrete Mix Design

The concrete mix shall be designed to provide adequate strength and durability for the intended use and to meet the requirements specified in the Contract Documents.

366.04.02 Submission Requirements

366.04.02.01 Concrete Mix Design

The concrete mix design(s) shall be submitted according to OPSS 1350.

Linear shrinkage test results shall be submitted to the Contract Administrator within 40 Days of the mix design submission, for information purposes. Concrete specimens may be obtained from a laboratory batch or sampled in the field. Linear shrinkage testing shall be according to LS-435.

366.04.02.02 Calibration Charts and Autogenous Cylinder Method for High Early Strength and Fast-track Concrete Repairs

The following information, according to the Autogenous Cylinder Method Calibration Charts for High Early Strength and Fast-track Concrete Repairs subsection, shall be submitted to the Contract Administrator at the time of submission of the concrete mix design for the high early strength and fast-track concrete repairs:

- a) Calibration chart indicating compressive strength versus temperature.
- b) Calibration chart indicating temperature versus time.
- c) Ambient air temperature during development of the calibration charts.

The above data shall be accompanied by a covering letter, signed by an Engineer, identifying the curing method, the test method, and detailing the development of the calibration chart.

For high early strength concrete repairs, calibration charts shall be developed prior to construction of the repairs. For fast-track concrete repairs, calibrations charts shall be developed prior to commencement of the trial area. Calibrations charts shall be developed according to the Autogenous Cylinder Method Calibration Charts for High Early Strength and Fast-track Concrete Repairs subsection. If a trial area is not required, calibration charts shall be developed prior to construction of the fast-track repairs.

All supporting test data shall not be more than 12 months old at the time the concrete mix design is submitted to the Contract Administrator.

If the ambient air temperature at time of placement differs from the ambient air temperature during the development of the calibration charts by more than 10 °C, new calibration charts shall be submitted.

In the event that field performance or conditions are no longer representative of the conditions under which the submitted calibration charts were developed, a new mix design and charts shall be resubmitted prior to proceeding with concrete repairs.

366.04.02.03 Method of Removal of Existing Concrete

A description of the method to be used to remove the existing concrete shall be submitted to the Contract Administrator at least 2 weeks prior to the start of the work. The description shall comply with the requirements in the Concrete Removal subsection and include the sawcutting and removal process, equipment, and disposal.

A proposal for repair and/or replacement of disturbed, removed or damaged underlying material including the material, mixing and placement method shall be submitted to the Contract Administrator for review. Repair shall not proceed until the proposal is accepted by the Owner.

366.04.02.04 Chipping Hammers

The manufacturer's published specifications on the chipping hammers shall be submitted to the Contract Administrator 1 week prior to the commencement of the partial depth removal operation.

366.04.02.05 Temperature Control Plans

366.04.02.05.01 Cold Weather

Temperature control plans for all concrete repairs except fast-track concrete repair, shall be submitted according to OPSS 904 in the event of cold weather conditions.

366.04.02.05.02 Hot Weather

For all concrete repairs subject to hot weather conditions, a temperature control plan that describe the methods to be used to control the temperature of the concrete shall be submitted to the Contract Administrator 7 Days prior to placement.

366.04.02.06 Curing Compound

Curing compound submissions shall be according to OPSS 904.

366.04.02.07 Effluent Management

Effluent management submissions shall be according to OPSS 350.

366.05 MATERIALS

366.05.01 Bond Breaker

Bond breaker shall be RC-250, Tectyl 506, or an alternative type of material acceptable to the Owner.

Dowel bars and load transfer devices shall be shop coated with bond breaker, except for dowels which are installed into existing concrete.

366.05.02 Bonding Agent

Bonding agent shall consist of Portland cement and fine aggregate mixed with water to form a stiff mixture. Portland cement shall be according to OPSS 1301. Fine aggregate shall be according to OPSS 1002. The consistency of the mixture shall be such that it can be applied with a stiff brush to the concrete surface in a thin even coating that will not run or puddle.

366.05.03 Burlap

Burlap shall be according to OPSS 1306.

366.05.04 Concrete

Materials for concrete shall be according to the Materials section of OPSS 1350 with the following exceptions and additions:

- a) The nominal maximum size of coarse aggregate shall be as specified in Table 1.
- b) The minimum 28-Day concrete compressive strength shall be 35 MPa, unless otherwise specified in the Concrete Documents.
- c) The compressive strength of the concrete in the repair area shall be a minimum of 20 MPa prior to opening to traffic.
- d) For partial depth repairs in areas where the greatest dimension (width or length) of the repair area is less than 300 mm, a proposal to use a proprietary patching material may be submitted to the Contract Administrator for approval.
- e) The requirements for rapid chloride permeability do not apply.
- f) Fast-track concrete repairs shall not be used for partial depth repairs.
- g) For high early strength concrete and fast-track concrete repairs, the maximum temperature of concrete at the time of discharge from the truck shall not exceed 35 °C.
- h) For fast-track concrete repairs, the requirement for greenhouse gas (GHG) reduction does not apply.
- i) For fast-track concrete repairs, the requirement for plastic air content does not apply.
- j) For fast-track concrete repairs, superplasticizer may be used and may be added at the plant or site. Testing of slump prior to addition of superplasticizer is not required.
- k) For fast-track concrete repairs, calcium chloride based accelerator or other accelerators may be used. When used, it shall be measured accurately to ensure a consistent dosage for each load, and it shall be added and mixed in a manner to ensure consistent distribution throughout the load.
- l) For high early strength concrete repairs, the use of accelerating admixtures shall not be permitted.

366.05.05 Curing Compound

Curing compound for concrete shall be according to OPSS 1315.

366.05.06 Epoxy Adhesives

Epoxy resins dowel adhesives used for dowel and tie bars shall be from the MTO DSM approved for horizontal applications and mixed in the nozzle (cartridge). Cementitious grouts shall not be permitted for this application.

366.05.07 Expansion Joint Filler

Expansion joint filler shall be according to OPSS 1308.

366.05.08 Moisture Vapour Barrier

Moisture vapour barrier shall be white opaque polyethylene film according to ASTM C171 and shall not be less than 100 µm thick.

366.05.09 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's list of acceptable concrete patching materials. The list of proprietary patching materials may be obtained from the Contract Administrator.

366.05.10 Tie Bars, Dowel Bars and Load Transfer Devices

Tie bars and dowel bars shall be according to OPSS 1440. Tie bars and dowel bars shall be epoxy coated according to OPSS 1442. Load transfer devices shall be according to OPSS 1441.

366.05.11 Water

Water used for curing of concrete, pre-soaking of burlap, making bonding agent and mixing proprietary patching materials shall be according to OPSS 1302.

366.06 EQUIPMENT

366.06.01 Air Compressor

The compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free from oil and other contaminants.

366.06.02 Batching Plant and Delivery Equipment

The batching plant shall be according to the Batching Plant subsection of OPSS 1350. Delivery equipment shall be according to the Delivery Equipment subsection of OPSS 1350.

366.06.03 Chipping Hammer

Chipping hammers shall be hand-held and have a maximum weight of 9.0 kg prior to any handle modification, where applicable, and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and part or model number engraved on them by the manufacturer. All information shall be clearly legible. The manufacturer's published specifications shall be the sole basis for determining weight and piston stroke.

366.06.04 Diamond Grinder

When a diamond grinder is used, it shall be power-driven, self-propelled equipment specifically designed to grind and texture concrete surfaces. It shall be equipped with a grinding head with at least 50 diamond blades per 300 mm of shaft. The grinding head shall be at least 0.9 m wide. The grinder shall be equipped with the capability to adjust the depth, slope and cross-fall to ensure that concrete is removed to the desired dimensions and uniformly feathered and textured across the width and length of the required area.

The diamond grinder shall be equipped with a vacuum system that is, capable of removing all standing effluent, leaving the roadway in a clean, near dry condition after each pass. Residue shall not be permitted to encroach into open lanes, ditches or enter, into closed drainage systems. The management of effluent from diamond grinding operation shall be according to OPSS 350.

366.06.05 Gang Drill

The gang drill shall consist of not less than three independently powered pneumatic drills. Drilling shall not damage adjacent concrete.

366.06.06 Hand Finishing Equipment

Floats used to finish concrete shall be made of magnesium.

366.06.07 Placing and Finishing Equipment

Equipment used for placing, consolidating and finishing concrete for full depth repairs 3 m or greater in length (measured in the direction of traffic) shall be a vibratory steel screed or steel cylinder screed with integral internal vibration including automatic shut-off, and shall operate on fixed forms.

For partial depth repairs and full depth repair areas less than 3 m in length (measured in the direction of traffic), the concrete may be placed and consolidated using hand-held vibrators and finished with a straightedge.

366.06.08 Straight Edge

Straight edge shall be commercially made of metal, and 3 m long.

366.06.09 Thermocouples and Dataloggers

Thermocouples and associated instrumentation shall have an accuracy of $\pm 1.5^{\circ}\text{C}$, record temperatures at time intervals not exceeding 15 minutes, and shall display the temperature.

366.07 CONSTRUCTION

366.07.01 Autogenous Cylinder Method Calibration Charts for High Early Strength and Fast-track Concrete Repairs

For high early strength concrete repairs and fast-track concrete repairs, autogenous cylinder calibration charts shall be developed for the purpose of determining the rate of early strength development of the high early strength and fast-track concrete mixes. The minimum length of time for the calibration chart shall be the period of lane closure specified in the Contract Documents.

The size, preparation and testing of cylinders shall be according to the Early Strength Determination for High Early Strength and Fast-track Concrete Repairs clause.

Development of the calibration charts for high early strength concrete repair and fast-track concrete repair shall be according to the following:

- a) Compressive strength testing at each time interval shall be done on sets of two cylinders.
- b) For high early strength concrete repair, a minimum of six sets of cylinders shall be tested for compressive strength and the Contractor is responsible for determining the timing of testing of the first set of cylinders.
- c) For fast-track concrete repair, the first set of cylinders shall be tested no later than 3 hours after the cylinders are cast.
- d) After the first set of cylinders are tested, testing shall continue at a minimum frequency of every 30 minutes for the length of time of the lane closure.
- e) A thermocouple or sensor shall be installed in one of the cylinders in each set, and the temperature of the concrete shall be recorded at a minimum of every 30 minutes after casting until the time of testing.

366.07.02 Trial Area for Fast-track Concrete Repairs

A typical fast-track full depth concrete repair shall be demonstrated at the trial repair area specified in the Contract Documents a minimum of 1 week prior to any concreting operation. A trial repair area is not required if the Contractor has demonstrated successful placement of fast-track concrete repairs, meeting all specification requirements, within the last 5 years on another ministry Contract.

If a trial repair area is not specified in the Contract Documents, a location acceptable to the Contract Administrator shall be selected to demonstrate a repair. The selected repair area shall be a minimum of 2 m long by 3.75 m wide and 0.250 m deep.

The ability to fully complete the trial repair area within the time frame of the lane closure specified in the Contract Documents shall be demonstrated. The trial repair shall simulate the Contract site conditions as if it were the last repair of the closure and shall include sampling and testing as specified in the Material Sampling and Testing subsection. The trial repair shall use the same mix design and equipment as will be used for the Work. The trial repair area shall not be overlaid and shall remain exposed for at least 7 Days to permit inspection for deficiencies.

The Contractor shall verify the calibration chart for the mix design strength versus temperature and the calibration chart for the mix design temperature versus time using the autogenous cylinder method.

Five cores shall be obtained from the trial repair area according to the Coring for 28-Day Compressive Strength and Air Void System Parameter Testing clause. Three cores shall be tested for compressive strength and two cores shall be tested for AVS according to the Quality Assurance section. The compressive strength and air void system shall meet the requirements of this specification.

Repairs shall not proceed until written permission from the Contract Administrator has been received indicating that all of the above conditions have been met.

366.07.03 Operational Constraints

366.07.03.01 General

The Contract Administrator shall be notified in writing of the intent to repair the concrete pavement or concrete base 1 week prior to the commencement of the repairs.

Concrete shall not be placed when the air temperature is below 5 °C, or is above 30 °C. Concrete shall not be placed on or against any material with a surface temperature below 5 °C, or above 30 °C.

Vehicles shall not be permitted to drive on areas where the concrete pavement or concrete base has been removed, in whole or part.

The concrete pavement or concrete base shall be protected from damage to the surface at all times when steel-tracked equipment is used. Traffic, other than foot traffic and rubber-tired sawing equipment, shall not be permitted on the concrete until it has attained a compressive strength of 20 MPa.

366.07.03.02 Concrete Base Repairs

The Contract Administrator shall be notified 72 hours prior to the asphalt pavement removal. After asphalt pavement removal is complete, the concrete base surface shall be power swept prior to the visual inspection and/or falling weight deflectometer (FWD) testing. Access and any traffic control signing shall be provided to facilitate visual inspection and FWD testing by the Contract Administrator. Equipment which may cause vibrations in the pavement structure shall not be used within 100 m of FWD testing.

366.07.03.03 High Early Strength Concrete Repair

Repairs to each high early strength concrete repair location shall be completed within the time frames specified in the Contract Documents.

If the repair is not progressing at a rate that will permit the opening of traffic within the specified time period, appropriate temporary measures acceptable to the Contract Administrator shall be undertaken to allow opening to traffic. These measures shall be at the Contractor's expense. A high early strength concrete repair shall replace the above temporary work during the next scheduled closure.

366.07.03.04 Fast-track Concrete Repairs

Fast-track concrete repairs shall not be placed between October 1 and May 1. Fast-track concrete repairs shall not be performed in cold weather conditions. Fast-track concrete repairs shall be full depth.

Repairs to each fast-track concrete repair location shall be completed within the time frames specified in the Contract Documents.

If the repair is not progressing at a rate that will permit the opening to traffic within the specified time period, appropriate temporary measures acceptable to the Contract Administrator shall be undertaken to allow opening to traffic. These temporary measures shall be at the Contractor's expense. A fast-track concrete repair shall replace the above temporary work during the next scheduled closure.

366.07.04 Concrete Removal

366.07.04.01 Full Depth Repairs

Full depth repair areas shall be as specified in the Contract Documents or as demarcated by the Contract Administrator. Repairs shall extend the full width of the lane and shall be a minimum of 2 m in length. Partial lane-width repairs shall not be permitted.

The outer limits of the concrete removal area shall be sawcut full depth. Where exposed concrete pavement or concrete base conditions are sufficient to support traffic loading, advanced sawcutting is permitted up to 7 Days in advance of the expected date of removal. Sawcuts shall extend no more than 100 mm into existing adjacent concrete that is to remain in place. Sawcuts in concrete that are to remain in place shall be filled with an epoxy resin acceptable to the Owner.

Concrete removal shall be by a lift-out method rather than breaking in place. Adjoining concrete and underlying base shall remain undisturbed. Heavy breaking equipment such as hoe rams shall not be used in the removal operation.

If during the removal, the underlying material below the concrete pavement or concrete base is disturbed, removed, or damaged, the underlying materials shall be repaired and/or replaced with the same type of underlying material at no additional cost to the Owner.

When the underlying material is open graded drainage layer (OGDL), repair and/or replacement shall be according to OPSS 320. For small localized repair areas, a repair proposal using an alternative OGDL placement method may be submitted for consideration to the Contract Administrator.

When the underlying material is granular, the material requirements shall be according to OPSS 1010. Compaction of the granular materials shall be by means of:

- a) A plate tamper with a minimum mass of 80 kg, or
- b) A self-propelled (walk-behind) single or tandem steel drum with a minimum static mass of 500 kg used in vibration mode.

If during the removal process the adjacent concrete in the lane is damaged or cracked due to the removal procedure, the damaged area shall be cut back full depth to sound concrete and repaired according to this specification and as directed by the Contract Administrator. The full area shall be repaired as one continuous placement.

366.07.04.02 Partial Depth Repairs

Partial depth repair areas shall be as specified in the Contract Documents or as demarcated by the Contract Administrator. The perimeter of the repair area shall be sawcut vertically to a depth of 25 mm. The concrete within the sawcut area shall be removed using a chipping hammer to a minimum depth of 50 mm, and to a maximum depth of one-third the thickness of the existing concrete pavement or concrete base, without damaging the underlying sound concrete. Any wire mesh in the concrete shall be removed within the repair area.

If the partial depth concrete removal operation reveals deterioration extending to a depth greater than one-third the thickness of the existing concrete pavement or concrete base, the repair shall be treated as a full depth repair and concrete shall be removed according to the Full Depth Repairs clause of the Concrete Removals subsection. Full depth repair works shall not proceed without prior approval from the Contract Administrator.

If during the removal process the adjacent concrete in the lane is damaged, the damaged area shall be cut back to sound concrete and repaired according to this specification and as directed by the Contract Administrator. The full area shall be repaired as one continuous placement.

366.07.05 Preparation Work

366.07.05.01 Full Depth Repairs

Prior to placing concrete, the underlying material immediately ahead of the concrete placing operation shall be wetted down thoroughly. The wetting down shall be carried out without leaving standing water.

All standing water shall be removed, and any disturbed underlying material shall be repaired prior to concrete placement operation.

366.07.05.02 Partial Depth Repairs

All concrete surfaces to receive new concrete shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to wetting the concrete surface, all dust and loose material shall be removed from the prepared surface of the repair area by using compressed air.

The surface of the patch to receive new concrete shall be maintained in a wet condition for a period of 1 hour prior to placing any new concrete. Prior to placing concrete, excess water shall be removed from the surface using compressed air.

Immediately prior to filling the repair area with concrete, a thin even coat of bonding agent shall be brushed onto all vertical and horizontal prepared surfaces against which concrete will be placed. After application of the bonding agent, any fine aggregate separated from the mixture or any excess bonding agent shall be removed from the surface of the concrete.

The bonding agent shall be applied within 30 minutes after mixing and shall not be permitted to dry prior to placing any concrete on it. In the event that the bonding agent has dried, it shall be removed and reapplied prior to concrete placement. All bonding agent or concrete deposited in areas other than the intended point of discharge shall be removed immediately.

366.07.06 Joints for Full Depth Repairs

366.07.06.01 General

The locations and the type of the joints for concrete pavement and concrete base shall be as specified in the Contract Documents. Possible joint types specified may include construction, transverse, longitudinal, and expansion joints. All joints shall be cut or formed to the joint details specified in the Contract Documents.

A reservoir cut and sealant are not required for concrete base.

Where the operation requires a staged repair, a construction joint shall be placed between stages.

366.07.06.02 Installation of Dowel Bars and Tie Bars

Dowel bars and tie bars shall be installed at locations specified in the Contract Documents. Where reinforcement is present in the existing concrete, tie bars and dowel bars may be adjusted ± 25 mm horizontally and ± 10 mm vertically, to avoid drilling through the steel reinforcement.

Gang drills shall be used to drill holes in the existing concrete for insertion of the dowel bars and tie bars. The diameter of the drill hole shall be no more than 5 mm larger than the diameter of the dowels or tie bars. Prior to filling the drill holes, the inside surfaces of each drill hole shall be wire brushed and then cleaned using compressed air. The dowel bars and tie bars shall be secured into the existing concrete with epoxy adhesive. The epoxy adhesive shall be injected into the back of the cleaned drill hole and the dowel or tie bar, with grout retention disks attached, shall be inserted to completely encase the bars with epoxy adhesive for the full depth of the hole.

If during the drilling process the existing concrete is cracked due to the drilling procedure, the cracked area shall be cut back full depth to sound concrete.

The dowel bars shall be placed mid-depth of the specified concrete pavement or concrete base thickness and parallel to the longitudinal axis (horizontal alignment) and the horizontal plane (vertical alignment) of the concrete pavement or concrete base within the following tolerances:

- a) Vertical alignment: ± 15 mm along the length of the dowel bar.
- b) Horizontal alignment: ± 15 mm along the length of the dowel bar.
- c) Longitudinal side shift: The centre of the dowel bar shall lie within ± 50 mm from the transverse joint.
- d) Depth:
 - i. For a specified concrete pavement or concrete base thickness of < 215 mm: mid-depth ± 6 mm.
 - ii. For a specified concrete pavement or concrete base thickness from 215 to 229 mm: mid-depth $+ 15$ /- 12 mm.
 - iii. For a specified concrete pavement or concrete base thickness of 230 mm or greater: mid-depth $+ 25$ /- 15 mm.

The tie bars shall be installed within a tolerance of ± 15 mm from mid-depth of the specified concrete pavement or concrete base thickness. Tie bars shall not be placed within 600 mm of a transverse joint.

Dowel bars and tie bars shall be installed and secured in a manner that will ensure they remain in the proper position and orientation during the concreting operation.

The epoxy adhesive shall be fully cured prior to placing concrete. Immediately prior to placing concrete, the free end of the dowel bars (not tie bars) and the exposed vertical concrete face along the transverse joint shall be coated with bond breaker.

Where tie bars are not specified, the exposed vertical concrete face along the longitudinal joint shall be coated with bond breaker.

Holes that have been started but not completed shall be cleaned and filled with a proprietary patching material.

366.07.06.03 Transverse Joints

Transverse joints shall be cut or formed to the joint details specified in the Contract Documents and skewed if required. Joints shall have a minimum spacing of 2 m and a maximum spacing of 4 m.

Expansion joints shall be placed where specified in the Contract Documents and when replacing existing expansion joints.

366.07.06.04 Mid-Lane Longitudinal Joints for Fast-track Concrete Repair

In repair areas where the transverse joint spacing is 3 m or less in length, a longitudinal joint shall be created in the middle of the lane and for the full length of the repair.

Tie bars shall be placed at mid-depth of the concrete pavement or concrete base along the full length of the longitudinal joint. The tie bars shall be 25M deformed bars and shall be 760 mm in length. These bars shall be spaced every 400 mm and shall not be placed within 400 mm of a transverse joint.

Tie bars shall be installed and secured so that they remain in the proper position and orientation during the concreting operation.

366.07.06.05 Sawcutting, Cleaning and Sealing of Joints

Sawcutting, cleaning and sealing of joints shall be according to OPSS 369 with the following addition:

For fast-track concrete repairs, equipment specifically designed for dry-cut joint sawing shall be used and the sawing shall be carried out within 2 hours of final finishing. In lieu of sawcutting, the joint may be formed to a minimum depth of one third the pavement thickness when the concrete is in the plastic state.

366.07.07 Production of Concrete

Production of concrete shall be according to the General, Temperature Control, Mixing Time and Mixing Rate, and Delivery subsections in OPSS 1350.

366.07.08 Placing of Concrete

Prior to placing concrete, the Contract Administrator may request a demonstration of the equipment.

Delivery of concrete shall be according to OPSS 1350.

Placing of concrete in the repair areas shall be according to the Placing of Concrete section of OPSS 350 with the following additions:

- a) Concrete shall be placed in such a way as to avoid disturbing or displacing tie bars, dowel bars or load transfer devices.
- b) When an interruption of more than 45 minutes occurs during placing of full depth repairs using conventional concrete, or 20 minutes for high early strength concrete or 5 minutes for fast-track concrete repairs, a transverse construction joint shall be formed. Notwithstanding the time limits, there shall be no delays which will result in a cold joint. Concrete placed in the areas between the newly formed joint and the previous joint is subject to removal and replacement at no additional cost to the Owner if the Contract Administrator deems it necessary.
- c) For high early strength concrete and fast-track concrete repairs, the use of insulation to retain heat is permitted.

366.07.09 Consolidating

Concrete shall be thoroughly consolidated against and along the face of all forms of existing concrete and into the face of previously placed concrete. The vibrators shall not come in contact with the base, subbase, subgrade, underlying material, forms, tie bars, dowel bars or load transfer devices.

For fixed-form placement, hand-held vibrators shall be used to supplement consolidation adjacent to and along the full length of the form. They shall also be inserted at regularly spaced intervals along both sides of load transfer devices, when used.

366.07.10 Concrete Finishing

No water or other chemical agents shall be applied to the concrete surface or finishing tools to aid in the finishing.

The concrete edge adjacent to fixed forms or existing concrete pavement or concrete base shall be finished using an edging tool prior to texturing. The edging tool shall have a radius of not more than 6 mm. The finished concrete pavement or concrete base edge shall be left smooth, true to line and grade.

366.07.11 Texturing of Pavement Surface

The plastic surface of the concrete pavement and concrete base shall receive an initial texturing immediately after finishing and before the application of curing on the concrete. The initial texturing shall be performed by dragging burlap longitudinally to produce a uniform textured surface. The burlap shall be kept in a clean condition and free from tears and encrusted mortar. It shall be kept damp but shall not add excessive water to the concrete surface.

Concrete pavement shall receive a final texturing using equipment manufactured to produce transverse tines 3 mm $\pm$ 1 mm wide on 16 mm $\pm$ 3 mm centres with a tine depth of 4 mm $\pm$ 1 mm. Tining shall not extend within 75 mm $\pm$ 15 mm of the concrete pavement edge. The surface of the concrete shall be free in all cases from displaced aggregate particles and local projections. Tining for small or irregular areas may be done by hand methods. Manual devices may be used to provide the tined textured.

Final texturing is not required on concrete base or when diamond grinding of the concrete pavement surface is specified in the Contract Documents.

366.07.12 Curing

Curing shall be applied within 15 minutes of placing concrete and immediately following texturing.

The curing period shall be a minimum of 7 Days for concrete cured with curing compound and for concrete subject to cold weather. For all other types of curing, the curing period shall be a minimum of 4 Days.

For high early strength and fast-track concrete repairs, only curing compound shall be used for curing and may remain in place following the 7 Day curing requirement.

For conventional concrete repairs, concrete shall be cured using one of the following methods, according to the applicable clauses in OPSS 904:

- a) Curing with Curing Compound, or
- b) Curing with Burlap and Water, except when the air temperature is below 0 °C, curing shall be according to Curing with Moisture Vapour Barrier clause in OPSS 904.

When curing compound is used, it shall not be applied to joint faces against which joint sealing compound is to be placed or to concrete surfaces to which concrete is to be bonded.

Curing compound used on the surface of a concrete base shall be removed completely prior to the application of tack coat and overlaying with asphalt pavement. The method of removal shall be by abrasive blasting according to OPSS 929 and it shall not result in any damage to the concrete surface. The removal process shall meet all environmental constraints as specified in the Contract Documents.

366.07.13 Retaining Heat for High Early Strength Concrete and Fast-Track Concrete Repairs

Insulating blankets or protection systems of any type may be used for retaining heat to accelerate the strength gain of high early strength and fast-track concrete repairs. Insulating blankets used for the purpose of accelerating strength gain for high early strength concrete and fast-track concrete repairs are not required to meet the requirements for cold weather protection of other types of concrete.

366.07.14 Cold Weather Protection - Conventional and High Early Strength Concrete Repairs

366.07.14.01 General

The temperature of the concrete during cold weather shall be monitored and controlled for a period of 7 Days to ensure that the concrete temperature does not fall below 15 °C for the first 3 Days of curing and 10 °C for the subsequent 4 Days. The monitoring shall commence at the start of the concrete placing operation.

The cold weather protection system shall be designed for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required. For cold weather conditions, concrete shall be protected according to the Concrete Subject to Cold Weather clause in OPSS 904. The conditions shall be monitored, and the protection system modified as required.

Cold weather protection may be removed for sawcutting of joints; however, when removed, no concrete shall be left unprotected for more than 1 hour and no more than 25 linear metres of concrete shall be exposed at any one time.

366.07.14.02 Monitoring and Control of Temperature

During cold weather, monitoring and control of the concrete and ambient air temperature shall be recorded and submitted to the Contract Administrator. The monitoring shall commence when the concrete is placed.

For each Day's placement of concrete, thermocouples or sensors shall be embedded within 5 mm of the concrete surface in a minimum of four locations distributed throughout the repair areas, as directed by the Contract Administrator. At least one additional thermocouple or sensor shall be installed to measure ambient air temperature above the surface of the concrete and outside of the specified cold weather protection.

The recording of concrete temperatures shall begin at the start of concrete placement. The temperature shall be recorded automatically at intervals no greater than 15 minutes. The thermocouples and instrumentation shall be left in place and temperatures recorded until the end of the temperature monitoring period.

Concrete and ambient air temperature readings shall be monitored and verified on site every 6 hours or more frequently as required for the first 3 Days, and every 12 hours or more frequently as required for the remainder of the monitoring period. Temperature verification shall be carried out in person at each concrete repair location. All necessary action shall be taken to maintain the temperature within the specified limits.

The Contract Administrator shall be provided physical and digital access to verify temperature readings.

366.07.14.03 Submission of Temperature Records

At the end of each Day during the temperature monitoring period, datalogger temperature records for all of the thermocouples and sensors and a record of any actions taken to maintain control of temperature shall be submitted to the Contract Administrator. At the end of the temperature monitoring period, the complete temperature record for all thermocouples and sensors, including graphical plot of temperature versus time, shall be submitted to the Contract Administrator.

366.07.15 Surface Tolerance

The surface of the concrete repair shall join flush with the existing concrete pavement or concrete base.

The surface of the concrete pavement shall be such that when tested with a 3 m long straightedge placed in any location and direction, including the edge of pavement and joints, except across the crown or drainage gutters, there shall not be a gap greater than 3 mm between the bottom of the straightedge and the surface of the concrete. For concrete base, the tolerance over a 3 m straightedge shall be maximum of 6 mm.

Use of diamond grinding to meet the above requirements shall require the prior approval of the Contract Administrator. The maximum depth of concrete removed by diamond grinding shall not exceed 10 mm.

366.07.16 Material Sampling and Testing

366.07.16.01 Slump, Air Content and Temperature

Plastic concrete sampling, testing, acceptance, field adjustments, visual acceptance, and submission of plastic concrete test results shall be according to the Material Sampling and Testing subsection of OPSS 1350, with the following exceptions and additions:

- a) Testing of plastic air content is not required for fast-track concrete repairs.
- b) The minimum frequency of testing slump and concrete temperature shall be once for each load of concrete.
- c) For fast-track concrete repairs, if the slump exceeds the maximum allowable slump of 230 mm, the load of concrete shall be rejected. Re-testing slump of fast-track concrete is not permitted.

366.07.16.02 Coring for 28-Day Compressive Strength and Air Void System Parameter Testing

For all concrete pavement repairs including fast-track concrete repairs, cores shall be removed from the hardened concrete for acceptance testing by the Owner. Coring shall be carried out when the concrete is 7 to 10 Days of age.

Concrete shall be sampled on a lot basis according to the Quality Assurance section of this specification. For each lot, a total of five cores shall be obtained. Cores shall be taken at random locations specified by the Contract Administrator. Four cores shall be taken from one repair area in the lot within 1 m of one another; three for 28-Day compressive strength testing, and one for air void system (AVS) testing. A single core shall be taken from another repair area within the lot for AVS testing. Cores shall be 100 mm diameter and full depth.

Coring shall be carried out according to CSA A23.2-14C. Cores shall not contain steel reinforcement or other embedded material. A covermeter shall be used to establish the location of steel reinforcement and other embedded material prior to coring. No core shall be taken within 500 mm of any joint or repair area edge.

The Contract number, lot number, repair area identification information, component type (concrete pavement or concrete base), and date of concrete placement and extraction shall be marked legibly on each core with durable ink immediately after removal.

Each core shall be placed in a plastic bag and sealed to prevent loss of moisture, before they are placed in a security bag in the presence of the Contract Administrator. The cores, a transmittal form, and the MTO form PH-CC-433-A, Concrete Mix Design Submission Form A, of the concrete mix design for the concrete pavement or concrete base shall all be submitted to the Contract Administrator.

Core holes shall be filled according to OPSS 1350.

366.07.16.03 Early Strength Determination for Conventional Concrete Repairs

For conventional concrete repairs, the Contractor may elect to take cores for early strength determination in addition to the cores required for determination of 28-Day compressive strength. In order to demonstrate that the pavement has achieved sufficient strength for loading of construction vehicles or traffic, one set of three cores shall be taken for each Day's placement, from the last repair placed during that Day. Cores shall be 100 mm diameter and full depth. All cores of the same set shall be removed at a location no more than 1 m from the location of the first core for that set.

When the Contractor elects to take cores for early strength determination, core removal and handling shall be carried out according to the Coring for 28-Day Compressive Strength and Air Void System Parameter Testing clause.

The Contract Administrator shall be provided with 1 Business Day advance notice to arrange testing by the designated quality assurance laboratory.

Core holes shall be filled according to OPSS 1350.

366.07.16.04**Early Strength Determination for High Early Strength and Fast-track Concrete Repairs**

The autogenous cylinder method shall be used to determine compressive strength for purposes of opening the lane to traffic. The Contractor is responsible for the timing and frequency of testing of the autogenous cylinders and shall determine when the concrete pavement or concrete base has attained a minimum compressive strength of 20 MPa.

The Contractor shall make a minimum of three sets of two autogenous test cylinders for the final repair area of each lane closure according to CSA A23.2-3C. The cylinders shall be 150 mm in diameter and 300 mm long. Compressive strength testing of autogenous cylinders shall be carried out according to CSA A23.2-9C by the Contractor to verify that the concrete in the repair area has attained a minimum compressive strength of 20 MPa. The testing shall be performed at a laboratory certified as a concrete testing laboratory by the Canadian Council of Independent Laboratories (CCIL) that has successfully participated in the MTO correlation program. The concrete compressive strength specimen shall be tested to complete failure. These test results shall be communicated immediately to the Contract Administrator, prior to re-opening the lane to traffic.

The compressive strength of the concrete in the repair area shall be based on the following procedure:

- a) Install thermocouple or sensors at a minimum of two test locations in the final full depth repair area for each lane closure. The thermocouple or sensors shall be embedded within 5 mm of the concrete surface and at the edge of the repair area. Thermocouple or sensors shall also be embedded in each of the autogenous cylinders.
- b) Monitor and record the temperature of the repaired slab and autogenous cylinders a minimum of once every 30 minutes for high early strength concrete repairs and every 15 minutes for fast-track concrete repair.
- c) Autogenous test cylinders shall be tested in pairs for compressive strength at time intervals determined by the Contractor, until a compressive strength of 20 MPa or greater is obtained. The repaired slab shall not be opened to traffic until the slab temperature has reached at least the same temperature as the cylinders which attained a compressive strength of 20 MPa or greater.

The Contract Administrator shall be provided physical and digital access to verify temperature readings. If the datalogger does not have a digital display for verifying the temperature, the Contract Administrator shall be provided with the necessary instruments to verify thermocouple function and readings.

A record of the temperatures of the repaired slab and autogenous cylinders, and the compressive strength test results shall be submitted to the Contract Administrator for each lane closure.

366.07.17**Unacceptable Repair Areas**

Concrete found to be unacceptable shall be removed and replaced with new concrete meeting the Contract requirements.

The area to be removed shall extend to the nearest transverse joint and longitudinal joint or edge outside the deficient area so that there are no additional joints.

Concrete which does not meet the surface tolerance may be corrected by diamond grinding in lieu of removal and replacement, subject to approval by the Owner.

366.07.18**Management of Excess Material**

Management of excess material shall be according to the Contract Documents.

366.08 QUALITY ASSURANCE

366.08.01 Acceptance of Concrete Pavement and Concrete Base Repairs

Concrete pavement and concrete base repairs shall be acceptable if the requirements of this specification are met, including:

- a) Compressive strength prior to opening to traffic.
- b) 28-Day compressive strength.
- c) Air void system in hardened concrete.
- d) FWD test results indicating a load transfer efficiency of greater than or equal to 70%.
- e) Surface tolerance.
- f) Defects listed in the Defects section of this specification are not present in the work.

366.08.02 Lot Size for 28-Day Compressive Strength and Air Void System Acceptance Testing

Concrete shall be accepted on a lot basis. A lot shall consist of up to 400 m² of each type of repair of the same concrete mix design. Conventional concrete repairs, high early strength concrete repairs and fast-track concrete repairs shall be treated as separate lots. Partial depth and full depth repairs shall be treated as separate lots.

For each lot, one set of three cores shall be tested for 28-Day compressive strength and two cores shall be tested for AVS.

366.08.03 Acceptance of 28-Day Compressive Strength

366.08.03.01 General

One set of three core samples per lot shall be tested to determine the acceptability of 28-Day compressive strength of the lot. Compressive strength shall be determined according to LS-410. The 28-Day compressive strength result of a lot shall be the average of the set of the three acceptance cores, rounded to one decimal place.

28-Day Compressive strength of a lot shall be considered acceptable when:

- a) The average 28-Day compressive strength of the set of three cores is equal to or greater than specified strength, and
- b) No individual core result is more than 10% below the specified strength.

Unacceptable lots shall be rejected. Concrete from unacceptable lots shall be removed and replaced.

Individual test results shall be forwarded to the Contractor as they become available.

366.08.03.02 Referee Testing

366.08.03.02.01 General

Referee testing for 28-Day compressive strength shall be according to OPSS 1350, except that referee testing shall be done on a new set of cores removed within 24 hours of invoking the referee testing. A set of referee cores for 28-Day compressive strength shall consist of three individual cores and shall be taken from the same repair area from which acceptance samples were obtained in the presence of the Contract Administrator. The core size and core extraction shall be according to the Coring for 28-Day Compressive Strength and Air Void System Parameter Testing clause.

All cores of the same set shall be removed at a location no more than 1 m from the location of the first core for that set.

Coring shall be carried out according to CSA A23.2-14C. No core shall be taken within 500 mm of any joint or repair area edge. The Contractor shall use a covermeter to establish the location of steel reinforcement and other embedded material prior to coring. Cores shall not contain steel reinforcement or other embedded material.

The Contract number, lot number and repair area identification information shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag and sealed to prevent loss of moisture.

The Contractor shall fill the core holes according to OPSS 1350.

366.08.03.02.02 Referee Testing Cost

The cost of referee testing of 28-Day compressive strength shall be as specified in the Contract Documents.

When the referee results indicate that the refereed lot is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed lot is not acceptable, the Contractor shall be charged the cost of the 28-Day compressive strength referee testing.

366.08.04 Acceptance of Air Void System in Hardened Concrete

366.08.04.01 General

One half of each core shall be tested according to LS-432 to determine the acceptability of concrete AVS of the lot. The other half of each core shall be retained by the Owner for audit purposes.

For a lot to be considered acceptable, the cores shall have an air content of 3.0% or more and a spacing factor of 0.230 mm or less.

An unacceptable lot is a lot represented by one or two cores that fail to meet the air void system parameters.

Unacceptable lots shall be rejected. Concrete from unacceptable lots shall be removed and replaced.

Individual test results shall be forwarded to the Contractor as they become available.

366.08.04.02 Referee Testing

366.08.04.02.01 General

Referee testing of AVS parameters may only be invoked by the Contractor within 3 Business Days of receiving the test result.

When referee testing is invoked, all core samples representing a lot shall be referee tested and the acceptance test results discarded. The lot referee test results shall replace the acceptance test result in the acceptance requirements of this specification.

Referee testing shall be carried out on the same half of the core sample that was tested for acceptance.

Cores shall be tested according to LS-432. Referee test results shall be forwarded to the Contractor as they become available.

366.08.04.02.02 Referee Testing Cost

The cost of AVS referee testing shall be as specified in the Contract Documents.

When the referee results indicate that the refereed lot is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed lot is not acceptable, the Contractor shall be charged the cost of the air void system referee testing.

366.08.05 Falling Weight Deflectometer Acceptance Testing

366.08.05.01 General

The work shall be made available for FWD testing by the Owner.

The Contract Administrator shall determine the load transfer efficiency across all transverse joints of the full depth concrete repair area by carrying out FWD testing. FWD testing, equipment calibration, and reporting shall be according to LS-449. The new joint shall be acceptable if the FWD test results indicate load transfer efficiency of 70% or greater. The new joint with a load transfer efficiency less than 70% shall be removed and replaced full depth and full lane width as specified in the Contract Documents.

366.08.05.02 Referee Testing

FWD referee testing may only be invoked by the Contractor within 3 Business Days of receiving the test result. Referee testing shall be according to LS-449. The referee test result shall replace the acceptance test result in the acceptance requirements of this specification. Referee test results shall be forwarded to the Contractor, as they become available.

366.08.05.03 Referee Testing Cost

When the referee results indicate that the refereed repair is acceptable, the Owner shall bear the cost. When the referee results indicate that the refereed repair is not acceptable, the Contractor shall be charged the cost of the FWD referee testing.

366.08.06 Acceptance of Surface Tolerance

Each repair area shall meet the requirements of the Surface Tolerance subsection of this specification. Repair areas that do not meet the surface tolerance requirements of this specification shall be considered unacceptable and shall be repaired according to this specification or removed and replaced.

366.08.07 Defects

Concrete repair areas are unacceptable if they contain any of the following defects:

- a) Concrete with any visible surface cracks in the repair, unless the Contractor demonstrates, at no cost to the Owner, that the depth of the crack is less than 10 mm.
- b) Concrete with honeycombing or other deficiencies detected visually.
- c) Partial depth repairs with debonding identified by sounding.
- d) Dowel bars and tie bars not meeting the requirements of this specification.

Unacceptable repairs shall be removed and replaced.

366.09 MEASUREMENT FOR PAYMENT

366.09.01 Actual Measurement

366.09.01.01
Conventional Concrete Repair (Full Depth)
Conventional Concrete Repair (Partial Depth)
High Early Strength Concrete Repair (Full Depth)
High Early Strength Concrete Repair (Partial Depth)
Fast-track Concrete Repair

Measurement of conventional concrete repair, high early strength concrete repair, and fast-track concrete repair shall be by the area of the repair in square metres. Each repair area shall be measured to the nearest 0.1 m².

366.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

366.10 BASIS OF PAYMENT

366.10.01
Conventional Concrete Repair (Full Depth) - Item
Conventional Concrete Repair (Partial Depth) - Item
High Early Strength Concrete Repair (Full Depth) - Item
High Early Strength Concrete Repair (Partial Depth) - Item
Fast-track Concrete Repair - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the Work.

TABLE 1
Nominal Maximum Size of Coarse Aggregate

Concrete Repair Depth	Nominal Maximum Size of Coarse Aggregate
Partial Depth	19.0 mm
Full Depth	19.0 mm or combined gradation of nominal maximum aggregate size of 37.5 mm and 19.0 mm



**CONSTRUCTION SPECIFICATION FOR
SEALING OR RESEALING OF JOINTS AND CRACKS
IN CONCRETE PAVEMENT AND CONCRETE BASE**

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369.01 SCOPE

This specification covers the requirements for sealing and resealing of joints and cracks up to 25 mm in width in concrete pavement and concrete base.

369.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 366	Repairing Concrete Pavement and Concrete Base
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1350	Concrete - Materials and Construction

CSA Standards

A23.2-14C Obtaining and Testing Drilled Cores for Compressive Strength Testing*
*[Part of A23.1-19/A23.2-19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

369.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Backer Rod means a compressible material inserted into the joint reservoir to achieve the required shape factor for the joint sealing compound and prevent loss of joint sealing compound.

Concrete Base means as defined in OPSS 350.

Concrete Pavement means as defined in OPSS 350.

Effluent means as defined in OPSS 350.

Reservoir means a sawcut cavity used in some existing concrete pavement longitudinal and transverse joints of specific dimensions designed to receive a backer rod and joint sealing compound.

Shape Factor means the ratio of width to depth of a field poured liquid sealant within the reservoir.

369.04 DESIGN AND SUBMISSION REQUIREMENTS

369.04.01 Submission Requirements

369.04.01.01 Joint Sealing Compound

The following joint sealing compound product information shall be submitted to the Contract Administrator prior to the joint sealing operations:

- a) Product name and manufacturer;
- b) The manufacturer's batch or lot number or designation;
- c) The manufacturer's recommended heating time and heating temperature range; and
- d) The manufacturer's installation procedures.

369.05 MATERIALS

369.05.01 Backer Rods

Backer rods shall be made of polyethylene foam, cross-linked polyethylene foam, polyurethane foam, or equivalent material acceptable to the Owner.

369.05.02 Joint Sealing Compound

Hot poured rubberized asphalt joint sealing compound shall be according to OPSS 1212 and shall be on the MTO DSM list designated for use with the joint design specified in the Contract Documents.

369.06 EQUIPMENT

369.06.01 Air Compressor

The air compressor used to supply the hot-compressed air lance shall be equipped with oil and moisture filters and provide a minimum pressure of 700 kPa at a minimum air volume of 4.25 cubic metres per minute (150 cfm).

369.06.02 Heating and Mixing Kettle for Joint Sealing Compound

The heating and mixing kettle shall be used for the hot poured rubberized asphalt joint sealing compound.

The kettles shall be of the double boiler oil heat transfer type with a built-in agitator and equipped with two functional permanently installed dial type thermometers. The thermometers shall measure the temperature of the melted compound and the oil to an accuracy of ± 2 °C. Heating shall be controlled by an automatic thermostat to maintain the temperature of the product used within the range required by the manufacturer. Infrared or direct heat kettles shall not be used.

Certificates of calibration from an organization accredited by the Standards Council of Canada shall be available for review when requested by the Contract Administrator for each gauge certifying that the thermometers can measure the temperature within a tolerance of ± 2 °C.

369.06.03 Hot Compressed Air Lance

The hot compressed air lance shall have an oil free discharge of air at a temperature greater than 200 °C and less than 500 °C, and an air velocity greater than 1,000 m per second.

369.06.04 Sawcutting Equipment

The sawcutting equipment shall be self-propelled, guided, and capable of sawcutting the joints to the dimensions specified in the Contract Documents. The sawcutting equipment shall be capable of sawcutting the joints without causing spalling or damage to the adjacent concrete.

For resealing cracks with an existing reservoir, sawcutting equipment shall be capable of following the path of random cracks to create a reservoir to the dimensions specified in the Contract Documents, without causing spalling or damage to the adjacent concrete.

The saw shall be equipped with a diamond blade.

369.06.05 Thermometer

A separate calibrated thermometer with an accuracy of ± 2 °C for verification of the joint sealing compound temperature shall be available on the job site.

369.07 CONSTRUCTION

369.07.01 General

Joints and cracks identified in the Contract Documents and in the field by the Contract Administrator shall be sealed with hot poured rubberized asphalt joint sealing compound.

The maximum width of repair shall be 25 mm for both transverse and longitudinal joints or cracks. Joints or cracks exceeding the maximum repair width shall be repaired as directed by the Contract Administrator.

369.07.02 Operational Constraints

Joints may be sealed prior to or after grinding, milling, or grooving operations. Cracks shall be sealed after grinding, milling or grooving operations are completed.

Joint sealing compound shall not be placed until new concrete has cured for a minimum period of 7 Days.

Joint sealing compound shall not be placed when the ambient air or concrete pavement surface temperatures are less than 5 °C.

Joints and cracks shall be sealed between 24 and 48 hours after completion of the water flushing.

Cracks and joints shall be kept in a dry condition for a minimum period of 24 hours prior to joint sealing compound installation. This time period shall be extended only if necessary to ensure the joint or crack is dry.

For newly constructed joints, joints shall be sealed within the same calendar year in which they are constructed. For crack and joint resealing, cracks and joints shall be resealed within the same calendar year in which the existing sealant is removed.

369.07.03 Removal of Existing Sealant and Seals

All existing sealant, seals, bond breaker tapes, and backer rod shall be removed without damaging the adjacent joint or crack faces.

369.07.04 Sawcutting

369.07.04.01 Reservoir

For resealing joints with a reservoir cut or cracks with a reservoir cut, sawcutting equipment shall be used to create a reservoir with the dimensions specified in the Contract Documents. Routers shall not be used for creating the reservoir.

The shape factor for hot poured rubberized joint sealing compound shall be 1H:1V.

When resealing joints and cracks, if the existing reservoir is determined by the Contract Administrator to be in an acceptable condition with minimal spalling, with no joint sealant adhered to the side of the joint and with proper dimensions, sawcutting shall not be required. The existing reservoir shall be cleaned according to the Joint or Crack Cleaning subsection.

When sawcutting existing joints, the least amount of concrete shall be removed to meet the specified requirements.

369.07.04.02 New Longitudinal and Transverse Joints

New longitudinal and transverse joints, in newly constructed and repair areas of concrete pavement and concrete base shall be sawcut to the dimensions specified in the Contract Documents.

Sawcutting equipment shall be used to create the joints. Routers should not be used for creating the joints.

The initial sawcut for longitudinal and transverse joints shall be carried out as soon as the joint can be sawcut without ravelling the joint or damaging the concrete surface, and prior to any cracks developing.

Longitudinal and transverse sawcutting operations shall be carried out concurrently. Sawcutting of the joints to the specified dimensions may be done with the initial sawcut or in two parts with an initial sawcut and a final sawcut. The initial sawcut, and final sawcut, if applicable, shall be a minimum of one third the depth of the concrete slab and shall not be so deep as to cut the tie bars or dowel bars.

369.07.05 Joint or Crack Cleaning

Cleaning of joints or cracks shall remove all sawcut slurry, grinding and grooving effluent, if applicable, and any other debris from the joint or crack. Cleaning of joints or cracks shall consist of flushing the joints or cracks with water in one direction to remove slurry, effluent and debris. Additional methods of cleaning the joints or cracks may be required and shall be approved by the Contract Administrator.

Cracks shall be cleaned at a minimum between 24 and 48 hours before sealing. Joints shall be cleaned at a minimum at each of the following times:

- a) Immediately after each sawcutting operation.
- b) Immediately after final texturing for unsealed joints.
- c) Between 24 and 48 hours before sealing.

Immediately prior to sealing operations, all new or existing joint and crack faces shall be abrasive blast cleaned according to OPSS 929.

The new or existing joint or crack and adjacent concrete pavement surface shall then be blown clean and dried, using a hot compressed air lance.

When resealing joints and cracks, cleaning shall remove all existing joint sealing compound.

369.07.06 Backer Rod Installation

Backer rod installation is required when a reservoir cut is used.

Backer rods shall have a minimum diameter of 25% greater than the reservoir width. They shall be installed immediately after cleaning and drying of the joints and cracks before joint sealing compound installation. Backer rods shall be inserted uniformly to the required depth to achieve the required shape factor.

Backer rods shall be inserted using a double wheel steel roller and shall not be punctured or stretched during the installation process.

369.07.07 Joint Sealing Compound Installation

369.07.07.01 General

Transverse joints shall be filled prior to longitudinal joints.

Joint sealing compound shall be installed according to the manufacturer's recommendations and as specified in the Contract Documents.

369.07.07.02 Joint Sealing Compound Preparation and Installation

The joint sealing compound shall be slowly melted with constant agitation until it is in a lump-free, free-flowing state, within the application temperature range recommended by the manufacturer for application.

The Contract Administrator shall be informed at least 24 hours prior to the initial charging of the empty kettle with joint sealing compound. The initial charge of material shall be placed in an empty kettle. The Contract Administrator shall be granted access to witness the empty kettle and initial charge of joint sealing compound upon request.

Joints and cracks shall be clean and dry when the joint sealing compound is placed.

The joint sealing compound shall be placed by a manual pouring cone or hose and wand fitted with a tip from a low pressure pump connected to the heating kettle. The tip shall be small enough to fit inside the joint or crack and extend to the bottom of the sawcut or, when specified, to the top of the backer rod.

When filling joints or cracks with a reservoir, the tip of the cone or wand shall be placed to the top of the backer rod to ensure uniform application.

When filling joints without reservoir, the tip of the cone or wand shall be placed at the bottom of the sawcut to ensure uniform application.

Joints and cracks shall be filled with joint sealing compound so that upon cooling, the joint sealing compound is recessed 3 to 6 mm below the adjacent concrete pavement surface. If the initial placement of material subsides below the required recess depths, additional joint sealing compound shall be placed within 8 hours of the original placement.

Joint sealing compound shall be fully adhered to the concrete on both sides of the joint or crack.

Joint sealing compound damaged by construction traffic or by the Contractor's operations shall be removed and replaced.

Any spilled material or excess material in the joints or cracks shall be removed immediately and the concrete pavement surface cleaned.

The material heated shall be placed on the same Day. Excess heated material shall be disposed of and shall not be used on subsequent Days.

369.07.08 Material Sampling and Testing

369.07.08.01 Sampling of Hot Poured Rubberized Joint Sealing Compound

During the installation of the joint sealing compound, a 4-litre sample of the joint sealing compound shall be submitted to the Contract Administrator, upon request, for testing by the Owner. The joint sealing compound shall be sampled from the heating kettle.

All containers used for sampling shall be metal, with double tight lids. The Contract Administrator shall be allowed to examine the sample containers prior to sampling to ensure they are clean and free of debris.

Samples shall be accompanied by a sample data sheet and WHMIS label. Samples shall be delivered with a transmittal form identifying the following information:

- a) Contract number.
- b) Name of Contractor and a contact person's name and telephone number.
- c) Contract Administrator's name and telephone number.
- d) Quantity, type of sample, and product name.
- e) Date sampled (yyyy-mm-dd).
- f) Temperature of the joint sealing compound in the heating kettle at the time of sampling.
- g) Date shipped.
- h) Sample location.

369.07.08.02 Coring for Cleaning and Sealing Inspection

After sealing operations are complete, the Contract Administrator may require that cores be taken at joint or crack locations to evaluate the acceptability of the joint or crack cleaning and sealing.

Coring shall be carried out according to CSA A23.2-14C. The cores shall be 100 mm in diameter and shall be drilled through the full depth of concrete pavement or concrete base, perpendicular to the surface of the concrete pavement or concrete base. No core shall be taken within 250 mm of any joint or edge of slab.

If the samples show that the joint or crack cleaning and sealing are not according to this specification, additional cores may be required at no additional cost to the Owner to determine the extent and locations of the improperly cleaned or improperly sealed joints.

Core holes shall be repaired according to OPSS 1350.

369.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

369.08 QUALITY ASSURANCE

369.08.01 Acceptance of Hot Poured Rubberized Joint Sealing Compound

When hot poured rubberized joint sealing compound is tested, acceptance shall be according to OPSS 1212. Unacceptable hot poured rubberized joint sealing compound shall be removed and replaced.

369.08.02 Acceptance of Cleaning and Sealing

During and after sealing operations, the Contract Administrator will inspect the joints and cracks including any cores taken at joint or crack locations to evaluate the acceptability of the joint and crack cleaning and sealing. The Contract Administrator will reject all or a portion of the work if the inspection shows that the joint or crack cleaning and sealing is not according to this specification. Rejected portions of the work shall be removed and replaced.

369.09 MEASUREMENT FOR PAYMENT

369.09.01 Actual Measurement

369.09.01.01 Sealing of Cracks

Measurement of sealing of cracks in existing concrete pavement or concrete base shall be by length in metres measured along the centreline of the crack.

369.09.01.02 Resealing of Joints and Cracks

Measurement of resealing of joints and cracks in existing concrete pavement or concrete base shall be by length in metres measured along the centreline of the joint or crack.

369.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

369.10 BASIS OF PAYMENT

369.10.01 Sealing of Cracks - Item Resealing of Joints and Cracks - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

Sawcutting, cleaning and sealing of joints in new concrete pavement shall be paid under the Concrete Pavement item according to OPSS 350.

Sawcutting and cleaning of joints in new concrete base shall be paid under the Concrete Base item according to OPSS 350.

Sawcutting, cleaning and sealing of joints for concrete pavement repairs and the sawcutting and cleaning of joints for concrete base repairs shall be paid under the appropriate tender items according to OPSS 366.

When the maximum width of repair is greater than 25 mm for both transverse and longitudinal cracks and joints, the work directed by the Contract Administrator shall be administered as a Change in the Work.



CONSTRUCTION SPECIFICATION FOR TRENCHING, BACKFILLING, AND COMPACTING

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401-A	Commentary

401.01 SCOPE

This specification covers the requirements for excavating, backfilling, and compacting trenches for the installation of sanitary and storm pipe sewers; pipe culverts and end sections; pipe subdrains; forcemains and associated appurtenances; watermain and associated appurtenances; and other underground Utilities.

401.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

401.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

401.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 902	Excavating and Backfilling - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1359	Unshrinkable Backfill

Provincial Statute

Occupational Health and Safety Act

R.S.O. 1990, c. O.1, as amended

Ontario Regulations 213/91 - Regulations for Construction Projects, as amended

401.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Additional Excavation means all excavation ordered in writing by the Contract Administrator beyond excavation specified in the Contract Documents.

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Backfill Material means fill material used above the embedment or cover material and below the lower of the subgrade or finished grade or the original ground.

Bedding Class means a classification system that defines the depth of the bedding material.

Bedding Material means material as it relates to rigid pipe, from the bottom of the trench to the bottom of the cover.

Cover Material means the material placed from the top of the bedding to the bottom of the backfill for rigid pipe.

Embedment Material means material as it relates to flexible pipe, from the bottom of the trench to the bottom of the backfill.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Flexible Pipe means pipe that can deflect 2% or more without cracking such as polyvinyl chloride, polyethylene, or steel pipe.

Imported Material means material obtained from a source other than the Working Area.

Native Material means the material removed to form an excavation within the Working Area for return to the same or other excavation.

Pipe means sanitary or storm pipe sewers, watermains, forcemains, pipe culverts, and subdrains.

Rigid Pipe means pipe that cannot deflect more than 2% without cracking such as concrete pipe.

Trench means as defined in Ontario Regulations 213/91.

Trenching means the earth or rock excavation required to construct a trench in which to install pipes and their associated appurtenances.

Trench Width means the horizontal distance between the trench walls as measured at the bedding grade.

Unshrinkable Fill means as defined in OPSS 1359.

401.05 MATERIALS

401.05.01 Embedment Material

Embedment material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.
- c) Unshrinkable fill.

401.05.02 Bedding Material

Bedding material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.
- c) Unshrinkable fill.

401.05.03 Cover Material

Cover material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III, with 100% passing the 26.5 mm sieve.
- c) Native material.

401.05.04 Granular Material

Granular material shall be according to OPSS 1010.

401.05.05 Backfill Material

401.05.05.01 General

Backfill material shall be one of the following, as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I, II, or III.
- c) Unshrinkable fill.
- d) Native material.

401.05.05.02 Native and Imported Material

Native and imported material shall be approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

401.05.06 Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

401.07 CONSTRUCTION

401.07.01 General

Trenches shall be stable and dry, unless designated as subaqueous work.

401.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

401.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

401.07.04 Removals

Removals shall be according to OPSS 510.

401.07.05 Dewatering

Dewatering shall be according to OPSS 517 for placement of pipe or to OPSS 902 for placement of structure.

401.07.06 Support Systems

Support systems shall be according to OPSS 404.

401.07.07 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, appropriate protection shall be provided. Protection may include sheathing, shoring, and the driving of piles, when necessary.

401.07.08 Removal of Frozen Ground

Written permission shall be obtained from the Contract Administrator prior to starting any excavation in frozen ground. The method used for removal of frozen ground shall not cause damage to adjacent structures or Utilities.

401.07.09 Trenching

Trenches shall be excavated to the lines, grades, and dimensions specified in the Contract Documents. The width of the trench at the bottom shall not exceed the width at the top.

Trenching for pipe culverts shall include the excavation for frost tapers and end sections.

No more than 15 m of trench shall be open in advance of the completed pipe system.

The Contract Administrator shall be notified immediately if the bottom of the trench appears to give an unsuitable foundation.

When installing rigid pipe, if the trench is excavated wider than the allowable width without authorization, the Contract Administrator may require the use of a stronger pipe or a higher class of bedding or both.

If the trench depth is excavated beyond the limits of the required excavation without the Contract Administrator's authorization, granular material shall be placed and compacted in the trench to reinstate the required trench limits prior to backfilling the trench as specified in the Contract Documents. Alternatively, another structurally accepted design shall be provided by adjusting the limits of the excavation prior to backfilling.

Rock excavation for trenches shall be according to OPSS 403.

401.07.10 Backfilling and Compacting

401.07.10.01 General

The diameter or the span and rise of flexible pipes shall not vary from the manufactured dimensions by more than 5% during cover and backfill placing operations.

Pipe installation and backfilling shall be completed prior to the start of subbase and base course construction over the pipe location.

Compacting of embedment, bedding, cover, and backfill materials during pipe installation shall be according to OPSS 501.

Prior to allowing the movement of any construction equipment or vehicular traffic over the buried infrastructure, the depth of backfill shall be sufficient enough to protect the buried infrastructure from damage.

401.07.10.02 Embedment

Placement of embedment material shall be as described in the Bedding and Cover clauses.

401.07.10.03 Bedding

Pipe bedding shall be of the class specified in the Contract Documents.

The surface upon which the pipe is to be laid shall be true to grade and alignment.

The pipe bedding shall be shaped to the dimensions specified in the Contract Documents. When bell and spigot pipe is to be laid, recesses shall be shaped to receive the bells.

Bedding material placed in the haunches shall be compacted prior to continued placement of cover material.

Bedding material shall be placed in uniform layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Bedding material shall be placed on each side of the pipe and shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

401.07.10.04 Cover

Cover material shall be placed so that damage to or movement of the pipe is avoided.

Cover material shall be placed in uniform layers not exceeding 200 mm in thickness, loose measurement,

and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Cover material shall be placed on each side of the pipe and shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

401.07.10.05 Backfill

Backfill material shall be placed in uniform layers not exceeding 300 mm in thickness, loose measurement, for the full width of the trench and each layer shall be compacted according to OPSS 501 before a subsequent layer is placed.

Backfill material shall be placed to a minimum depth of 900 mm above the crown of the pipe before power operated tractors or rolling equipment shall be used for compacting. Uniform layers of backfill material exceeding 300 mm in thickness may be placed with the approval of the Contract Administrator.

When the Contract specifies native backfill material, acceptable earth backfill material may be substituted with the approval of the Contract Administrator. In areas within the roadway, for a depth equal to the frost treatment, the earth backfill material shall have frost susceptible characteristics similar to the adjacent material.

401.07.11 Additional Trenching, Backfilling, and Compacting

Additional trenching, backfilling, and compacting shall be as described in the Trenching and Backfilling and Compacting subsections.

Unsuitable material shall be excavated and the resulting excavation shall be backfilled and compacted to obtain a suitable foundation.

401.07.12 Site Restoration

Site restoration shall be according to OPSS 492.

401.07.13 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

401.09 MEASUREMENT FOR PAYMENT

401.09.01 Actual Measurement

401.09.01.01 Additional Trenching, Backfilling, and Compacting

Additional trenching, backfilling, and compacting shall be based on the volume of the additional excavation measured in cubic metres prior to installation of the pipe.

The volume of the excavation that is in addition to the limits specified in the Contract Documents shall be determined.

401.10 BASIS OF PAYMENT

401.10.01 Trenching, Backfilling, and Compacting

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, subdrains, forcemains and associated appurtenances,

watermains and associated appurtenances, and other underground Utilities shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Any expenses for remedial work resulting from unauthorized over-excavation of the trench width and depth shall be borne by the Contractor.

When native material is deemed unsuitable for backfill for reasons other than those attributed to the Contractor's mode of operation, any additional work done to provide acceptable backfill beyond the work herein specified shall be administered as a Change in the Work.

401.10.02 Additional Trenching, Backfilling, and Compacting - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

401.10.03 Rock Excavation for Trenches

Payment for rock excavation for trenches shall be according to OPSS 403.

Appendix 401-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.PROV 402
APRIL 2017**

(Formerly, OPSS 402, NOVEMBER 2013)

Note: The PROV implemented in April 2017 replaces OPSS 402 COMMON, November 2013 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
EXCAVATING, BACKFILLING, AND COMPACTING
FOR MAINTENANCE HOLES, CATCH BASINS,
DITCH INLETS, AND VALVE CHAMBERS**

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402.10	BASIS OF PAYMENT

APPENDICES **Not Used**

402.01 **SCOPE**

This specification covers the requirements for excavating, backfilling, and compacting for the installation of storm and sanitary pipe sewer maintenance holes, storm sewer catch basins and ditch inlets, and valve chambers for watermains and forcemains.

402.01.01 **Specification Significance and Use**

This specification has been developed for use in provincial oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

402.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

402.02 REFERENCES

When the Contract Documents indicate that provincial specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1359	Unshrinkable Backfill

402.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Additional Excavation means all excavation ordered in writing by the Contract Administrator beyond excavation specified in the Contract Documents.

Backfilling means the operation of filling the excavation with bedding and backfill material.

Backfill Material means approved fill material used above the bedding and below the lower of the subgrade or finished grade or original ground.

Bedding Material means the material used to support the maintenance hole, catch basin, ditch inlet, or valve chamber.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Imported Material means material obtained from a source other than the Work Area.

Native Material means the material removed to form an excavation within the Work Area for return to the same or other excavation.

Over-Excavation means all excavation beyond that specified in the Contract Documents, performed without the written order of the Contract Administrator.

Structure means maintenance hole, catch basin, ditch inlet, or valve chamber.

Unshrinkable Fill means a controlled density cement treated aggregate material.

402.05 MATERIALS

402.05.01 Granular Material

Granular material shall be according to OPSS 1010.

402.05.02 Backfill Material

402.05.02.01 General

Backfill material shall be as specified in the Contract Documents.

402.05.02.02 Native and Imported Material

Native and imported material shall be material approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks, and boulders over 150 mm in any dimension, and other deleterious material.

402.05.03 Unshrinkable Fill

Unshrinkable fill shall be according to OPSS 1359.

402.07 CONSTRUCTION

402.07.01 General

Excavations shall be stable and dry, unless designated as subaqueous Work.

402.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

402.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

402.07.04 Removals

Removals shall be according to OPSS 510.

402.07.05 Dewatering

Dewatering shall be according to OPSS 517.

402.07.06 Support Systems

Support systems shall be according to OPSS 404.

402.07.07 Removal of Frozen Ground

Written permission shall be obtained from the Contract Administrator prior to starting an excavation in frozen ground. The method used for removal of frozen ground shall not cause damage to adjacent structures or Utilities.

402.07.08 Excavation

402.07.08.01 General

Excavation shall be performed to the lines, elevations, and dimensions specified in the Contract Documents plus an allowance for support systems, where required.

Rock excavation for maintenance holes, catch basins, ditch inlets, or valve chambers shall be according to OPSS 403.

402.07.08.02 Additional Excavation

Structures shall not be placed or constructed on an unsuitable foundation as may be determined by the Contract Administrator.

Unsuitable material shall be excavated and the resulting excavation shall be backfilled and compacted to obtain a suitable foundation.

402.07.08.03 Over-Excavation

Corrective measures ordered by the Contract Administrator to rectify deficiencies caused by over-excavation shall be performed. Soil that has become disturbed by construction methods or procedures shall be removed and replaced with granular material compacted to 95% maximum dry density where the excavated surface is below or beside the proposed structure.

402.07.09 Backfilling and Compacting

402.07.09.01 Bedding

A 150 mm layer of granular bedding material shall be placed on the bottom of the excavation and compacted according to OPSS 501, prior to the placing of a structure.

402.07.09.02 Backfill

Backfill material shall be placed simultaneously on all sides of the structure in layers not exceeding 300 mm in thickness, loose measurement, and compacted according to OPSS 501, prior to the placement of a subsequent layer.

Backfill material shall not commence around cast-in-place concrete structures until approval has been obtained from the Contract Administrator.

402.07.10 Additional Excavating, Backfilling, and Compacting

Additional excavating, backfilling, and compacting shall be as described in the Excavation and Backfilling and Compacting subsections.

The volume of the excavation that is in addition to the limits specified in the Contract Documents shall be determined.

402.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

402.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

402.09 MEASUREMENT FOR PAYMENT

402.09.01 Actual Measurement

402.09.01.01 Additional Excavating, Backfilling, and Compacting

Additional excavating, backfilling, and compacting shall be based on the volume of the additional excavation measured in cubic metres prior to installation of a structure.

The volume of the additional excavation shall be determined beyond the limits specified in the Contract Documents.

402.10 BASIS OF PAYMENT

402.10.01 Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Payment at the Contract price for the appropriate tender items for the installation of maintenance holes, catch basins, ditch inlets, and valve chambers shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

Any expenses for remedial work resulting from over-excavation shall be borne by the Contractor.

402.10.02 Additional Excavating, Backfilling, and Compacting - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

402.10.03 Rock Excavation for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Payment for rock excavation for maintenance holes, catch basins, ditch inlets, and valve chambers shall be according to OPSS 403.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.PROV 403
APRIL 2017**

(Formerly OPSS 403, November 2010
(Formerly OPSS 515, November 2005)

Note: The PROV implemented in April 2017 replaces OPSS 403 COMMON, November 2010 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
ROCK EXCAVATION FOR PIPELINES, UTILITIES,
AND ASSOCIATED STRUCTURES IN OPEN CUT**

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403.08	QUALITY ASSURANCE - Not Used
403.09	MEASUREMENT FOR PAYMENT
403.10	BASIS OF PAYMENT

APPENDICES **Not Used**

403.01 **SCOPE**

This specification covers the rock excavation requirements for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermains and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers in open cut.

403.01.01 **Specification Significance and Use**

This specification has been developed for use in provincial oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

403.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

403.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut

403.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

Associated Structures means a maintenance hole, catch basin, ditch inlet, or valve chamber.

Rock means rock as defined in OPSS 206.

403.07 CONSTRUCTION

403.07.01 General

Rock excavation to install sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, and watermain and associated appurtenances; underground Utilities; and maintenance holes, catch basins, ditch inlets, and valve chambers in open cut shall be performed to the lines and grades specified in the Contract Documents.

403.07.02 Use of Explosives

The requirements for the use of explosives shall be as specified in the Contract Documents.

403.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

403.09 MEASUREMENT FOR PAYMENT

403.09.01 Actual Measurement

403.09.01.01 Rock Excavation for Pipelines, Utilities and Associated Structures

Measurement shall be in cubic metres.

The volume of rock excavation for pipelines, Utilities, and associated structures shall be determined by the product of the relevant following dimensions measured in place:

a) Height

The height of rock excavation for pipelines, Utilities, and associated structures is the difference in elevation between the theoretical bottom of bedding and the lower of the top of the original rock or the top of shatter.

The top of the original rock shall be determined using one of the following methods:

- i. Elevations taken after the overburden has been removed but before rock excavation.
- ii. From rock surface elevations on both sides of the excavation after rock excavation has been completed.

b) Width

The width of rock excavation for pipelines and Utilities is the actual width of trench measured horizontally to a maximum of the specified trench width.

c) Length

The length of rock excavation for pipelines and Utilities is measured horizontally along the centreline of the trench to the outside limits of the backfill for the associated structures or to the outlet end of a pipe where it emerges from the rock.

d) Horizontal

The horizontal measurement for associated structures is the:

- i. diameter at the external surfaces of a circular structure plus 300 mm all around; or
- ii. the length and width to the external surfaces of a rectangular or square structure plus 300 mm on all sides.

Where the excavation for this item overlaps rock excavation for other items there shall be no deduction for the overlap.

The volume of boulders in an excavation shall be determined by the product of the three maximum rectilinear dimensions. Where boulders classified as rock are measured for payment, only the amount

actually removed shall be considered for payment, the total volume of rock considered for payment shall not exceed the volume of excavation within the theoretical lines.

403.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

403.10 BASIS OF PAYMENT

403.10.01 Rock Excavation for Trenches and Associated Structures - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



Note: The PROV published in November 2017 replaces OPSS 404, November 2010 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR SUPPORT SYSTEMS

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404.07	CONSTRUCTION
404.08	QUALITY ASSURANCE - Not Used
404.09	MEASUREMENT FOR PAYMENT
404.10	BASIS OF PAYMENT

404.01 SCOPE

This specification covers the requirements for supplying, placing, maintaining, and removing support systems required to permit the excavation and backfilling of trenches or excavations for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, and valve chambers; and any other specified subsurface construction.

404.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 412 Sewage Forcemain Installation in Open Cut

Provincial Statute

Occupational Health and Safety Act

R.S.O. 1990,

c. O.1, as amended

Ontario Regulations 213/91 - Regulations for Construction Projects, as amended

404.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances mean as defined in OPSS 412 and OPSS 441.

Sheathing means the vertical members of the support system that are placed up against the walls of an excavation to directly resist the pressure exerted from the walls of the excavation. Sheathing may be either wood or steel sheet piling.

Support Systems means as described in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

Trench means the definition as provided in the *Occupational Health and Safety Act* and Regulations for Construction Projects.

404.04 DESIGN AND SUBMISSION REQUIREMENTS

404.04.01 Submission Requirements

404.04.01.01 Pre-Condition Survey

When specified in the Contract Documents, a pre-condition survey shall be prepared for all buildings, Utilities, structures, roadway infrastructure, and facilities within 30 m of the location where the support system is to be installed. The pre-condition survey shall include, as a minimum: existing structural and cosmetic damage or defects.

A copy of the pre-condition survey shall be provided to the Contract Administrator upon request.

404.07 CONSTRUCTION

404.07.01 General

Support systems shall be supplied, placed, and maintained at the locations and elevations that are necessary or required to:

- a) support and protect the sides and bottom of the excavation.
- b) prevent undue disturbance or weakening of the supporting material below or beside the works.
- c) prevent movement of ground which may disturb or damage the works, adjacent pavements, property, structures, or other works.

404.07.02 Installation

Support systems shall be placed so they can be removed as backfilling takes place without damage to the works and without settlement of or damage to adjacent pavements, property, structures, or other works.

404.07.03 Removal, Backfilling, and Compacting

As the excavation is backfilled, the support system shall be removed, unless it is specified in the Contract Documents to be left in place or approved by the Contract Administrator.

Support systems shall be withdrawn gradually as backfilling progresses. Backfill shall be placed and compacted in a manner that fills the voids left by pulled support systems. The procedure for extracting the support system and placing backfill shall ensure the backfill load is applied gradually and disturbance of the works or foundation material is avoided.

Backfill shall be placed and compacted around and over the support systems left in place. Support systems left in place shall be cut off as specified in the Contract Documents.

404.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

404.09 MEASUREMENT FOR PAYMENT

404.09.01 Actual Measurement

404.09.01.01 Support System Left in Place

Measurement for support systems left in place shall be based on the sheathing area for all sides of the excavation in square metres according to the following:

a) Height

The vertical distance of the sheathing actually left in place. If the sheathing is cut off less than 1,200 mm from its top then the actual vertical height placed shall be used.

b) Length

The horizontal distance along the line of the supported excavation from the beginning to the end of the sheathing left in place.

404.10 BASIS OF PAYMENT

404.10.01 Support Systems

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermain and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets or valve chambers; and any other specified subsurface construction shall include full compensation for all labour, Equipment, and Material to do the work.

404.10.02**Support Systems Left in Place - Item**

Payment at the Contract price for the above tender item shall be full compensation for all Material left in place.

No additional payment shall be made for support systems left in place at the Contractor's option.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**OPSS.PROV 405
NOVEMBER 2017
(Formerly OPSS 405 November 2008)**

Note: The PROV published in November 2017 replaces OPSS 405 COMMON, November 2008 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
PIPE SUBDRAINS**

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405.09	MEASUREMENT FOR PAYMENT
405.10	BASIS OF PAYMENT

405.01 SCOPE

This specification covers the requirements for the installation of pipe subdrains.

405.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 320	Open Graded Drainage Layer
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 421	Pipe Culvert Installation In Open Cut

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1004 Aggregates - Miscellaneous
OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1801 Corrugated Steel Pipe Products
OPSS 1840 Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841 Polyvinyl Chloride (PVC) Pipe Products
OPSS 1860 Geotextiles

Canadian Standards Association (CSA)

G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles

Bureau De Normalisation Du Quebec (BNQ)

3624-115 (2007) Polyethylene (PE) Pipe and Fittings - Flexible Corrugated Pipes for Drainage - Characteristics and Test Methods.

Water Research Centre (WRc) Publication

MSCC Manual of Sewer Condition Classification, 4th Edition, December 2003

405.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfilling means the operation of filling the trench with embedment and backfill material.

Backfill Material means the material used to fill the trench above the embedment material and below the lower of the subgrade or finished grade or the original ground.

Bedding means the embedment material placed in the subdrain and outlet pipe trenches below the pipe.

CCTV means closed-circuit television.

Embedment Material means the material used to fill the trench from the bottom of bedding to the height specified in the Contract Documents.

Knitted Sock Geotextile means a textile structure produced by knitting in a continuous tube specifically intended to cover perforated subdrain. Knitted geotextiles are suitable only for wrapping of perforated subdrain pipe.

OGDL means open graded drainage layer.

Outlet means the terminal 2.5 m of the outlet pipe.

Outlet Pipe means a non-perforated 100 or 150 mm diameter pipe that is placed for the purpose of conveying subsurface water from a subdrain to a proper outlet.

Subdrain means a perforated 100 or 150 mm diameter pipe that is placed for the purpose of collecting subsurface water and conveying it to a proper outlet pipe.

405.04 DESIGN AND SUBMISSION REQUIREMENTS

405.04.01 Submission Requirements

Upon request, prior to the placement of subdrain or outlet pipe, documentation from the manufacturer verifying that the material supplied meets the Contract requirements shall be submitted to the Contract Administrator.

405.05 MATERIALS

405.05.01 General

Subdrain shall be a perforated polyvinyl chloride pipe, polyethylene pipe, or corrugated steel pipe.

Outlet pipe shall be a non-perforated corrugated steel pipe or a non-perforated smooth inside wall pipe constructed of high density polyethylene or polyvinyl chloride.

Outlets shall be constructed of non-perforated corrugated steel pipe or double-walled polyethylene or polyvinyl chloride pipe having a minimum stiffness of 300 kPa.

405.05.02 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 1801 and as specified in the Contract Documents.

405.05.03 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840 or BNQ 3624-115 and as specified in the Contract Documents.

405.05.04 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841 and as specified in the Contract Documents.

405.05.05 Geotextiles

Geotextiles shall be according to OPSS 1860 and as specified in the Contract Documents.

405.05.06 Fittings

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

Caps shall be polyethylene.

Galvanizing of rodent gates shall be according to CSA G164.

05.05.07 Granular

Granular material shall be according to OPSS 1010 and as specified in the Contract Documents.

405.05.08 Clear Stone

Clear stone shall be 19 mm, Type I or Type II, according to OPSS 1004.

405.05.09 Open Graded Drainage Layer Aggregate

OGDL aggregate shall be according to OPSS 320.

405.07 CONSTRUCTION

405.07.01 General

Contractor inspection reports shall confirm the following at each outlet pipe connection and at the midpoint between outlets:

- a) Trench alignment, grade, and width.
- b) Grade of bedding material.
- c) Condition of subdrain, outlet pipe, and geotextile.
- d) Compaction.

Contractor inspection reports shall be submitted to the Contract Administrator upon request.

Geotextile, subdrain, or outlet pipe damaged by exposure to sunlight or damaged by any other means shall be replaced.

The stability of the subdrain and outlet pipe trenches shall be maintained at all times during excavation and backfilling.

405.07.02 Excavation

Trenches shall be excavated to the lines, grades, and dimensions specified in the Contract Documents.

The excavation shall be inspected with grade checks and certified by the Contractor prior to placement of the pipe bedding.

405.07.03 Unstable Foundations

When unstable foundation conditions are encountered, the Contractor shall take the necessary steps to ensure a stable foundation as directed by the Contract Administrator. An inspection report to verify the foundation stability shall be submitted to the Contract Administrator upon request.

405.07.04 Geotextile

Subdrain shall be wrapped with a knitted sock geotextile.

When a geotextile wrapped trench is specified in the Contract Documents, wrapping of the subdrain with a knitted sock geotextile shall not be required, and the geotextile shall be installed as specified in the Contract Documents.

When OGDL or 19 mm clear stone embedment are specified in the Contract Documents, the subdrain trench and outlet pipe trench shall be wrapped with geotextile.

When granular embedment and backfill material are specified for an outlet pipe connection to a catch basin, the outlet pipe trench shall not require geotextile wrap.

405.07.05 Bedding

Bedding shall be placed in the trench to the depth specified in the Contract Documents prior to laying the subdrain or outlet pipe.

The pipe bedding grade shall be inspected with grade checks and certified by the Contractor prior to laying the subdrain or outlet pipe.

405.07.06 Laying Subdrain and Outlet Pipe

405.07.06.01 General

Pipe installation shall be according to OPSS 421 and as specified below.

The pipe shall be placed firmly on the bedding and secured in place to prevent any movement or disturbance during backfilling. Pipe with perforations on only one side shall be installed with perforations down. Pipe shall not be laid in water or on saturated bedding. Pipe shall not be used as a drain for the Contractor's operation.

Connections between the subdrain and outlet pipe shall be made with prefabricated 45° elbows or pre-manufactured pipe curves as required.

Outlet pipe shall be installed at all low lying areas, at the end of subdrain, and at a uniform spacing of 100 m along the length of the subdrain.

Subdrain and outlet pipe installation shall be inspected and approved by the Contractor prior to backfilling.

405.07.06.02 Outlets

405.07.06.02.01 General

The outlet shall have an internal diameter that is slightly larger than the outlet pipe diameter so that the outlet pipe can be inserted into the outlet a minimum distance of 300 mm.

Outlets shall extend beyond the front of the ditch or fill slope for a distance of 300 mm.

The ends of all outlets shall be fitted with galvanized rodent gates.

The joint between the outlet pipe and the outlet shall be wrapped with a 0.5 m width of geotextile.

405.07.06.02.02 Marking of Outlets

Each outlet location shall be marked with a 25 x 25 mm square galvanized steel bar, 2.2 m long, embedded from 0.6 to 1.0 m into the ground, adjacent to the outlet, clearly visible from the driving portion of the roadway.

405.07.06.03 Connection to Drainage Structures

Subdrain shall be connected to maintenance holes, catch basins, and ditch inlets by a 1 m section of non-perforated pipe. Subdrain and outlet pipe connections to concrete maintenance holes, catch basins, and ditch inlets shall be cored and grouted as specified in the Contract Documents.

405.07.07 Embedment and Backfill Material

Embedment material shall be clear stone, granular, or open graded drainage layer aggregate as specified in the Contract Documents.

Backfill material shall be as specified in the Contract Documents.

The Contractor shall ensure that the subdrain and outlet pipe are not damaged or dislodged during the placement and compaction of embedment and backfill material. Damaged or dislodged subdrain and outlet pipe shall be removed and replaced.

Any earth from cave-ins and all other unsuitable material shall be removed from embedment and backfill material.

Compaction of embedment and backfill material shall be according to OPSS 501.

At the termination of a day's work, backfilling shall be complete over all subdrain and outlet pipe placed.

405.07.07.01 Winter Grading of Material

All ice and snow shall be removed from all portions of the work area. Frozen material shall not be incorporated into the work. Material shall not be placed over frozen ground, ice or snow, except, at the Contractor's option, a single lift may be placed over frozen ground in which case final grading and compaction shall be done after the underlying materials have thawed.

405.07.08 Closed-Circuit Television Inspection

When specified in the Contract Documents, the Contractor shall inspect the drainage system using CCTV inspection to ensure that the subdrain and outlet pipes are intact and were not crushed or damaged during construction. CCTV inspection shall be according to OPSS 409.

CCTV inspection shall be based on selected sampling at locations identified by the Contract Administrator. A minimum of 5% of the entire length of subdrain pipe and 100% of the outlet pipes shall be video inspected and recorded. Where defective, damaged, or improperly installed pipe is encountered, the Contract Administrator may request additional CCTV inspection. The inspection shall be conducted following the placement of the granular course and prior to the placement of the pavement surface.

The equipment used for CCTV inspection of the drainage system shall be according to OPSS 409 with the following exceptions:

- a) The system shall be capable of providing CCTV inspection of subdrain and outlet pipes of minimum 100 mm inside diameter within a wet environment and shall be capable of negotiating a minimum 45° bend.
- b) The system shall be capable of inspecting a length of pipe up to 90 m by push rodding, pull cabling, jetting, or tractoring the camera through the pipe.
- c) The system shall be capable of recording the distance traversed by the camera to within 150 mm.

When the CCTV inspection report shows any of the following defects, as defined by the MSCC manual, they shall be identified to the Contract Administrator and the defective, damaged, or improperly installed subdrain and outlet pipe sections shall be removed and replaced:

- a) Fracture.

- b) Broken.
- c) Large joint displacement.
- d) Large open joint.
- e) Deformed pipe such that the camera is not able to navigate through the pipe.
- f) Ponding water.

Replaced subdrain and outlet pipes shall be re-inspected by CCTV to verify installation.

405.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

405.08 QUALITY ASSURANCE

The Contractor shall demonstrate the outlet pipe is on grade and unobstructed for its full length after backfilling.

405.08.01 Acceptance Criteria

Acceptance of the subdrain and outlet pipes shall be installation according to the requirements of the Contract Documents and no damage or defects as defined in this specification. Subdrain and outlet pipe with damage or defects or that is improperly installed shall be removed and replaced.

405.09 MEASUREMENT FOR PAYMENT

405.09.01 Actual Measurement

405.09.01.01 Pipe Subdrain

Measurement of pipe subdrain shall be by length in metres horizontally along the centreline of the pipe between the ends of the pipe subdrain, including outlets, or between the upstream end of the pipe subdrain and the centre of a maintenance hole, catch basin, or ditch inlet.

405.09.01.02 CCTV Inspection

Measurement for a CCTV inspection of subdrain and outlet pipe shall be by length in metres on the ground surface along the centreline of the subdrain from the centre of one drainage structure to the centre of another drainage structure or the outlet end of the subdrain.

405.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

405.10**BASIS OF PAYMENT****405.10.01****Pipe Subdrain - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When excavation and backfilling of subdrain and outlet pipe overlaps the excavation and backfilling required for other work, payment for overlapping excavation and backfilling shall be made in accordance with the specifications for such other work as though no excavation and backfilling were required for pipe subdrain.

When subdrain and outlet pipe are placed below subgrade and the embedment and backfill material are the same material used in the road base or subbase, the embedment and backfill material shall be paid for with the road base or subbase item. When embedment or backfill material or both are different than the material used for the road base or subbase, payment for the embedment and backfill material shall be included in the Contract price for the pipe subdrain.

When unstable foundations are encountered, payment for stabilization shall be as Extra Work.

Maintenance of the stability of the trench shall be at no extra cost to the Owner.

Correction of any defective workmanship and defective or damaged material shall be at no extra cost to the Owner.

405.10.02**Closed-Circuit Television Inspection - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Re-inspection by CCTV inspection to verify the installation of replaced subdrain or outlet pipe shall be at no extra cost to the Owner.



**CONSTRUCTION SPECIFICATION FOR INSTALLATION
OF NEW MAINTENANCE HOLES, CATCH BASINS,
DITCH INLETS AND VALVE CHAMBERS**

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407.01	SCOPE

This specification covers the requirements for the installation of maintenance holes, catch basins, ditch inlets, and valve chambers.

407.02 REFERENCES

This specification refers to the following standards, specifications, and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 353	Concrete Curb and Gutter Systems
OPSS 402	Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 404	Support Systems
OPSS 408	Adjusting or Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures

OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 517	Dewatering
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1351	Precast Reinforced Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1850	Frames, Grates, Covers, and Gratings
OPSS 1853	Rubber Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers
OPSS 1854	High Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers

ASTM International

C923/C923M-20	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

407.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Adjustment Units means circular and rectangular units used between the drainage structure and the frame to adjust the elevation of the frame for grates and covers.

Benching means smoothed infill concrete placed between the channel pipes and the chamber walls of a maintenance hole.

Channeling means constructing a channel that runs through the base of the maintenance hole from incoming pipe to outflow pipe that is most typically formed by using a half pipe to form the channel through the base of the maintenance hole. The “half pipe” form creates an unobstructed flow through the maintenance hole.

Drainage Structure means cast-in-place and precast maintenance holes, catch basins, ditch inlets, and valve chambers.

Floatation means exhibition of upward movement.

Goss Trap means point of entry trap installed in catch basins to capture debris, sediment and oils at source.

Joint Seal System means system for sealing horizontal and vertical construction and butt joints in waterproof concrete structures against water.

Mono Base means cast as a single unit.

Support Systems means as described in the Occupational Health and Safety Act and Regulations for Construction Projects.

Steel Reinforcement means as defined in OPSS 905.

Valve Chamber means precast concrete sealed sump maintenance hole with factory-fitted saddles to house the pump.

407.04 DESIGN AND SUBMISSION REQUIREMENTS

407.04.01 Submission Requirements

407.04.01.01 Precast Components

The Contract Administrator shall be notified in writing a minimum of 10 Business Days prior to precast components for drainage structures being delivered to the Working Area. The notification shall include:

- a) Name of the company that shall be supplying the materials.
- b) The schedule for the delivery of each component to the Working Area.

407.05 MATERIALS

407.05.01 Adjustment Units

Concrete for precast concrete adjustment units shall be according to OPSS 1351.

Rubber adjustment units shall be according to OPSS 1853.

High density polyethylene (HDPE) and expanded polystyrene (EPS) adjustment units shall be according to OPSS 1854.

407.05.02 Aluminum Safety Platforms

Aluminum safety platforms shall be according to OPSS 1351.

407.05.03 Concrete

Concrete for cast-in-place drainage structures shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

407.05.04 Frames with Covers or Grates

Frames with covers or grates shall be according to OPSS 1850.

407.05.05 Grout

Grout shall be non-shrink.

Cementing materials for grout shall be according to OPSS 1301. Sand for grout shall be mortar sand according to OPSS 1004. Water for grout shall be according to OPSS 1302. Admixtures for grout shall be according to OPSS 1303.

The workability of the grout mix shall be suitable for the application.

407.05.06 Joint Seal Systems

Joint seal systems for precast concrete drainage structures shall be according to OPSS 1351.

407.05.07 Mortar

Mortar for joints shall be according to OPSS 904.

407.05.08 Precast Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

When specified in the Contract Documents, precast units shall be according to OPSS 1351.

407.05.09 Resilient Connectors

Resilient connectors between pipes and drainage structures shall be according to ASTM C923M.

407.05.10 Steel Reinforcement

Steel reinforcement for cast-in-place drainage structures shall be according to OPSS 1440.

407.05.11 Steps and Ladders

Steps shall be according to OPSS 1351.

Ladders shall be as specified in the Contract Documents.

Rubber adjustment units shall be according to OPSS 1853.

407.07 CONSTRUCTION

407.07.01 General

Drainage structures shall be installed on undisturbed and competent foundations at the locations and to the elevations specified in the Contract Documents and shall be constructed plumb and true to alignment.

The top of drainage structures shall be installed below the final grade to allow for the placement of adjustment units to facilitate the placement of the top of the frame with grate or cover to the final grade.

When specified in the Contract Documents, special design drainage structures shall be according to the Contract Documents.

407.07.02 Operational Constraints

Precast concrete maintenance hole tees may be used only when the mainline pipe sewer is concrete.

Precast concrete maintenance hole tees shall not be used when a change in pipe size, longitudinal grade, or direction is required.

All work shall be protected from freezing. Drainage structures shall not be installed on frozen ground.

Damage to drainage structures due to floatation shall be prevented during construction and until Contract Completion.

407.07.03 Site Preparation

Site preparation shall be according to OPSS 490.

407.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

407.07.05 Transporting, Unloading, Storing, and Handling

Manufacturer recommendations for transporting, unloading, storing, and handling of drainage structures shall be followed.

Drainage structures shall not be damaged during transporting, unloading, storing, and handling.

407.07.06 Excavating, Backfilling, and Compacting

Excavating, backfilling, and compacting for the installation of drainage structures shall be according to OPSS 402.

407.07.07 Support Systems

Support systems shall be according to OPSS 404.

407.07.08 Dewatering

Dewatering shall be according to OPSS 517.

407.07.09 Cast-In-Place Drainage Structures

Concrete placement shall be according to OPSS 904.

All inside wall projections, such as fins and bulges, shall be removed once the forms are stripped.

407.07.10 Precast Drainage Structures

Precast or mono bases shall be placed level. Subsequent sections complete with joint seal systems shall be installed according to the manufacturer's recommendations.

Adjustment of the drainage structure shall be carried out by lifting the affected sections free of the excavation, re-levelling the base, if necessary, and re-installing the sections. Damaged sections and gaskets shall be replaced.

Lift holes shall be plugged with mortar.

Surface contaminants must be removed prior to installing the mortar.

407.07.11 Installation of Inlet and Outlet Pipes into Concrete Drainage Structures

To accommodate inlet and outlet pipe installation into concrete drainage structure, the appropriate size opening in the wall shall be constructed as specified in the Contract Documents.

Inlet and outlet pipes shall be securely set into the drainage structure's concrete base or walls using grout or joint sealing product to ensure the drainage structure is watertight.

One of the following connections shall be provided where a pipe connects to a drainage structure:

- a) A flexible pipe joint shall be provided within 300 mm of the outside face of the drainage structure for flexible and rigid pipe.

- b) A concrete cradle to the first joint for rigid pipe.
- c) A resilient connector (i.e., a flexible, watertight connector) in the drainage structure opening for flexible and rigid pipe.

A drainage structure designed for pipe support shall be provided when specified in the Contract Documents.

An external joint sealing product shall be according to OPSS 1351.

Installation of pipe connectors shall be according to the manufacturer's recommendations. All pipes, except in valve chambers, shall be flush with the inside walls of the drainage structure.

A goss trap shall be placed at the outlet pipe of the catch basin.

407.07.12 Benching and Channelling

The inside concrete bottom of the drainage structures shall be benched and channeled to accommodate the pipe.

Where benching is hand finished, it shall have a wood float finish and channelling shall have a steel trowel finish. Channelling shall be smooth and flush with adjacent pipe inverts.

407.07.13 Installation of Adjustment Units

Installation of adjustment units shall be according to OPSS 408.

407.07.14 Installation of Frames with Grates or Covers

When precast concrete adjustment units are used, frames with grates or covers shall be set in a full bed of mortar on the precast concrete adjustment units.

When HDPE or EPS adjustment units are used, frames with grates or covers shall be installed and sealed according to the HDPE or EPS adjustment unit manufacturer's instructions.

When rubber adjustment units are used, frames with grates or covers shall be set firmly in place on the rubber adjustment unit by laying a continuous strip of butyl tape on the top surface of the rubber adjustment units and on the bottom of the frame.

When specified in the Contract Documents, ditch inlet grates shall be installed.

Installation of frames with grates or covers which lie within the flow lines of a curb and gutter system shall be according to OPSS 353.

407.07.15 Installation of Aluminum Safety Platforms

A drainage structure that has a total height of 5.0 m or more shall have a safety platform installed. Aluminum safety platforms shall be installed as specified in the Contract Documents.

407.07.16 Installation of Extension Stems and Boxes for Valve Chambers

Extension stems and boxes shall be installed as specified in the Contract Documents.

Caps for valve boxes shall be installed flush with the final grade. Guides for the valve extension stems shall be securely anchored to the valve chamber.

407.07.17 Installation of Ladders and Steps

Ladders shall be installed as specified in the Contract Documents.

Steps shall be according to OPSS 1351. If the drainage structure is being cast-in-place, steps shall be accurately set in the forms and supported to prevent their displacement during the placing of concrete.

If the first step is greater than 450 mm from the adjusted cover or grate reference elevation written approval from the Contract Administrator is required.

407.07.18 Installation of Frost Straps

Frost straps shall be installed as specified in the Contract Documents.

407.07.19 Valve Chamber Insulation

Insulation for the roof, wall, or access way of the valve chamber shall be installed as specified in the Contract Documents.

407.07.20 Clean Out of Drainage Structures

During the progress of the work and until Contract Completion, drainage structures shall be kept clean and free of all foreign material

407.07.21 Site Restoration

Site restoration shall be according to OPSS 492.

407.07.22 Leakage Test

Maintenance holes shall be tested for leakage. Leakage shall not exceed a rate of three litres per hour per metre of head above the lowest pipe invert in the maintenance hole.

The test shall be performed by plugging all pipe openings in the maintenance hole and filling the maintenance hole with water. After one hour has elapsed, the distance the surface of the water has dropped shall be measured and the leakage determined by calculating the volume of that portion of the maintenance hole formerly occupied by the water.

Maintenance holes failing the initial test shall have the leaks repaired and be re-tested until the leakage is below the allowable limit.

There shall be no visible infiltration.

407.07.23 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

407.09 MEASUREMENT FOR PAYMENT

407.09.01 Actual Measurement

407.09.01.01 Maintenance Holes, Catch Basins, and Ditch Inlets Valve Chambers Rectangular Valve Chambers Special Design Drainage Structure

For measurement purposes, a count shall be made of the number of the drainage structures installed.

407.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

407.10 BASIS OF PAYMENT

407.10.01 Maintenance Holes, Catch Basins, and Ditch Inlets - Item
Valve Chambers - Item
Rectangular Valve Chambers - Item
Special Design Drainage Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for safety platform installation for all drainage structures with a total height of 5 m or more shall be included with the above tender items.

407.10.02 Elevation Adjustment

Prior to the installation of a drainage structure, the Owner may, at its sole discretion, raise or lower the invert or grate elevation by 150 mm or less, at no additional cost. Bedding elevations shall be adjusted accordingly.

A change in invert or grate elevation exceeding 150 mm shall be administered as a Change in the Work.



**CONSTRUCTION SPECIFICATION FOR ADJUSTING OR
REBUILDING MAINTENANCE HOLES, CATCH BASINS,
DITCH INLETS, AND VALVE CHAMBERS**

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408.01	SCOPE

This specification covers the requirements for adjusting or rebuilding maintenance holes, catch basins, ditch inlets, and valve chambers.

408.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 353	Concrete Curb and Gutter Systems
OPSS 402	Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basis, Ditch Inlet, and Valve Chamber Installation
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 904	Concrete Structures
OPSS 920	Deck Joint Assemblies, Preformed Seals, Joint Fillers and Joint Sealing Compounds - Structures
OPSS 928	Structure Rehabilitation-Concrete Removal

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1308	Joint Filler In Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1351	Precast Reinforced Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1850	Frames, Grates, Covers, and Gratings
OPSS 1853	Rubber Adjustment Units for Maintenance Holes, Catch Basins, and Valve Chambers
OPSS 1854	High Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) Adjustment Units for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

408.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Adjusting means changing the final grade or position of the frame with a cover or grate on an existing or new drainage structure:

- a) upwards by the addition of adjustment units,
- b) downwards by removal of existing adjustment units, regardless of the size or type of drainage structure, or
- c) lateral deviation from centreline.

Adjustment Units means as defined in OPSS 407.

Drainage Structure means as defined in OPSS 407.

Lift Rings means circular and rectangular pre-fabricated metal or high density polyethylene units used to adjust the elevation of the grates and covers only. They are inserted between the frame and the grate or cover.

Rebuilding means changing the final grade of the frame with grate or cover on an existing drainage structure:

- a) upwards by the addition of precast concrete sections or bricks and mortar or,
- b) downwards by the removal of precast concrete sections or bricks and mortar, regardless of the size or type of drainage structure.

Steel Reinforcement means as defined in OPSS 905.

Valve Chamber means as defined in OPSS 407.

408.05 MATERIALS

408.05.01 Adjustment Units

Precast concrete adjustment units shall be according to OPSS 1351.

Rubber adjustment units shall be according to OPSS 1853.

High density polyethylene (HDPE) and expanded polystyrene (EPS) adjustment units shall be according to OPSS 1854.

408.05.02 Aluminum Safety Platforms

Aluminum safety platforms shall be according to OPSS 1351.

408.05.03 Bonding Agent

Bonding agent shall be according to OPSS 904.

408.05.04 Concrete

Concrete for cast-in-place drainage structures shall be according to OPSS 1350 with a minimum 28-Day compressive strength of 30 MPa.

408.05.05 Frames with Covers or Grates

Frames with covers or grates shall be according to OPSS 1850.

408.05.06 Grout

Grout shall be non-shrink.

Cementing materials for grout shall be according to OPSS 1301. Sand for grout shall be mortar sand according to OPSS 1004. Water for grout shall be according to OPSS 1302. Admixtures for grout shall be according to OPSS 1303.

The workability of the grout mix shall be suitable for the application.

408.05.07 Joint Fillers

Joint fillers shall be according to OPSS 1308.

408.05.08 Joint Sealing Compounds

Joint sealing compounds shall be according to OPSS 1212.

408.05.09 Joint Seal Systems

Joint seal systems for precast concrete drainage structures shall be according to OPSS 1351.

408.05.10 Mortar

Mortar for joints shall be according to OPSS 904.

408.05.11 Precast Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

Precast units shall be according to OPSS 1351 and as specified in the Contract Documents.

408.05.12 Steel Reinforcement

Steel reinforcement for cast-in-place drainage structures shall be according to OPSS 1440.

408.05.13 Steps and Ladders

Steps shall be according to OPSS 1351.

Ladders shall be as specified in the Contract Documents.

408.07 CONSTRUCTION

408.07.01 General

The work of adjusting or rebuilding drainage structures shall:

- a) Include the removal and subsequent replacement of the frame with grate or cover.
- b) Be plumb, true to alignment and grade, and flush with adjacent finish grade of the shoulder.

During the progress of the work and until Contract Completion, all drainage structures in service shall be kept clean and free of all extraneous material.

Prior to adjusting or rebuilding a drainage structure, or the installation of a temporary frame and grate, the existing frame with cover or grate shall be carefully removed and salvaged according to OPSS 510. Suitability of the salvaged frame with cover or grate for reuse shall be determined by the Contract Administrator.

Adjustment units, frames, covers, grates, lift rings, precast concrete components, cast-in-place aprons, and joint seal systems shall be of the type specified in the Contract Documents.

All existing brickwork and mortar or adjustment units shall be removed from the top of the existing drainage structure.

When there are adjustment units on a drainage structure:

- a) There shall be a minimum of one adjustment unit on the top of the drainage structure.
- b) No more than three adjustment units are permitted on the top of the drainage structure without prior written approval from the Contract Administrator.

Adjustments shall be completed prior to placing the frame with grate or cover.

The maximum allowable total lateral deviation of catch basin covers and grates from the centreline of the drainage structure is 75 mm.

If the first step is greater than 450 mm from the adjusted cover or grate reference elevation written approval from the Contract Administrator is required.

Alterations to ladders, valve extension stems and boxes, and frost straps shall be as specified in the Contract Documents.

After adjusting or rebuilding a valve chamber, insulation shall be installed according to the manufacturer's recommendations on the roof, wall, or access way of the valve chamber when specified in the Contract Documents.

408.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

408.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

408.07.04 Cold Weather Work

All work shall be protected from freezing.

408.07.05 Transporting, Unloading, and Storing and Handling

Transporting, unloading, storing, and handling shall be according to manufacturer's recommendations. Materials that are damaged shall be rejected.

408.07.06 Excavating, Backfilling, and Compacting

Excavating, backfilling, and compacting for the adjustment or rebuilding of drainage structures shall be according to OPSS 402.

408.07.07 Support Systems

Support systems shall be according to OPSS 404.

408.07.08 Adjusting

408.07.08.01 General

The type of adjustment unit to be used shall be as specified in the Contract Documents. The different types of adjustment units are as follows:

- a) Precast concrete.
- b) High density polyethylene (HDPE) or expanded polystyrene (EPS).
- c) Rubber.

408.07.08.02 Precast Concrete Adjustment Units

Precast concrete adjustment units shall be used to set the frame with grate or cover at the required position and elevation.

A minimum of one adjustment unit, but not more than three adjustment units are required at each drainage structure to a maximum height of 300 mm.

The first adjustment unit shall be laid in a full bed of mortar and aligned with the opening in the drainage structure. Successive adjustment units shall be laid plumb to the first adjustment unit and sealed according to manufacturer's recommendations.

408.07.08.03 High Density Polyethylene (HDPE) and Expanded Polystyrene (EPS) Adjustment Units

When specified in the Contract Documents, HDPE or EPS adjustment units shall be used to set the frame with grate or cover at the required position and elevation.

A minimum of one adjustment unit is required at each drainage structure up to a maximum height of 100 mm.

HDPE or EPS adjustment units shall be installed and sealed according to the manufacturer's recommendations.

408.07.08.04 Rubber Adjustment Units

One rubber adjustment unit is used to replace the top precast concrete adjustment unit per drainage structure and shall be used in conjunction with one or two precast concrete adjustment units. More than one rubber adjustment unit may be placed when wedge shaped rubber units are used to provide slope to the frame with grate or cover. In either instance, the total height of the rubber units shall be greater than 25 mm and less than 75 mm. The rubber unit is to be placed on the precast concrete adjustment unit so it provides the surface on which the frame rests.

The rubber adjustment unit shall be bonded firmly in place on the precast concrete adjustment unit by laying a continuous strip of butyl tape on the top surface of the precast concrete unit. If more than one rubber unit is used, a continuous strip of butyl tape shall be laid between each rubber adjustment unit.

Rubber adjustment units shall not be used in conjunction with HDPE or EPS adjustment units.

408.07.09 Rebuilding

408.07.09.01 Cast-In-Place Drainage Structures

When the top of the drainage structure is to be lowered, the concrete shall be carefully removed to the elevation specified in the Contract Documents and exposed steel reinforcement shall be cut off. The upper section of the drainage structure shall then be rebuilt to its original configuration using cast-in-place concrete and steel reinforcement.

To raise the top of drainage structures with a tapered upper section, the concrete in the drainage structure shall be removed according to OPSS 928 for the entire depth of the taper. The upper section, including straight walls and taper shall then be rebuilt to the original configuration using cast-in-place concrete and steel reinforcement.

To raise the top of straight walled drainage structures, the existing roof section, if any, shall be removed.

The existing walls shall then be extended upward and the roof section rebuilt to the original configuration using cast-in-place concrete and steel reinforcement.

When cast-in-place units are to be raised or lowered with cast-in-place concrete, the top surface of all existing walls shall be roughened and a concrete bonding agent according to OPSS 904 shall be applied to the joint before the walls are extended upwards.

All inside wall projections, such as fins and bulges, shall be removed once the forms are stripped.

408.07.09.02 Precast Concrete Drainage Structures

Precast concrete drainage structures shall be installed according to OPSS 407.

408.07.09.03 Catch Basin Apron

Curb and gutter with concrete aprons on existing catch basins shall be constructed at the locations specified in the Contract Documents.

The work shall include, but not be limited to, the following:

- a) Remove existing curb and gutter and existing pavement by saw cutting to the limits shown in the Contract Documents.
- b) Construction of concrete curb and gutter shall be according to OPSS 353.
- c) Placement of concrete for concrete apron shall be according to OPSS 904.
- d) Concrete for curb and gutter and apron shall be a continuous pour.
- e) Placement of joint sealing compound and joint filler in construction joints shall be according to OPSS 920.
- f) The horizontal limits of the concrete apron shall be field-fit.

408.07.09.04 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers

To accommodate inlet and outlet pipe installation into existing or rebuilt drainage structure, the appropriate size opening in the wall shall be constructed as specified in the Contract Documents.

Openings shall be made as necessary in an existing maintenance hole, catch basin, ditch inlet, pipe culvert, or pipe sewer to install the new pipe sewer and connect it to the drainage structure according to OPSS 407. Benching in existing maintenance holes shall be altered to accommodate the flow in the new pipe sewer system.

When specified in the Contract Documents, the opening for the connection of a subdrain outlet shall be formed by coring. The subdrain outlet pipe shall be sealed into place using grout. When specified in the Contract Documents, a 50 mm diameter weep hole shall be cored into the same wall as the subdrain connection and at the same invert elevation.

408.07.10 Temporary Frame and Grate

The installation and removal of a temporary frame and grate to the maintenance hole or catch basins shall be at the locations and of the type specified in the Contract Documents.

The temporary frame and grates shall be installed prior to opening the detour to traffic.

The maintenance holes or catch basins shall be adjusted to match the grade of the pavement required during the construction stages.

The temporary frame and grate shall be removed according to OPSS 510. The salvaged original frame and grate shall be reinstalled after the temporary frame and grate is removed.

408.07.11 Site Restoration

Restoration shall be according to OPSS 492.

408.07.12 Maintenance Hole Leakage Testing

Sanitary sewer maintenance holes and storm sewer maintenance holes shall be tested for leakage according to OPSS 407.

408.07.13 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

408.09 MEASUREMENT FOR PAYMENT

408.09.01 Actual Measurement

408.09.01.01 Adjusting and Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets and Valve Chambers Catch Basin Apron Temporary Frame and Grate

For measurement purposes, a count shall be made of the number of drainage structures and catch basin aprons adjusted or rebuilt, and temporary frames and grates installed.

All adjustments of an existing drainage structure including those required by construction staging and winter shutdown as specified in the Contract Documents shall count as one adjustment.

408.09.01.02 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers

For measurement purposes, a count shall be made of the number of openings made.

408.09.01.03 Interim Adjustments of New Drainage Structures

All interim adjustments of a new drainage structure required by construction staging including winter shutdown as specified in the Contract Documents shall count as one adjustment.

408.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

408.10 BASIS OF PAYMENT

408.10.01 Adjusting and Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets and Valve Chambers - Item
Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item
Catch Basin Apron - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

408.10.02 Temporary Frame and Grate - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

For progress payment, 70% of the Contract price shall be paid after the installation of the temporary frame and grate. The remaining 30% of the Contract price shall be paid after the reinstallation of the existing salvaged frame and grate.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

OPSS.PROV 409
NOVEMBER 2017
(Formerly OPSS 409, November 2013)

Note: The PROV published in November 2017 replaces OPSS 409 COMMON, November 2013 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
CLOSED-CIRCUIT TELEVISION (CCTV) INSPECTION OF PIPELINES**

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409.01 SCOPE

This specification covers the requirements for inspecting new and existing storm and sanitary sewers, watermains, pipe culverts or other accessible conduits by closed-circuit television (CCTV).

409.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

CSA Standards

PLUS 4012 (2010) Technical Guide: Visual Inspection of Sewer Pipe

Water Research Centre (WRc) Publication

MSCC Manual of Sewer Condition Classification, Third Edition, 1993.

409.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Business Day means any day except Saturdays, Sundays, and statutory holidays.

CCTV means closed-circuit television.

Digital Storage Device means compact disc (CD), digital videodisc (DVD), flash memory card, hard drive, or other industry-standard digital storage mediums.

Drainage Structure means a catch basin, maintenance hole, or ditch inlet.

DVD means digital videodisc.

MPEG means movie photographic experts group.

NASSCO means North American Society of Sewer Service Companies.

PACP means Pipeline Assessment and Certification Program.

Pipeline means storm, sanitary, watermain, or other accessible conduit pipe culverts.

USB means universal serial bus.

409.04 DESIGN AND SUBMISSION REQUIREMENTS

409.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator two weeks prior to the start of the CCTV inspection operations:

- a) A copy of the CCTV operator's NASSCO Certification Certificate. A copy of said certificate is required for each CCTV operator working on the Contract. Operators shall have been certified or re-certified within the three years prior to the start of the Contract.
- b) A sample inspection report, resolution tests of digital video recording format, and digital data file. One submission is required for each camera proposed for use on the work. The camera make, model, and serial number shall be clearly identified on each video recording.
- c) The details of the coding accuracy verification system that is to be used to verify inspection accuracy shall be submitted for approval.

409.05 MATERIALS

409.05.01 General

Media storage shall be as specified in the Contract Documents.

Digital storage device with minimum USB 2.0 or higher compatibility shall be placed inside envelopes with labels displaying the following information.

- a) Owner's Name
- b) Contract Number or Project Name
- c) Sewer Identification Number
- d) City or Town
- e) Street Name
- f) Inspection Date

The digital storage device shall include a file in either Word or text format including the information provided above. The digital storage device shall be labelled. The label shall include the information in points a) and b) above to identify the content. CD and DVD shall be placed in a 5.2 mm slim-line clear jewel case with permanent labels displaying all the information above or as specified in the Contract Documents.

409.05.01.01 Photographs

Digital photograph files shall meet or exceed a resolution of at least 640 x 480 pixels. Printed photographs shall be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper.

409.06 EQUIPMENT

409.06.01 General

Survey and camera equipment used to inspect watermain shall have been used exclusively for work in watermain only.

409.06.02 Survey Vehicle

The survey vehicle shall contain a separate area for viewing, recording, and controlling the CCTV operation.

The viewing and control area shall be insulated against noise and extremes in temperature. Cooling and heating units shall be independent from the main vehicle engine and in good working order. External and internal sources of light shall be controlled in a manner as to ensure the light does not impede the view of the monitor screen. Seating accommodation for one person shall be provided in addition to the operator seating to clearly view the monitor screen.

All equipment used within the pipeline shall be stored outside the viewing, recording, and control area.

The vehicle shall include a cell phone or suitable alternative as agreed by the Contract Administrator for the duration of the work.

409.06.03 Survey Equipment

The surveying equipment shall be capable of surveying a length of pipeline up to:

- a) 300 m when entry to the pipeline may be obtained at each end of the pipeline.

- b) 30 m when rodding is used.
- c) 150 m when a self-propelled unit is used when entry is at only one end of the pipeline.
- d) 200 m when being towed.

Work shall not commence in a work shift until the Contract Administrator is satisfied that all items of the survey equipment have been provided and are in full working order.

Each survey unit shall contain a means of transporting the CCTV camera in a stable condition through the pipeline.

When the CCTV camera is towed by winch and cable through the pipeline, all winches shall be stable during the entire CCTV inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera.

Each unit shall carry sufficient number of guides and rollers so that, when surveying, all cables are supported away from pipe and maintenance hole edges. All CCTV cables and lines used to measure the camera's location within the pipeline shall be maintained in a taut manner and set at right angles, when possible, to run through or over the measuring equipment.

409.06.04 Video Equipment Quality

The electronic systems, television camera, and monitor shall be of adequate quality to enable the following to be achieved.

409.06.04.01 Camera

The pan and tilt camera shall have the capability of panning the pipe at 360° with tilt capability of 275° to ensure complete inspections and view of all laterals and deficiencies.

Resolution:

The live picture shall be visible with no interference and capable of registering a minimum number of lines of resolution at the periphery as indicated below:

- a) Fixed view camera 350 lines of resolution.
- b) Pan and tilt camera 400 lines of resolution.

Colour Constancy:

The lighting shall be set prior to commencing the survey to ensure the camera provides optimum results when used with its own illumination source. To ensure colour constancy, no variation in illumination shall take place during the survey.

Focus, Iris, and Illumination:

The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The illumination shall be such as to allow an even distribution of the light around the pipeline perimeter without the loss of contrast or flare out of picture shadowing.

409.06.04.02 Monitor

Monitors shall be a minimum size of 21 inches and shall support resolution equal to or greater than the corresponding video camera resolution.

409.06.04.03 Digital Video Recorder

Digital video recorders shall be able to capture in colour from the live video source with the following requirements:

- a) MPEG-2 or higher or as required by Owner.
- b) NTSC 720 x 480 @ 29.97 frames per second.

409.07 CONSTRUCTION

409.07.01 Pipeline Cleaning

When specified in the Contract Documents, pipelines shall be cleaned and flushed immediately prior to CCTV inspection.

409.07.02 Resolution of Videotape and Digital MPEG Video Recordings

Prior to the start of the CCTV inspection, the resolution of digital MPEG video playback for each camera shall be confirmed by recording a resolution chart approved by the Contract Administrator, using the following procedure:

- a) Set up the camera as is done for the actual inspection.
- b) Show the camera being introduced and reaching its final position for the test.
- c) Fill the monitoring screen with the resolution chart.
- d) Illuminate the resolution chart evenly and uniformly without reflections ensuring that the illumination source accurately simulates the lighting used in the sewer.
- e) Record a test video for 30 seconds.
- f) Identify the camera make, model, and serial number on the recording.
- g) Record the test at the start of a digital recording.

The resolution test shall be submitted to the Contract Administrator.

409.07.03 Coding Accuracy

Prior to commencement of the CCTV inspection, a formal coding accuracy verification system shall be developed and submitted to the Contract Administrator and implemented when approved. The coding accuracy shall be based on accuracy as a function of the number of defects or construction features not recorded, and the correctness of the coding and classification shall be recorded.

Verification of coding accuracy shall be completed on a random basis on a minimum of 10% of the inspection reports. A minimum of two accuracy verifications shall be completed for each operator for each week working.

Inspections not satisfying the accuracy requirements shall be re-coded to meet the accuracy requirements and the accuracy of the inspections, immediately preceding and following the non-compliant inspection, shall be verified. This process shall be repeated until the preceding and subsequent inspections meet the accuracy requirements.

Coding accuracy checks shall be submitted to the Contract Administrator along with the corresponding video recording.

409.07.04 CCTV Inspection

409.07.04.01 General

The work shall include a CCTV inspection of the pipeline and the preparation of all video, digital, and written reports.

A certified, trained, and competent CCTV operator shall be used to operate the inspection equipment and code the inspection.

A fixed camera may be used for pipelines less than 300 mm in diameter. For pipelines equal to or greater than 300 mm, a pan and tilt camera shall be used. Each camera shall have an accepted sample submissions report prior to being used for inspection work. The camera lens shall be kept clean at all times during the inspection.

Flow control measures as specified in the Contract Documents shall be implemented to ensure a minimum of 80% of the height of the pipeline is visible for the entire inspection and shall be approved by the Contract Administrator.

All fog shall be evacuated from the pipeline and the pipeline kept clear of fog during the inspection.

At the start of each pipeline being surveyed, the length of pipeline from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of one of the following:

- a) Pipe sewer length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the pipe sewer
- b) Pipe culvert length from one end of the pipe culvert to the other
- c) Watermain length from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

The position meter-reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the survey to the cable calibration point so that the meter-reading at the start of the survey is zero.

In the case of surveying through a maintenance hole when a new header sheet is required, the meter-reading shall be set at zero with the camera focused on the outgoing pipe entrance.

At the start of each maintenance hole length, a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alphanumeric form containing the following minimum information:

- a) Automatic update of the camera's meter-reading position in the pipeline from adjusted zero.
- b) Pipeline dimensions.
- c) Maintenance hole and pipe length reference numbers.

- d) Date of survey.
- e) Road name and location.
- f) Direction of survey.
- g) Time of start of survey.
- h) Pipeline use.

Once the survey of the maintenance hole length is underway, an automatic update of the camera's meter-reading position in the pipeline from zero in metres and tenths of a metre shall be continually displayed.

The camera shall be stopped when defects are being noted on the coding sheet.

Defects in each pipeline length shall be coded according to the standard being used (i.e., CSA Plus 4012, NASSCO Canadian Edition of the Pipeline and Assessment Certification Program (PACP), or WRC) or as specified in the Contract Documents. Any variation from the manual shall be noted in the survey report.

The survey shall be restarted at the opposite end of the pipeline if a blockage or obstruction is encountered.

Inspections shall be recorded in colour.

Digital video recordings may be saved to a computer hard drive and transferred to a portable hard disk drive, compact disc, or digital video for submission.

A digital format video recording of an inspection shall be produced in colour from a first generation recording by one of the following methods:

- a) A computer system and a video capture card shall be used to capture the recording continuously, regardless of the progression of the inspection. Prior to submission, the raw digital data shall be edited to remove pauses when the inspection progress was not continuous.
- b) A computer system and a video capture card shall be used to intermittently capture the recording. Prior to submission, the raw digital file shall be edited to form one continuous file.
- c) Specialized video recording equipment capable of pausing and resuming live recording shall be used to capture original recording. A single file is to be produced for submission.

Video capture equipment shall be capable of capturing digital video from first generation recordings with no frame loss.

Non-linear video editing software shall be used to edit digital videos. Edited digital files shall not be recompressed.

409.07.04.02 Camera Position

The camera lens shall be positioned centrally in a circular pipeline and at two-thirds of the vertical dimension in a non-circular pipeline with a positioning tolerance of $\pm 10\%$ of the vertical pipeline dimension.

In all instances, the camera lens shall be positioned looking along the longitudinal axis of the pipeline.

409.07.04.03 Camera Travel Speed

The travelling speed of the camera in the pipeline shall be limited to:

- a) 0.1 m/s for pipeline of diameter less than 200 mm.
- b) 0.15 m/s for diameters exceeding 200 mm but not exceeding 310 mm.
- c) 0.20 m/s for diameters exceeding 310 mm.

409.07.04.04 Camera Position Meter-Reading Device

A suitable meter-reading device shall be used that enables the cable length to be accurately measured to indicate the location of the camera. The meter-reading device shall be accurate to $\pm 1\%$ of the length of the sewer being surveyed. The tolerance shall be demonstrated using one or both of the following methods in conjunction with a linear measurement audit form that shall be completed each day during the survey:

- a) Cable calibration device.
- b) Tape measurement of the surface distance between maintenance holes.

If the accuracy of the measuring device fails, it is to be replaced. The Contract Administrator may require that the lengths of pipeline first inspected with the original measuring device be resurveyed using the new measuring device.

409.07.05 Final Documentation

409.07.05.01 Survey Reporting

Survey reports shall be submitted to the Contract Administrator in the following formats, with the noted number of copies, within 10 Business Days of the completion of the fieldwork:

- a) 3 copies of the printed survey report.
- b) 2 portable hard disk drives, other digital storage devices and software database as specified in the Contract Documents, each containing the identical survey report information as in the printed copies.
- c) 2 copies of the digital video recording.

Entire inspections shall be contained within one digital file on a digital storage device, as applicable. When possible, reverse set-up inspections shall be recorded immediately after the original inspection.

Each digital file shall contain the file name, as specified by the Owner and may include the following:

- a) Tender number
- b) E<Entity number>
- c) F<From entity number>
- d) T<To entity number>
- e) Street Name
- f) M<Measured length>
- g) I<Inspected length>

h) <Inspection direction:DS or US>

i) <Letter designating inspection sequence> .MPEG

For example: 910-200 E5329 F5328 T5350 BERRY M100.0 I39.2 US B.MPEG indicates that this is the second or "B" partial inspection of this entity, 39.2 m long.

All required header information fields shall be completed and verified for correctness. The software used to produce the survey report shall not allow the operator to continue inputting information until the preceding field has been completed. The report shall be machine printed and presented according to the standard used.

All dimensions in the survey report shall be metric.

The survey report shall identify major defects and shall include photographs when the need for photographs is specified in the Contract Documents.

409.07.05.02 Drawings

One clean set of the Owner's drawings showing maintenance hole numbers that coincide with the coding sheets and videotapes shall be returned to the Contract Administrator on completion of the survey. The drawings shall be clearly annotated to show any discrepancies between the drawings and the survey report. Such discrepancies shall be brought to the attention of the Contract Administrator during the survey.

409.07.06 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

409.08 QUALITY ASSURANCE

Upon submission, printed and digital inspection reports, and digital MPEG video recordings, magnetic data files, and coding accuracy checks shall be reviewed to ensure compliance with the Contract Documents.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 10 Business Days of submission. Only inspections with minimum accuracy for header information of 95% and minimum detail accuracy for defects and features of 85% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 5 Business Days.

Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the Contract, unless they successfully re-attain NASSCO qualification based on the standard being used (i.e., Canadian Edition of PACP or WRc).

409.09 MEASUREMENT FOR PAYMENT

409.09.01 Actual Measurement

Measurement for a CCTV inspection of pipeline shall be measured in metres on the ground surface along the centreline of the pipe sewer from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. Measurement for pipe culverts shall be from one end of the pipe culvert to the other end of the pipe.

Measurement for a CCTV inspection of watermain shall be measured in metres on the ground surface along the centreline of the watermain from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

In the event that a CCTV inspection is terminated due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

409.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

409.10 BASIS OF PAYMENT

409.10.01 CCTV Inspection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for the appropriate tender item for the installation of pipe sewers, pipe culverts, or the lining of watermain shall include full compensation for all labour, Equipment, and Material to do the work of CCTV inspection.

Non-compliant submissions returned for correction shall be corrected and resubmitted at no expense to the Owner.



CONSTRUCTION SPECIFICATION FOR PIPE SEWER INSTALLATION IN OPEN CUT

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410.01 SCOPE

This specification covers the requirements for the installation and inspection of storm and sanitary pipe sewers, laterals, service connections, and concrete appurtenances in open cut.

410.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 408	Adjusting or Rebuilding Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 411	The Cleaning and Flushing of Culverts, Pipe Sewers, Catch Basins, Maintenance Holes, Ditch Inlets, and Oil-Grit Separators
OPSS 421	Pipe Culvert Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering

OPSS 902	Excavating and Backfilling - Structures
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1205	Clay Seal
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride Pipe Products
OPSS 1843	Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860	Geotextiles

Ontario Ministry of Transportation Publications

Gravity Pipe Design Guidelines

CSA Standards

B1800:21	Thermoplastic Nonpressure Piping Compendium

410.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Aluminum Alloy means as defined in OPSS 421.

Backfilling means as defined in OPSS 421.

Concrete Appurtenances means as defined in OPSS 421.

Drainage Structure means as defined in OPSS 407.

Elastomeric Gasket means a gasket that is made from a silicone elastomer based material.

Flexible Pipe means as defined in OPSS 421.

Gravity Pipe Installation means as defined in OPSS 421.

Inspection Assessment means as defined in OPSS 421.

Pipe Run means a section of a pipe sewer between two drainage structures or between a drainage structure and an outlet.

Pipe Sewer means an installation designed for the conveyance of sanitary sewage or storm water using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable jointing material and connected by maintenance holes for sanitary pipe sewers and by maintenance holes, catch basins, ditch inlets, or concrete appurtenances for storm pipe sewers.

Pipe Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

Post Installation Inspection means quantifying the final installed condition of gravity pipe installations using accepted surveillance and measuring methods.

Service Connection means the pipe used to convey sanitary sewage or storm water from the property line to the main sanitary or storm pipe sewer respectively.

Test Segment means as defined in OPSS 421.

410.05 MATERIALS

410.05.01 Clay Seal

Clay seal material shall be according to OPSS 1205.

410.05.02 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

410.05.03 Geotextile

Geotextile shall be according to OPSS 1860.

410.05.04 Elastomeric Seal

Elastomeric seal (gaskets) for pipe joints shall be according to ASTM F477.

410.05.05 Mortar

Mortar for joints shall be according to OPSS 904.

410.05.06 Pipe Materials

410.05.06.01 General

Pipe sewer size, type, and class shall be consistent throughout a pipe run and as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

410.05.06.02 Aluminum Alloy Pipe Products

Aluminum alloy pipe products shall be according to OPSS 421.

410.05.06.03 Concrete Pipe

Concrete pipes shall be according to OPSS 421.

410.05.06.04 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be according to OPSS 421.

410.05.06.05 Polyethylene Pipe Products

Polyethylene pipe products shall be according to OPSS 1840.

410.05.06.06 Polypropylene Plastic Pipe Products

Polypropylene plastic pipe products shall be according to OPSS 1843.

410.05.06.07 Polyvinyl Chloride Pipe Products

Polyvinyl chloride pipe products shall be according to OPSS 1841.

Polyvinyl chloride service connection pipe shall be according to CSA B1800 and shall have bell and spigot joints with elastomeric gaskets.

410.05.07 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

410.07 CONSTRUCTION

410.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

410.07.02 Removals

Removals shall be according to OPSS 510.

410.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

410.07.04 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the work.

410.07.05 Cold Weather Work

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

410.07.06 Transporting, Unloading, Storing, and Handling Pipe

The transporting, unloading, storing, and handling of pipe, shall be according to the manufacturer's recommendations.

All pipes, fittings, and gaskets that are unsound or damaged shall be rejected.

410.07.07 Excavation

Excavation for the placement of pipe sewers shall be according to OPSS 401.

410.07.08 Support Systems

Support systems shall be according to OPSS 404.

410.07.09 Dewatering

Dewatering shall be according to OPSS 517.

410.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 421.

410.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

410.07.12 Pipe Installation

410.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

The pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

The pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

The pipe shall not be laid until the preceding pipe joint has been completed and the pipe is carefully embedded and secured in place.

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

410.07.12.02 Circular Concrete Pipe

All circular concrete pipe joints shall have elastomeric gaskets.

410.07.12.03 Non-Circular Concrete Pipe

Elliptical concrete pipes and joints shall be used for storm pipe sewers only.

All non-circular concrete pipe joints shall be according to the procedures recommended by the manufacturer.

410.07.12.04 Corrugated Steel Pipe Products

Corrugated steel pipe products shall be used for storm pipe sewers only.

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe section shall be installed next to the previous section so that the lockseam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lockseam and corrugation.

Corrugated steel pipe sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipes being connected so that the corrugations or projections of the coupler properly engage the pipe corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

410.07.12.05 Polyethylene Pipe

Polyethylene pipes shall be installed according to OPSS 421.

410.07.12.06 Polyvinyl Chloride Pipe

Polyvinyl chloride pipe shall be according to OPSS 421.

410.07.12.07 Polypropylene Pipe

Polypropylene pipe shall be according to OPSS 421.

410.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe

Corrugated aluminum alloy structural plate pipe shall be according to OPSS 421.

410.07.13 Service Connections

Service connections to the main pipe sewer shall be made using factory made tees or wyes, strap-on- saddles, or mortar-on saddles. Factory made tees or wyes shall be used for all service connections when the diameter of the main pipe sewer is:

- a) less than 450 mm; or
- b) less than twice the diameter of the service connection.

Strap-on-saddles shall be installed before laying the pipe.

Holes in the main pipe sewer shall be cut to the minimum diameter required to accept the service connection saddle. If mortar-on saddles are used, the inside of the pipe shall be mortared at the connection.

Service connections shall be plugged at the property line with watertight caps or plugs.

When existing service connections shall be connected to new pipe sewers or service connections, jointing methods according to gravity pipe design guidelines shall be used.

410.07.14 Marking and Recording Service Connections

A painted temporary location marker consisting of a 50 x 75 mm stake or two short sections of lumber connected by a piece of heavy gauge wire shall be placed at the end of the plugged or capped service connection. The marker shall be placed from 300 mm below the finished grade to a point 300 mm above the plugged end of the service pipe.

A painted surface stake, 50 x 75 x 450 mm long, shall be placed after trench restoration. Service connections shall not be backfilled until they have been inspected and measurements of location have been taken by the Contract Administrator.

410.07.15 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts, and Sewers

Breaking into maintenance holes, catch basins, ditch inlets, culverts and sewers shall be according to OPSS 408.

410.07.16 Field Testing

410.07.16.01 General

Field tests shall be conducted when specified in the Contract Documents and applied to sanitary and storm pipe sewers. All tests shall be carried out in the presence of and accepted by the Contract Administrator.

When specified in the Contract Documents, leakage tests shall be carried out on completed pipe sewers 1,200 mm in diameter and smaller. There shall be no visible leakage for pipe sewers larger than 1,200 mm diameter.

Testing shall be carried out from maintenance hole to maintenance hole, including house service connections as work progresses.

The construction of new mainline pipe sewers shall not proceed when three previously placed sections of the pipe sewer have not been tested or have been tested and are unsatisfactory.

Leakage up to 25% in excess of the calculated limits shall be approved in any test section provided that the excess is offset by lower leakage measurements in adjacent sections so that the total leakage is within the allowable limits for the combined sections.

Pipe sewers shall be repaired and retested, as required, until the test results are within the limits specified in this specification. Visible leaks shall be repaired regardless of the test results.

No part of the work shall be accepted until the pipe sewers are satisfactorily tested following completion of installation of service connections and backfilling.

410.07.16.02 Prequalification Leakage Tests

Prequalification leakage tests shall be carried out as either infiltration or exfiltration tests, as required.

The test shall be performed on the first section of the pipe sewer of each size, not less than 100 m in length, installed by each crew in order to prequalify the crew and the material. Tests may be carried out prior to service connections being installed in the section being tested.

When tests are unsatisfactory, the test section shall be repaired and retested until satisfactory results are obtained.

410.07.16.03 Infiltration Test

Dewatering operations shall be discontinued at least 3 Days prior to conducting the test and allow for the groundwater level to stabilize. Infiltration tests shall be conducted when the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section. The test section is typically between adjacent maintenance holes.

A watertight bulkhead shall be constructed at the upstream end of the test section. All service laterals, stubs, and fittings shall be plugged or capped to prevent water entering at these locations. A V-notch weir or other suitable measuring device shall be installed at the downstream end of the test section. Infiltrating water shall be allowed to build up behind the weir until the flow through the V-notch has stabilized. The rate of flow shall then be measured. The rate of flow shall not exceed the maximum allowable infiltration calculated for the test section. The allowable infiltration shall be calculated by the following:

$$\text{Allowable Infiltration} = \frac{0.075 \text{ L/mm diameter}}{100 \text{ m of pipe/hour}}$$

410.07.16.04 Exfiltration Test

410.07.16.04.01 General

Exfiltration tests shall be conducted when the groundwater level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

The test section is typically between adjacent maintenance holes. The test section of the pipe sewer shall be isolated by temporarily plugging the downstream end and all incoming pipes of the upstream maintenance hole. All service laterals, stubs, and fittings are plugged or capped to prevent water entering at these locations.

410.07.16.04.02 Testing with Water

The test section shall be slowly filled with water ensuring that all air is removed from the line. A period of 24 hours for absorption or expansion shall be allowed prior to starting the test, except if exfiltration requirements are met by a test carried out during the absorption period.

Water shall be added to the pipeline prior to testing until there is a head in the upstream maintenance hole of 600 mm minimum over the crown of the pipe or at least 600 mm above the existing groundwater level, whichever is greater. The maximum limit of the net internal head on the line is 8 m. In calculating the net internal head, allowance for groundwater head, if any, shall be made.

The distance from the maintenance hole frame to the surface of the water shall be measured. After allowing the water to stand for one hour, the distance from the frame to the surface of the water shall again be measured. The leakage shall be calculated using volumes.

The leakage at the end of the test period shall not exceed the maximum allowable calculated for the test section. The allowable leakage shall be calculated by the following:

$$\text{Allowable Infiltration} = \frac{0.075 \text{ L/mm diameter}}{100 \text{ m of pipe/hour}}$$

An allowance of 3.0 litres per hour per metre of head above the invert for each maintenance hole included in the test section shall be made.

Maintenance holes shall be tested separately, if the test section fails.

410.07.16.04.03 Low Pressure Air Testing

The Contract Administrator may allow or require testing by use of air when water is not readily available or the differential head in the test section is greater than 8 m or freezing temperatures exist.

Air control equipment that includes a shut off valve, safety valve, pressure regulating valve, pressure reduction valve and monitoring pressure gauge with pressure range from 0 to 35 kPa with minimum divisions of 0.5 kPa and accuracy of approximately 0.25 kPa shall be provided.

Tests shall be conducted between two consecutive maintenance holes. The test section shall be plugged at each end. One plug shall be equipped with an air inlet connection to fill the pipe sewer system with air.

The test section shall be filled slowly until a constant pressure of 24 kPa is maintained. If the groundwater is above the pipe sewer being tested, the air pressure shall be increased by 3.0 kPa for each 300 mm that the groundwater level is above the invert of the pipe.

The air pressure shall be stabilized for 5 minutes and then regulated to maintain it to 20.5 kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5 kPa shall be recorded.

The time taken for a pressure drop of 3.5 kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the length for minimum time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

410.07.17 Cleaning and Flushing of Pipe Sewers

At least 2 Business Days prior to the commencement of the post installation inspection, the pipe sewers shall be prepared for inspection by cleaning and flushing. The cleanout material from the cleaning and flushing operation shall be managed according to OPSS 411.

410.07.18 Clay Seals

Clay seals shall be placed according to OPSS 421.

410.07.19 Concrete Appurtenances

Concrete appurtenances shall be constructed according to OPSS 421.

410.07.20 Site Restoration

Site restoration shall be according to OPSS 492.

410.07.21 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

410.08 QUALITY ASSURANCE

410.08.01 Acceptance

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

410.08.02 Post Installation Inspection

A post installation inspection shall be conducted by the Contractor when:

- a) Specified in the Contract Documents.
- b) A defective, damaged, or improperly installed pipe is encountered.
- c) At the request of the Contract Administrator.

When post installation inspection is conducted the following shall apply:

- a) The number of test segments per pipe sewer tender item shall account for a minimum of 25% of the total pipe sewer length in the work.
- b) On Contracts with less than four pipe runs, a minimum of one test segment shall be inspected.

410.09 MEASUREMENT FOR PAYMENT

410.09.01 Actual Measurement

410.09.01.01 Pipe Sewer

Measurement of pipe sewers shall be by length in metres along the horizontal centreline length of the pipe from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. When the grade of the pipe sewer is 10% or greater, the above measurement shall then be of the slope length.

410.09.01.02 Service Connections

Measurement of the service connections shall be by length in metres along its horizontal centreline from the centreline of the main pipe sewer to the end of the service connection.

410.09.01.03 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed.

410.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

410.10 BASIS OF PAYMENT

**410.10.01 "size, type, class" Pipe Sewer - Item
Clay Seal - Item
Concrete Appurtenances - Item
Service Connections - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

410.10.02 Elevation Adjustment

Prior to the installation of a drainage structure, the Owner may, at its sole discretion, raise or lower the invert of a pipe sewer by 150 mm or less, at no additional cost. Bedding elevations shall be adjusted accordingly.

A change in invert elevation exceeding 150 mm shall be administered as a Change in the Work.

TABLE 1
Exfiltration Test - Low Pressure Air Testing

Nominal Pipe Size mm	Minimum Time min: sec	Length for Minimum Time m	Time For Longer Length sec
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	35.040
825	15:35	22	42.397
900	17:00	20	50.450



**CONSTRUCTION SPECIFICATION FOR THE CLEANING
AND FLUSHING OF CULVERTS, PIPE SEWERS,
CATCH BASINS, MAINTENANCE HOLES, DITCH INLETS,
AND OIL-GRIT SEPARATORS**

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411.01 SCOPE

This specification covers the requirements for the cleaning and flushing of pipe and concrete culverts, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil-grit separators, including cleaning of concrete culverts and wall drains by means of pressure washing for the removal of corrosion deposits buildup and management of cleanout material.

411.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 409	Closed-Circuit Television Inspection of Sewers
OPSS 410	Pipe Sewer Installation in Open Cut
OPSS 421	Pipe Culvert Installation in Open Cut
OPSS 517	Dewatering

Ontario Ministry of Transportation Publications

MTO Environmental Guide for Fisheries - Best Management Practices Manual 2020

Others

Environmental Protection Act, R.S.O. 1990, c. E19

411.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Air Gap Method means a clear vertical separation between the pressurized potable water supply and a non-pressurized, non-potable water receiving vessel.

Backflow Prevention means a device used to protect potable water supplies from contamination or pollution due to backflow.

Cleaning means suction and vacuuming removal of debris within pipe sewers, catch basins, maintenance holes, ditch inlets, and oil-grit separators.

Combination Hydro-Jet Cleaner means a service vehicle or equipment capable of pressure washing, suction vacuum cleaning of debris.

Contaminant means contaminant as defined in the Environmental Protection Act, R.S.O. 1990, c. E19.

Debris means dirt, sand, gravel, rocks, bricks, other solid and semi-solid materials, and roots, grease, and encrustations and other materials that may cause restriction to flow in culverts, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil-grit separators.

Drainage System Components means the components required to collect and convey the stormwater and include pipe and concrete culverts, pipe sewers, catch basins, maintenance holes, ditch inlets, wall drains and oil-grit separators.

Flushing means hydraulic pressure washing using various nozzles, pressure and flow rates to flush debris within pipe sewer systems downstream.

Oil-grit Separator means an underground storage device designed to separate oil and suspended solids from stormwater.

Pipe Culvert means as defined in OPSS 421.

Pipe Sewer means as defined in OPSS 410.

Receiving Site means a municipal sanitary sewer or sewage treatment plant, certified waste treatment facility, or certified waste disposal site.

Wall Drain means perforated pipe system used to transmit water from the backfill through the wall structure into the drainage system to alleviate hydrostatic pressure on the wall and prevent erosion underneath and around the road due to unattended water overflow.

411.04 DESIGN AND SUBMISSION REQUIREMENTS

When equipment requiring an environmental compliance approval for a waste management system, issued by the Ontario Ministry of the Environment, Conservation and Parks, will be used for the work, a copy of the environmental compliance approval shall be submitted to the Contract Administrator a minimum of two weeks prior to commencement of the work.

Any approvals, releases, and agreements that are required to implement the strategy for the management of cleanout material shall be obtained.

The conditions of the site and the pipe sewer system shall be thoroughly assessed, including the degree of pipe blockage and types of debris. The equipment, nozzles, flow rates, and pressures necessary to complete the work shall be determined. Any supplemental information regarding the sewer network and the assessment method shall be as specified in the Contract Documents.

The proposed cleaning method and procedures, including method to manage effluent and cleanout material shall be submitted to the Contract Administrator at least 14 Days prior to commencing work.

The Contract Administrator shall be notified of the location where cleaning will be performed a minimum of 24 hours in advance of commencing the work.

411.04.01 Permission and Release of Operators of Receiving Sites

Written permission shall be obtained from the operator of a receiving site, prior to its use for disposal of the cleanout material. A copy of this permission shall be provided to the Contract Administrator a minimum of 14 Days prior to the commencement of such work.

411.05 MATERIALS

411.05.01 Water Source

Water source shall be as specified in the Contract Documents. When the source is not specified, water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

Backflow prevention and air gap methods shall be used when water is taken from potable water systems.

411.06 EQUIPMENT

411.06.01 Combination Hydro-Jet Cleaner

A combination hydro-jet cleaner specifically designed for the purpose of cleaning pipe sewers, catch basins, maintenance holes, ditch inlets, oil-grit separators, and similar facilities, using a selection of nozzles and attachments to permit reaming and root cutting as required, shall be used for the work. The equipment shall be able to clear blockages and remove debris from pipe sewer systems with varied sizes and downstream constraints.

411.07 CONSTRUCTION

411.07.01 General

The conditions of the site and the pipe sewer system shall be thoroughly assessed prior to work commencement, including the degree of pipe blockage and types of debris.

The work shall commence at the upstream end of pipe sewer systems and progress to the downstream end.

Prior to using any mechanical equipment in pipe sewer systems, verification of utility locates shall be obtained.

Water flow volumes and pressures shall not cause damage to the pipe sewer system or flooding of property. Water flow volumes and pressures shall be appropriate for the age and condition of the pipe sewer system.

Debris that cannot be removed by flushing shall be loosened and broken up using reamers and root cutters as required.

No blockage to service connections or laterals shall occur as a result of the cleaning and flushing or cleanout operation.

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

When beaver dam removal is required within culvert cleanout operations, the beaver dam removal shall be performed in accordance with MTO Best Management Practice for Beaver Dam Removal as specified in MTO Environmental Guide for Fisheries - Best Management Practices Manual.

For post installation inspections, pipe culverts and pipe sewers requiring cleaning and flushing shall be as specified in the Contract Documents.

The Owner may request additional documentation of findings after cleaning and flushing operations as specified in the Contract Documents.

During the cleaning operation, any encountered defects of the drainage system components shall immediately be reported to the Contract Administrator.

The road surface immediately above the culvert shall be monitored during cleanout operations. If any visual indications that pavement or embankment sinkholes are developing during cleaning or flushing operation, the work should stop immediately and reported to the Contract Administrator.

Any damage caused to the existing drainage system components surfaces resulting from the cleaning operations shall be reported to the Contract Administrator and repaired at no additional cost to the Owner.

411.07.02 Culvert Cleaning

Pipe culverts shall be cleaned out to the bottom of the pipe, unless otherwise directed by the Contract Administrator or specified in the Contract Documents.

Open footing concrete culvert shall be cleaned out to the level of the top of footing and closed box concrete culvert shall be cleaned out to the bottom slab level, unless otherwise directed by the Contract Administrator or specified in the Contract Documents.

All works within a watercourse shall be conducted in the dry. The surface waters of the watercourse shall be protected from the entry of any disturbed sediment or other debris. Dewatering shall be according to OPSS 517. The work shall include capturing and collecting of all removed sediment. When sediment control measures are found ineffective immediate changes shall be made.

The culvert shall be considered clean when all debris, including vegetation at the inlet and outlet that obstructs the flow, sand or silt has been removed from the top, side and bottom (invert) of the culvert.

411.07.03 Culvert and Wall Drain Cleaning by Pressure Washing

The pressure wash cleaning equipment with less than 3,000 PSI pressure at the nozzle shall be used for removal of the corrosion deposits buildup in concrete culverts, around the existing wall drains and cleaning the clogged wall drains. The pressure washer shall be operated at a distance of 150 mm to 300 mm from the surface.

Pressure washing shall not be allowed when ambient temperatures are less than 4°C.

Chemical cleaning compounds shall not be allowed during pressure washing operations.

During the cleaning operation, any encountered culvert defects shall immediately be reported to the Contract Administrator.

Scraping hand tools may be used to locally remove heavy leachate deposits. Upon the completion of the pressure wash cleaning, any standing water shall be removed by mopping and/or air blasting.

Local waterbody aggregates shall be removed and reinstated at repair locations to the top of floor slab.

411.07.04 Pipe Sewer Cleaning and Flushing

Flushing shall be used to transport debris from each section of pipe sewer to the downstream maintenance hole or catch basin. Each section of pipe sewer between maintenance holes, catch basins, ditch inlets shall be cleaned and flushed before cleaning and flushing the next downstream section. Debris shall be continuously cleaned from the downstream maintenance hole or catch basin as flushing occurs.

The passage of debris from one section of pipe sewer to another shall not be permitted, unless specified in the Contract Documents. A weir or sediment trap shall be placed in the maintenance hole to prevent passage of debris from the upstream pipes. When cleaning and flushing is completed for each section, the weir or sediment trap shall be removed.

Cleaning and flushing shall continue for each section of pipe sewer until no further debris is flushed from the pipe, and the pipe sewer section is free of impediments to flow. A minimum of 90% of the pipe sewer circumference shall be free of debris.

If cleanout cannot be completed due to damaged or broken pipe sewer, catch basin, maintenance hole, or ditch inlet, the Contract Administrator shall be immediately notified.

411.07.05 Catch Basin, Maintenance Hole, and Ditch Inlet Cleanout

A combination hydro-jet cleaner shall remove debris from catch basins, maintenance holes, and ditch inlets separately.

411.07.06 Oil-Grit Separator Cleanout

Oil-grit separators shall be cleaned out by closing or blocking off the inlet and outlet pipes, dewatering the system, removal of debris by vacuum or other mechanical means, and cleaning and flushing to remove sediment. The inlet and outlet pipes shall not be reopened or unblocked until after the separator has been inspected by the Contract Administrator.

411.07.07 Closed-Circuit Television Inspection

Unless otherwise specified in the Contract Documents, pipe culverts and pipe sewers shall be inspected after cleaning by closed-circuit television (CCTV) according to OPSS 409. The Contract Administrator shall be notified a minimum 24 hours prior to the inspection.

When specified in the Contract Documents, water shall be added immediately prior to CCTV inspection to the upstream end of the pipe culvert and pipe sewer system for minimum flow to the system low point by gravity.

411.07.08 Management of Cleanout Material

Cleanout material shall be inspected to identify the presence of any visual, olfactory or other evidence of the spill of a contaminant. Material that is found during cleanout to be impacted by a spill of a contaminant shall be managed as specified in the Contract Documents.

Debris removed from culverts, pipe sewers, catch basins, maintenance holes, ditch inlets, and oil-grit separators shall be managed as excess material according to the Contract Documents.

The cleanout material shall be managed by one, or a combination of, the following:

- a) as a composite material without dewatering; or
- b) by dewatering and subsequent management of sludge component.

A copy of the weigh tickets or receipts provided by the site operator shall be submitted to the Contract Administrator. Where such documentation is not available, written confirmation that the waste has been received shall be obtained from the owner of the disposal site, and provided to the Contract Administrator, a maximum of 14 Days after disposal activities are complete.

411.07.08.01 Management as a Composite Material Without Dewatering

When cleanout is done without dewatering, the composite material shall be managed as non-hazardous solid industrial or commercial waste and shall be transported from the area designated for cleanout directly to one of the following:

- a) a landfill site with an environmental compliance approval/certificate of approval for a disposal site valid for commercial and municipal waste;
- b) a waste treatment facility with an environmental compliance approval/certificate of approval for a waste disposal site (processing), or a certificate of approval for waste disposal site (mobile processing) valid for commercial or municipal waste.

411.07.08.02 Dewatering and Subsequent Management of Sludge Component

Cleanout material shall be dewatered as necessary. Dewatering shall be by discharge of the liquid component of cleanout material directly to one or a combination of the following:

- a) a waste treatment facility with an environmental compliance approval/certificate of approval for a waste disposal site (processing), or a certificate of approval for a waste disposal site (mobile processing), valid for commercial or municipal waste;
- b) the culvert, pipe sewer or ditch from which the material was removed.

The sludge or solid component of the cleanout material shall be managed as non-hazardous solid industrial waste or commercial waste and shall be transported directly, with the exception of dewatering en route, from the area designated for cleanout to a certified receiving site.

Transportation of the cleanout material shall be done by a hauler with a certificate of approval for a waste management system that is valid for the following:

- a) the entire work period;

- b) the entire area within the limits of the work and the entire haul route;
- c) the equipment to be utilized, and
- d) non-hazardous solid industrial waste, or commercial waste.

411.09 MEASUREMENT FOR PAYMENT

411.09.01 Actual Measurement

411.09.01.01 Clean out of Pipe Sewer

Measurement shall be in metres and along the centreline of the pipe sewer from the centre of the maintenance hole, catch basin, or ditch inlet at each end of the pipe sewer system to be cleaned out.

When cleaning and flushing is incomplete due to a collapsed pipe or immovable blockage, the length of collapsed pipe or blockage shall be deducted from the length measured for payment.

411.09.01.02 Clean Out of Pipe Culvert, Concrete Culvert, Catch Basin, Maintenance Hole, Ditch Inlet, and Oil-Grit Separator

For measurement purposes, a count shall be made of the number of structures cleaned.

411.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

411.10 BASIS OF PAYMENT

**411.10.01 Clean Out of Pipe Culvert - Item
Clean Out of Concrete Culvert - Item
Clean Out of Pipe Sewer - Item
Clean Out of Catch Basin - Item
Clean Out of Maintenance Hole - Item
Clean Out of Ditch Inlet - Item
Clean Out of Oil-Grit Separator - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for the management of material found, during the cleanout operation, to be contaminated by the spill of a contaminant shall be treated as a Change in the Work.

Any costs incurred due to delays in obtaining the approvals, releases, agreements or verifications required to complete the work as specified in the Contract, shall be borne by the Contractor at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR PIPE CULVERT INSTALLATION IN OPEN CUT

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421.01 SCOPE

This specification covers the requirements for the installation of pipe culverts, pipe culvert end sections, and concrete appurtenances in open cut.

421.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Construction

OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 411	The Cleaning and Flushing of Culverts, Pipe Sewers, Catch Basins, Maintenance Holes, Ditch Inlets, and Oil-Grit Separators
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 517	Dewatering
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe (CSP) Products
OPSS 1820	Circular and Elliptical Concrete Pipe
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride Pipe Products
OPSS 1843	Non-Pressure Polypropylene (PP) Plastic Pipe Products
OPSS 1860	Geotextiles

CSA Standards

G401-14 (R2019)	Corrugated Steel Pipe Products

ASTM International

B746/B746M-16	Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
C507-20	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
F477-14(2021)	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

421.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Aluminum Alloy means a material made with two or more metals in which aluminum is the predominant metal.

Backfilling means the operation of filling the trench with bedding, cover, and backfill material or embedment and backfill material.

Certification Body means an independent 3rd party agency accredited by the Standards Council of Canada that has the qualifications, skills, and expertise required to confirm that a pipe manufacturer produces pipe culvert products to the quality and requirements of an accepted standard and that has the mandate to certify the pipe culvert products produced.

Certified means pipe culvert products that have been marked with a certification body's logo confirming that the production of the pipe culvert product is according to the quality and requirements of the manufacturing standard.

Concrete Appurtenances means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe culvert.

Corrugated Steel Pipe Products means as defined in OPSS 1801.

Culvert Inlet Grate means a metal grate placed at the upstream end of a culvert to prevent woody debris, rocks etc from entering the culvert. Also called trash rack.

Delivered Quality means the pipe culvert products' physical condition upon arrival at the construction site in terms of the extent and degree of dents, scratches, cracks, pipe coating integrity, etc., that appear on the pipe culvert products delivered.

Elastomeric Seal means a gasket that is made from a silicone elastomer-based material.

Flexible Pipe means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride, polyethylene, or steel pipe.

Gravity Pipe Culvert Installation means a constructed pipe culvert conveying surface waters under the influences of gravity only.

Pipe Culvert means an installation designed to provide for the conveyance of surface water, pedestrians, or livestock using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable joint materials.

Pipe Culvert Type means a pipe's inner wall design, which can be smooth or corrugated.

Polypropylene Plastic means a material made with virgin polymers in which propylene is essentially the sole monomer.

Post Installation Inspection means quantifying the final installed condition of gravity pipe culvert installations using accepted surveillance and measuring methods.

Structural Plate Pipe Culvert means a pipe culvert that consists of corrugated steel sections that are bolted together to form the required shape.

421.05 MATERIALS

421.05.01 Clay Seal

Clay seal material shall be according to OPSS 1205.

421.05.02 Concrete

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

421.05.03 Elastomeric Seal

Elastomeric seal (gaskets) for pipe culvert joints shall be according to ASTM F477.

421.05.04 Geotextile

Geotextile shall be according to OPSS 1860.

421.05.05 Mortar

Mortar for joints shall consist of one part Portland cement and two parts mortar sand, wetted with sufficient water to only make the mixture plastic. The mortar sand shall be according to OPSS 1004, the normal Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

421.05.06 Pipe Culvert Materials

421.05.06.01 General

Pipe size, type, and class shall be as specified in the Contract Documents.

Pipe type shall be consistent throughout the length of the pipe culvert.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

421.05.06.02 Aluminum Alloy Pipe Culvert Products

Corrugated aluminum alloy structural plate pipe culvert products shall be according to ASTM B746M.

All corrugated aluminum alloy structural plate pipe culvert products used in the work shall be certified and supplied from a manufacturer that produces the corrugated aluminum alloy structural plate pipe culvert products according to ASTM B746M. Only products with an accepted certification body logo marking according to Figure 1 shall be used.

Inspection, testing, and record keeping for corrugated aluminum alloy structural plate pipe culvert products shall be according to ASTM B746M.

Certified corrugated aluminum alloy structural plate pipe shall be marked according to ASTM B746M and shall include as a minimum the name of the pipe manufacturer.

When requested by the Owner, a copy of the certificate of compliance issued by the certification body confirming that the manufacturer produces certified corrugated aluminum alloy structural plate pipe culvert products shall be submitted to the Contract Administrator.

Where the delivered quality of certified corrugated aluminum alloy structural plate pipe culvert products is deemed to be unacceptable by the Contract Administrator, the products shall be rejected.

421.05.06.03 Concrete Pipe Culvert

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C507.

421.05.06.04 Corrugated Steel Pipe Culvert Products

Corrugated steel pipe culvert products shall be according to OPSS 1801.

421.05.06.05 Polyethylene Pipe Culvert Products

Polyethylene pipe culvert products shall be according to OPSS 1840.

421.05.06.06 Polypropylene Plastic Pipe Culvert Products

Polypropylene plastic pipe culvert products shall be according to OPSS 1843.

421.05.06.07 Polyvinyl Chloride Pipe Culvert Products

Polyvinyl chloride pipe culvert products shall be according to OPSS 1841.

421.05.07 Steel Reinforcement

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

421.07 CONSTRUCTION

421.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

421.07.02 Removals

Removals shall be according to OPSS 510.

421.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

421.07.04 Protection Against Floatation

Damage to the pipe culvert due to floatation shall be prevented during construction and until completion of the work.

421.07.05 Cold Weather Installation

All work shall be protected from freezing. Pipes and bedding material shall not be placed on frozen ground.

421.07.06 Transporting, Unloading, Storing, and Handling of Pipe

The transporting, unloading, storing, and handling of pipe, shall be according to the manufacturer's recommendations.

All pipe, fittings, and gaskets that are unsound or damaged shall be rejected.

421.07.07 Excavation

Excavation for the placement of pipe shall be according to OPSS 401.

421.07.08 Support Systems

Support systems shall be according to OPSS 404.

421.07.09 Dewatering

Dewatering shall be according to OPSS 517.

421.07.10 Protection Systems

The construction of all protection systems shall be according to OPSS 539. When the stability, safety or function of an existing Roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring and driving piles, when necessary, to prevent damage to such works or proposed works.

421.07.11 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

421.07.12 Pipe Culvert Installation

421.07.12.01 General

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe culvert sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

Pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe is carefully embedded and secured in place.

The pipe culvert cut-end finish, end sections, and safety slope end treatments shall be as specified in the Contract Documents.

When installing gaskets, all pipe culvert ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened, and the gasket placed in its proper position. If necessary, a new gasket shall be installed.

421.07.12.02 Circular Concrete Pipe Culvert

All circular concrete pipe culvert joints shall have elastomeric gaskets.

421.07.12.03 Non-Circular Concrete Pipe Culvert

All non-circular concrete pipe culvert joints shall be according to the procedures recommended by the manufacturer.

421.07.12.04 Corrugated Steel Pipe Culvert Products

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe culvert section shall be installed next to the previous section so that the lock seam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lock seam and corrugation.

Corrugated steel pipe culvert sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipe culvert being connected so that the corrugations or projections of the coupler properly engage the pipe culvert corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

Structural plate pipe culverts may be assembled in the trench or beside the excavation. If the assembled structure must be moved to its final position, it shall be moved so that no damage or distortion is caused to the structure.

When the structural plate pipe culvert has been placed to the alignment and grade specified in the Contract Documents, all assembly bolts shall be tightened so that the torque on the bolts prior to backfilling is between 200 and 340 Nm.

Before backfilling, at least 5% of the bolts used in each circumferential and longitudinal connection shall be tested after assembly.

421.07.12.05 Polyethylene Pipe Culvert

Polyethylene pipe culvert shall be jointed by one of the following methods, as recommended by the pipe manufacturer:

- a) Bell and Spigot.
- b) Welded Joint.
- c) Thermal Fusion Joint.
- d) Screw-on Coupler.
- e) Split Coupler.
- f) Threaded Joint.
- g) Mechanical Restrained Joint with Gasket.

421.07.12.06 Polyvinyl Chloride Pipe Culvert

Polyvinyl chloride pipe culvert shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a Day's work, the last pipe shall be blocked as may be required to prevent movement.

421.07.12.07 Polypropylene Pipe Culvert

Polypropylene pipe culvert shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint according to the manufacturer's recommendations to satisfy the pipe joint specification.

421.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe Culvert

Corrugated aluminum alloy structural plate pipe culvert shall be jointed by means of bolts according to the manufacturer's recommendations to satisfy the pipe joint specification.

421.07.13 Cleaning and Flushing of Pipe Culverts

At least 2 Business Days prior to the commencement of the post installation inspection, the pipe culverts shall be prepared for inspection by cleaning and flushing. The material from the cleaning and flushing operation shall be managed according to OPSS 411.

421.07.14 Clay Seals

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the proctor maximum dry density.

421.07.15 Concrete Appurtenances

Concrete appurtenances shall be as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Culvert inlet grates shall be installed when specified in the Contract Documents.

421.07.16 Site Restoration

Site restoration shall be according to OPSS 492.

421.07.17 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

421.08 QUALITY ASSURANCE

421.08.01 Acceptance

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

421.08.02 Post Installation Inspection

A post installation inspection shall be conducted by the Contractor when:

- a) Specified in the Contract Documents.
- b) A defective, damaged, or improperly installed pipe is encountered.
- c) At the request of the Contract Administrator.

421.09 MEASUREMENT FOR PAYMENT

421.09.01 Actual Measurement

421.09.01.01 Pipe Culvert Pipe Culvert Extension Non-Circular Pipe Culvert Non-Circular Pipe Culvert Extension

Measurement of pipe culverts, non-circular pipe culverts, pipe culvert extensions, and non-circular pipe culvert extensions shall be along the horizontal length of the pipe culvert in metres, from one end of the pipe culvert or pipe culvert end section to the other end of the pipe culvert or the other pipe culvert end section. When the grade of the pipe culvert is 10% or greater, the above measurement shall then be of the slope length.

421.09.01.02 Concrete Appurtenances

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed.

421.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

421.10 BASIS OF PAYMENT

421.10.01 “size, type, class” Pipe Culvert - Item “size, type, class” Pipe Culvert Extension - Item “size, type, class” Non-Circular Pipe Culvert - Item “size, type, class” Non-Circular Pipe Culvert Extension - Item Clay Seal - Item Concrete Appurtenances - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

421.10.02 Elevation Adjustment

Prior to the installation of a drainage structure, the Owner may, at its sole discretion, raise or lower the invert of a pipe culvert by 150 mm or less, at no additional cost. Bedding elevations shall be adjusted accordingly.

A change in invert elevation exceeding 150 mm shall be administered as a Change in the Work.



**FIGURE 1
CSA Standards
Certification Logo**



**CONSTRUCTION SPECIFICATION FOR INSTALLATION OF
PRECAST REINFORCED CONCRETE BOX CULVERTS
WITH SPAN 3m OR LESS IN OPEN CUT**

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422.01 SCOPE

This specification covers the requirements for the installation of precast reinforced concrete box culverts with span 3 m or less (including imperial sized spans of 3.048 m) in open cut and includes the requirements for concrete appurtenances, excavation, bedding, backfilling, granular cover and protection layer.

422.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 404	Support Systems
OPSS 501	Compacting
OPSS 517	Dewatering
OPSS 539	Temporary Protection Systems
OPSS 902	Excavating and Backfilling - Structures
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1303	Admixtures for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1821	Precast Reinforced Concrete Box Culverts with Span 3m or Less
OPSS 1860	Geotextiles

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and a 305 mm Drop

MTO Forms:

PH-CC-701 Request to Proceed

PH-CC-702 Notice to Proceed

CSA Standards

A23.4-16(R2021)	Precast Concrete - Material and Construction
S6-19	Canadian Highway Bridge Design Code

ASTM International

A240/A240M-22	Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications
D2487-17	Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D6938-17a	Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
F593-17	Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F594-09(2020)	Specification for Stainless Steel Nuts

422.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Backfill means earth, rock, or granular material used as fill within the excavation placed beyond the limits of bedding and cover below the subgrade elevation, including frost tapers.

Bedding means the material used to cushion and evenly distribute the soil reaction at the bottom of the structure.

Box Culvert means as defined in OPSS 1821.

Box Unit means as defined in OPSS 1821.

Competent Native Material means rock, or soil with a density of compact or greater or a consistency of firm or greater, or otherwise determined by the Contract Administrator to be suitable as a foundation material.

Concrete Appurtenances means head walls, cut-off walls, aprons, collars, and any other concrete fixtures associated with the box culverts.

Protection Layer means the material placed around the box unit to prevent damage to the box unit.

Distribution Slab means a reinforced concrete slab placed directly on the top slab of a box culvert when there is less than 600 mm of earth fill cover to improve load distribution on box culvert.

Earth means as defined in OPSS 206.

Granular Cover means the material placed as a protection layer above the box culvert to prevent damage to the box culvert.

Lot means as defined in OPSS 1821.

Native Material means the original material removed to form an excavation.

Protection Slab means a reinforced concrete slab that may be placed on the top of the culvert in an area exposed to chlorides.

Rock means as defined in OPSS 206.

Soil means as defined in OPSS 902.

422.04 DESIGN AND SUBMISSION REQUIREMENTS

422.04.01 Design Requirements

The design of the box culvert shall be according to CSA S6 and as specified in the Contract Documents.

422.04.02 Submission Requirements

422.04.02.01 Working Drawings

Electronic file of the fabrication and assembly drawings, including handling details, joint sealing compound, preformed gaskets material, placement of preformed seal produced by the manufacturer shall be submitted to the Contract Administrator 2 weeks prior to delivery of the box units. All Working Drawings shall bear the seal and signature of an Engineer certifying they are according to the Contract Documents.

422.04.02.02 Concrete Mix Designs

The concrete mix for concrete appurtenances, protection and distribution slabs shall be designed to provide adequate strength and durability for the intended use and to meet the requirements as specified in the Contract Documents. The concrete mix design shall be submitted according to the Mix Design clause of OPSS 1350.

422.05 MATERIALS

422.05.01 Backfill

Granular backfill material shall be according to OPSS 1010.

Earth backfill shall be classified as Group I, Group II according to Table 1. Within the areas of the Roadway, earth backfill shall have frost susceptibility characteristics similar to the native material for a depth equal to the frost treatment depth.

Rock backfill shall be according to the Rock Backfill to Structure subsection of OPSS 206.

422.05.02 Bedding

Bedding shall be as specified in the Contract Documents.

Earth bedding material shall be classified as Group I or Group II according to Table 1.

Granular aggregate materials shall be according to OPSS 1010.

422.05.03 Clay Seal

Clay seal shall be according to OPSS 1205.

422.05.04 Concrete

Concrete for appurtenances, protection slab, and distribution slab shall be according to OPSS 1350.

422.05.05 Connector Plates

Connector plates shall be according to ASTM 240M Type 304. Stainless steel threaded rods shall be according to ASTM F593 Type 316 with nuts according to ASTM F594.

422.05.06 Geotextile

Geotextile shall be according to OPSS 1860. Geotextile type shall be as specified in the Contract Documents and free of defects, rips, holes, flaws, and deterioration.

422.05.07 Granular Cover

Granular cover shall be according to OPSS 1010 and one of the following, or as specified in the Contract Documents:

- a) Granular A.
- b) Granular B, Type I or II, with 100% passing the 26.5 mm sieve.

422.05.08 Grout

Grout shall be non-shrink.

Cementing materials for grout shall be according to OPSS 1301. Sand for grout shall be a mortar sand according to OPSS 1004. Water for grout shall be according to OPSS 1302. Admixtures for grout shall be according to OPSS 1303.

The workability of the grout mix shall be suitable for the application.

422.05.09 Joint Sealing Compound

Joint sealing compound shall be as specified by the manufacturer of the box units.

422.05.10 Leveling Course

Leveling course shall be fine aggregate according to OPSS 1002.

422.05.11 Mortar

Mortar for joints and filling lift holes shall be according to OPSS 904.

422.05.12 Native Material

Classification of native material shall be according to ASTM D2487. The Contract Administrator shall determine if the native material is acceptable for use in the work.

422.05.13 Box Units

Box units shall be according to OPSS 1821.

422.05.14 Preformed Gasket

Preformed gaskets shall be as specified by the manufacturer of the box units.

422.05.05 Protection Layer

Protection layer shall be as specified in the Contract Documents.

Protection layer shall be free of stones having a diameter greater than 75 mm, debris, or frozen materials.

422.05.16 Steel Reinforcement

Steel reinforcement for concrete appurtenances, protection slab and distribution slab shall be according to OPSS 1440.

422.07 CONSTRUCTION

422.07.01 Selection of Box Units

The box units shall be according to OPSS 1821 based on the dimensions and height of fill as specified in the Contract Documents.

422.07.02 Delivery and Storage

The Contract Administrator shall be notified in writing a minimum of 3 Business Days prior to delivery of the box units.

Delivery shall include transportation, loading and unloading, and storage of the box units. Transportation and storage of the box units shall be according to CSA A23.4.

Box units shall be loaded for shipping in such a manner that they can be transported and unloaded at their destination without being damaged or exposed to stresses for which they were not designed. Box units shall be stored in such a manner to avoid damage or excessive stress.

Storage includes, but is not limited to, storage while awaiting delivery in temporary locations and/or, at the Working Area.

Lifting, storing, and transporting of box units shall be as specified in the Working Drawings.

Advertising by means of removable signing shall be permitted on box units only while in transit to the site. Any permanent markings on a surface that would be visible after installation shall not be permitted.

422.07.03 Excavation

The excavation for the installation of the box units shall be according to OPSS 902.

422.07.04 Support Systems

Support systems shall be according to OPSS 404.

422.07.05 Dewatering

Dewatering shall be according to OPSS 517.

422.07.06 Temporary Protection Systems

Temporary protection systems shall be according to OPSS 539.

422.07.07 Foundation

The foundation shall be as specified in the Contract Documents.

The excavation shall not disturb the material beyond the excavation limits.

When directed by the Contract Administrator, native material encountered at the excavation limits that is not considered to be competent shall be:

- a) sub-excavated to competent native soil or rock, in the presence of the Contract Administrator; and
- b) the sub-excavation backfilled with material acceptable to the Contract Administrator and compacted according to OPSS 501.

422.07.08 Bedding

Bedding shall be placed to the dimensions specified in the Contract Documents.

Bedding shall be placed in layers not exceeding 200 mm in thickness, uncompacted measurement, and each layer shall be compacted according to OPSS 501.

Bedding shall not be placed on frozen earth grade.

422.07.09 Levelling Course

The surface prepared to support the box units shall have a 75 mm minimum thickness of uncompacted levelling course.

422.07.10 Installing Box Units

422.07.10.01 General

Box units shall be installed to the alignment and grade specified in the Contract Documents.

Box units shall not be installed on bedding containing frozen material.

Box unit installation and backfill shall be completed prior to the start of any Subbase and Base course construction over the box unit location.

End units to accommodate concrete appurtenances shall be as specified in the Contract Documents. End box units shall be a minimum of 2.0 m in length, all other box units shall be a minimum of 0.914 m in length. All box units shall be less than 3.1 m in length. The box units shall be installed to make a continuous line forming a box culvert.

Installation of the box units shall commence at the outlet end and proceed in the upstream direction with the bell ends of the box units facing upgrade. The box units shall be placed with the base of each box unit in uniform contact with the prepared bedding throughout its full length. The ends of the box units shall be joined so there is no unevenness along the inside. The box units and joint surfaces shall be kept clean as work progresses. Water shall not be allowed to flow through the box units during installation. The excavation shall be kept dry and the box units shall not be installed in water.

The gap at box unit joints shall not exceed 20 mm.

For box units placed in parallel for multiple cell installations, a 60 mm $\pm$ 10 mm gap filled with grout between adjacent cells shall be provided.

422.07.10.02 Connector Plates

Connector plates shall be installed as specified in the Contract Documents.

422.07.10.03 Joint Treatment

Joints between box units shall be provided with a preformed seal. All joints, including the bottom side of box culvert, shall be effectively covered to prevent influx of material from the backfill or native soil through the joints. Unless otherwise specified, material for the joint cover shall be geotextile.

The geotextile shall be according to the requirements of OPSS 1860 and be free of defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

The geotextile cover layer shall have a minimum overlaps of 500 mm and shall be pinned together or adhered to the concrete surface.

422.07.10.04 Mortared Joints

When mortared joints are specified in the Contract Documents, the joints shall be thoroughly cleaned and wetted. Mortar shall then be applied around the inner and outer perimeter over the joint. After the mortar joint is complete, the joint inside shall be wiped clean and smooth.

422.07.10.05 Preformed Seal

Preformed seal shall be placed according to the manufacturer's recommendations.

422.07.10.06 Lift Holes

All lift holes shall be filled with mortar after installation of the box units.

422.07.10.07 Inspection After the Installation of the Box Culvert and Prior to Waterproofing

After installation of all box units within a construction stage, and prior to waterproofing, installation of distribution slab or protection slab when specified in the Contract Documents, MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator. The next operation shall not proceed until MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

422.07.10.08 Waterproofing of the Culvert

When waterproofing of the culvert is specified, it shall be according to the Contract Documents.

422.07.11 Concrete Appurtenances, Protection and Distribution Slabs

Concrete placement, curing, and quality assurance for cast-in-place concrete appurtenances, protection slabs or distribution slabs shall be according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905.

When a protection slab or distribution slab is specified, it shall be according to the Contract Documents. The protection slab or distribution slab shall be placed without any damage to or movement of the box culvert.

422.07.12 Backfill

Backfill shall be placed in layers not exceeding an uncompacted thickness measurement of 300 mm. Compaction shall be according to OPSS 501.

Backfilling on each side of the box units shall be completed simultaneously without any movement of the box culvert or any damage to it. At no time shall the levels on each side differ by more than 400 mm. Within the areas of the Roadway, earth backfill shall have frost susceptibility characteristics similar to the native material for a depth equal to the frost treatment depth.

Rock may be used as backfill provided the installed box units are protected by a protection layer having a minimum thickness as specified in the Contract Documents.

422.07.13 Granular Cover

Granular cover shall be placed in layers not exceeding an uncompacted thickness measurement of 200 mm, and each layer shall be compacted according to OPSS 501. The granular cover shall be placed without any damage to or movement of the culvert.

422.07.14 Clay Seal

When a clay seal is specified in the Contract Documents, the clay seal shall be placed to the dimensions specified in the Contract Documents and compacted to a minimum of 95% of the maximum dry density (MDD). The MDD shall be carried out on a single representative sample according to LS-706. Field density and field moisture determinations shall be made according to ASTM D6938.

422.07.15 Access for Quality Assurance

Unhindered access for inspection and testing of all the work shall be provided to the Contract Administrator or the Owner's representative. Any debris and obstructions shall be removed to allow access for the purposes of dimensional measurements and/or inspection.

422.07.16 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

422.08 QUALITY ASSURANCE

422.08.01 General

The acceptance of the box culvert shall be according to the requirements of this specification, including satisfactory completion of any repairs.

422.08.02 Installation Deficiencies

The Contract Administrator shall carry out an inspection of the box culvert to determine if the completed work contains any installation deficiencies. An installed box culvert not meeting the following tolerances, shall be deemed rejectable:

- a) Alignment of box units: ± 10 mm
- b) Joint Gap: 20 mm maximum
- c) Gap between adjacent side-by-side box (multi-cell) culverts: ± 10 mm

When the installation is rejectable, a proposal for remediation signed and sealed by an Engineer shall be submitted to the Contract Administrator for acceptance.

422.08.03 Defects

The Contract Administrator shall carry out an inspection of the box culvert to determine if the completed work contains cracks, spalls or delaminations. Any box unit with a crack width > 0.3 mm, or any delamination, or spall shall be deemed rejectable.

Where the crack width is between 0.3 mm and 1.0 mm, or where a spall or delamination is $< 0.1\text{m}^2$, a proposal for repair or remediation signed and sealed by an Engineer may be submitted to the Contract Administrator for acceptance.

422.08.04 Repair Proposal and Assessment of Repairs

If the repair proposal is deemed acceptable by the Owner, the box culvert or box unit shall be repaired according to the proposal. Repairs shall not be carried out without the prior written acceptance of the proposal by the Contract Administrator. If the repair proposal is not acceptable to the Owner, the box unit or box culvert shall be replaced.

The Contract Administrator shall inspect the repaired work. This inspection may include covermeter surveys, coring, and any other testing deemed necessary to assess the effectiveness and acceptability of the repair.

422.09 MEASUREMENT FOR PAYMENT

422.09.01 Actual Measurement

422.09.01.01 Precast Concrete Box Culvert, Fabrication

Measurement for the fabrication of precast concrete box culverts shall be by the horizontal length in metres along the centerline of the invert of the culvert.

422.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

422.10 BASIS OF PAYMENT

422.10.01 Precast Concrete Box Culvert, Fabrication (Span 1800 mm) - Item Precast Concrete Box Culvert, Fabrication (Span 2400 mm) - Item Precast Concrete Box Culvert, Fabrication (Span 3000 mm) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments.

422.10.01.01 Payment Adjustment for Air Void System in Hardened Concrete

The payment adjustment for concrete without silica fume shall be calculated based on individual lots and applied as follows:

Payment reduction for a lot = Lot quantity/tender quantity x Price x ((100 - P)/100)

Where:

Lot quantity = volume of concrete in a lot (m³) (calculated based on plan dimension)

Tender quantity = volume of concrete in tender (m³) (calculated based on plan dimension)

Price = Contract price for the fabrication tender item

P = pay factor for the lot according to the spacing factor specified below:

Spacing Factor, mm	Pay Factor (P)
> 0.200 but ≤ 0.220	90
> 0.220 but ≤ 0.240	80
> 0.240 but ≤ 0.250	70

422.10.01.02 Payment Adjustment for Rapid Chloride Permeability

The payment adjustment shall be calculated based on individual lots according to OPSS 1821 and applied as follows:

Payment adjustment = Lot quantity x (C-2500)/5

Where:

Payment adjustment = payment adjustment of a lot (\$)

C = rapid chloride permeability of a lot (coulombs)

Lot quantity = volume of concrete in a lot (m³) (calculated based on plan dimension)

The payment adjustment for concrete containing silica fume shall be calculated based on individual lots and applied as follows:

Payment adjustment = Lot quantity x (C-1000)/5

Where:

Payment adjustment = payment adjustment of a Lot (\$)

C = rapid chloride permeability of a lot (coulombs)

Lot quantity = volume of concrete in a lot (m³) (calculated based on plan dimension)

422.10.02 Precast Concrete Box Culvert, Delivery and Installation (Span 1800 mm) - Item
Precast Concrete Box Culvert, Delivery and Installation (Span 2400 mm) - Item
Precast Concrete Box Culvert, Delivery and Installation (Span 3000 mm) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Corrective work, including investigation of defects and deficiencies, design of repairs, site access, traffic staging and removal of existing work, shall be at no additional cost to the Owner.

Payment at the Contract price for the above tender items shall also include support systems.

422.10.03 Clay Seal - Item

Payment for clay seal shall be at the Contract price for the tender item "Clay Seal" according to OPSS 902.

422.10.04 Granular - Item

Granular material used for bedding, backfill, granular cover, and frost tapers shall be paid for under the appropriate granular items specified in the Contract Documents.

Payment will not be made for granular used to fill any area excavated beyond the lines specified in the Contract Documents or used as backfill when acceptable quality native material is available.

422.10.05 Steel Reinforcement in Concrete Appurtenances, Protection and Distribution Slabs

Payment shall be at the Contract price for the tender items "Reinforcing Steel Bar", "Stainless Steel Reinforcing Bar", "Mechanical Connectors" and "Stainless Steel Mechanical Connectors" according to OPSS 905.

422.10.06 Concrete in Appurtenances, Protection and Distribution Slabs

Payment shall be at the Contract price for the tender item "Concrete in Culverts", according to OPSS 904.

422.10.07 Excavation for Box Culverts

Payment for earth and rock excavation shall be at the Contract price for the tender items "Earth Excavation for Structure" and "Rock Excavation for Structure", according to OPSS 902.

When material not considered to be competent native material is encountered at the excavation limits, any subexcavation and backfill work directed by the Contract Administrator shall be administered as a Change in the Work.

422.10.08 Swamp Excavation

Payment for swamp excavation shall be at the Contract price for the tender item Earth Excavation, Grading, according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

TABLE 1
Soil Gradation Requirements for Earth Bedding, Backfill and Protection Layer

Group	Grain Size	Description	Symbols
I	16-64 mm	Well-Graded Gravel, Gravel-Sand Mixtures, little or no fines	GW
	16-64 mm	Poorly-Graded Gravel, Gravel-Sand Mixtures, little or no fines	GP
	0.5-2 mm	Well-Graded Sand, Gravelly Sand, little or no fines	SW
	0.5-2 mm	Poorly-Graded Sand, Gravelly Sand, little or no fines	SP
II	4-16 mm	Clayey Gravel or Gravel-Sand-Clay Mixtures	GC
	0.25-0.5 mm	Clayey Sand or Sand-Clay Mixtures	SC
	0.25-0.5 mm	Silty Sand or Sand-Silt Mixtures	SM
	4-16 mm	Silty Gravels or Gravel-Sand-Silt Mixtures	GM
	0.06-0.25 mm	Inorganic Silts and Very Fine Sands, Silty or Clayey Fine Sands, Clayey Silts	ML



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.PROV 441
APRIL 2017**

(Formerly OPSS 441, November 2014)

Note: The PROV implemented in April 2017 replaces OPSS 441 COMMON, November 2014 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
WATERMAIN INSTALLATION IN OPEN CUT**

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441.01 SCOPE

This specification covers the requirements for the installation of watermains, service connections, and associated appurtenances in open cut.

441.01.01 Specification Significance and Use

This specification has been developed for use in provincial oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

441.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

441.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 490	Site Preparation for Pipeline, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1842	Pressure Polyethylene Pipe Products

CSA Standards

B64.5-11	Double Check Valve (DCVA) Backflow Preventers [Part of B64 Series-11, Backflow Preventers and Vacuum Breakers Compendium]

B137.1-09	Polyethylene Pipe, Tubing and Fittings for Cold-Water Pressure Services [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.2-09	Polyvinyl Chloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.3-09	Rigid Polyvinyl Chloride (PVC) Pipe and Fittings for Pressure Applications [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.3.1-09	Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe and Fittings for Pressure Applications [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.10-09	Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure-Pipe Systems [Part of B137-09, Thermoplastic Pressure Piping Compendium]

ASTM International

A 153M-09	Zinc Coating (Hot Dip) on Iron and Steel Hardware
A 276-10	Stainless Steel Bars and Shapes
A 307-10	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
B 88-09	Seamless Copper Water Tube
B 633-11	Electrodeposited Coatings of Zinc on Iron and Steel
B 766-86 (2008)	Electrodeposited Coatings of Cadmium
C 361-11	Reinforced Concrete Low-Head Pressure Pipe
D 3139-98 (2011)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

American Water Works Association (AWWA)

C104/A21.4-08	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C110/A21.10-08	Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-07	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151/A21.51-02	Ductile-Iron Pipe, Centrifugally Cast, for Water
C153/A21.53-06	Ductile-Iron Compact Fittings for Water Service
C200-05	Steel Water Pipe - 6 In. (150 mm) and Larger
C205-07	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger
C206-11	Field Welding of Steel Water Pipe
C208-07	Dimensions for Fabricated Steel Water Pipe Fittings
C301-07	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
C302-11	Reinforced Concrete Pressure Pipe, Non-Cylinder Type
C303-08	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
C502-05	Dry-Barrel Fire Hydrants
C504-10	Rubber-Seated Butterfly Valves
C509-09	Resilient-Seated Gate Valves for Water Supply Service
C510-07	Double Check Valve Backflow Prevention Assembly
C800-05	Underground Service Line Valves and Fittings
C900-07	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Transmission and Distribution
C905-10	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 350 mm Through 1,200 mm (14 in. Through 48 in.) for Water Transmission and Distribution
C907-12	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Distribution
C909-09	Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 100 mm Through 600 mm (4 in. Through 24 in.), for Water Distribution

American Society of Mechanical Engineers (ASME)

B18.2.1-2010 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

NSF International

61-2008 Drinking Water System Components - Health Effects

441.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit, which are used in connection with a water distribution system, such as valves, hydrants, corporation cocks, services, and thrust restraints.

Backfilling means the operation of filling a trench with bedding, cover, and backfill material, or embedment and backfill material.

End Covers means temporary cover installed at the factory over both ends of uninstalled watermain pipe to prevent the entry of contaminants during shipping and storage.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Fitting means connections, appliances, and adjuncts designed to be used in connection with pipe: for example, elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a main; plugs and caps to close an end; and bushings, diminishers, or reducers to couple two pipes of different diameters.

Service Connection means the system used to supply water from the watermain to the property line.

Service Connection Appurtenance Set means the main stop, curb stop, couplings, service box, service box support, and service saddle used in the installation of a service connection.

Watermain means an installation designed for the conveyance of water under pressure using circular pipe.

441.05 MATERIALS

441.05.01 General

The pipe size shall be according to the size specified in the Contract Documents. Pipe type and class shall be as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe material and class with which they are used.

All material for watermains shall be NSF/ANSI 61 compliant.

441.05.02 Ductile Iron Pipe

Ductile iron pipe shall be according to AWWA C151/A21.51.

Fittings shall be gray iron according to AWWA C110/A21.10 or ductile iron according to AWWA C110/A21.10 or AWWA C153.

Ductile iron pipe and fittings shall be cement lined according to AWWA C104/A21.4.

Rubber gaskets for push-on or mechanical joints shall be according to AWWA C111/A21.11.

441.05.03 Concrete Pressure Pipe

Concrete cylinder pipe including joints and fittings shall be according to AWWA C301 or AWWA C303.

Non-cylinder pipe and joints shall be according to AWWA C302 or ASTM C 361. Fittings shall be according to AWWA C302.

441.05.04 Polyvinyl Chloride Pipe

441.05.04.01 General

Flexible elastomeric seals for bell and spigot joints shall be according to ASTM D 3139.

Fittings for polyvinyl chloride (PVC) and molecularly oriented polyvinyl chloride (PVCO) pipe shall be either:

- a) Gray iron according to AWWA C110/A21.10.
- b) Ductile iron according to C110/A21.10 or AWWA C153 and shall be cement lined according to AWWA C104/A21.4.
- c) Injection moulded polyvinyl chloride, blue in colour and according to AWWA C907 and CSA B137.2.
- d) Prefabricated polyvinyl chloride, blue in colour and according to AWWA C905 and CSA B137.3.

441.05.04.02 Polyvinyl Chloride Pipe (PVC)

Polyvinyl chloride pipe shall be according to AWWA C900 or AWWA C905 and CSA B137.3, and shall be blue in colour and supplied complete with gaskets.

441.05.04.03 Molecularly Oriented Polyvinyl Chloride Pipe (PVCO)

Molecularly oriented polyvinyl chloride pipe shall be according to AWWA C909 and CSA B137.3.1, and shall be blue in colour and supplied complete with gaskets.

441.05.05 Polyethylene Pipe

Polyethylene pressure pipe shall be according to OPSS 1842.

Fittings shall be either:

- a) Flanged gray iron according to AWWA C110/A21.10.
- b) Flanged ductile iron according to AWWA C110/A21.10 or AWWA C153 and shall be cement lined according to AWWA C104/A21.4.
- c) Polyethylene according to OPSS 1842.
- d) Heat fusion or insert or compression type fittings according to CSA 137.1.

441.05.06 Steel Pipe

Steel pipe shall be according to AWWA C200. Fittings shall be according to AWWA C208. Steel pipe shall have a cement-mortar protective lining and coating according to AWWA C205.

441.05.07 Copper Pipe

Copper pipe for service connections shall be according to ASTM B 88 and shall be type K soft copper.

441.05.08 Composite Pipe

Crosslink polyethylene/aluminum/crosslink polyethylene composite pressure pipe for service connections shall be according to CSA B137.10.

441.05.09 Valves

441.05.09.01 General

All valves shall open by operating in a counter clockwise direction.

Valves shall be designed for a minimum cold water working pressure of 1,035 kPa.

Valve types shall be one of the following:

- a) Valves less than 75 mm shall be brass or bronze gate valves.
- b) Valves greater than or equal to 75 mm, and less than or equal to 300 mm, shall be cast or ductile iron gate valves.
- c) Valves greater than 300 mm up to and including 500 mm shall be gate or butterfly valves.
- d) Valves greater than 500 mm shall be butterfly valves.

Fasteners shall be made from material meeting the strength requirements of ASTM A 307 with dimensions according to ASME B18.2.1. Bolts, studs, and nuts shall be cadmium plated according to ASTM B 766 or zinc coated according to ASTM A 153 or ASTM B 633. Fasteners for mechanical joints shall be ductile iron according to AWWA C111/A21.11.

441.05.09.02 Service Line Valves

Valves shall be according to AWWA C800. Type, pressure class, and end connections shall be as specified in the Contract Documents.

441.05.09.03 Gate Valves

Gate valves shall be according to AWWA C509.

Stem sealing on non-rising stem valves shall use O-ring type seals that do not require adjustment.

The gate valve end configuration shall be as specified in the Contract Documents.

441.05.09.04 Butterfly Valves

Butterfly valves shall be according to AWWA C504.

Valves shall be short body flanged or mechanical-joint, class 150B.

Valve shafts shall be stainless steel and, when they project through the body, shall have seals that do not require adjustment.

A vertical operating nut shall be provided. Valves shall be provided with an external indicator showing valve position by means of a pointer operating through a 90° arc from open to close.

441.05.09.05 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be single acting type.

441.05.10 Hydrants

Hydrants shall be according to AWWA C502. The type shall be as specified in the Contract Documents.

441.05.11 Double Check Valve Backflow Preventers

Double check valve backflow preventers shall be according to CSA B64.5 or AWWA C510.

441.05.12 Service Connection Fittings and Appurtenances

Main stops, curb stops, couplings, service boxes, and service saddles shall be as recommended by the manufacturer of the service connection pipe.

441.05.13 Concrete

Concrete for thrust blocks and fitting and appurtenance supports shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 20 MPa.

441.05.14 Mortar

Mortar for joints shall be composed of one part Portland cement and three parts mortar sand, wetted with sufficient water to make the mixture plastic.

The mortar sand shall be according to OPSS 1004, the Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

441.05.15 Straps, Tie-Rods, Angles, Nuts, and Bolts

Stainless steel straps, tie-rods, angles, nuts, and bolts used with concrete thrust blocks shall be according to ASTM A 276, Type 316 stainless steel.

441.07 CONSTRUCTION

441.07.01 General

The work for the installation of watermains shall include all watermain pipe, bends, tees, fittings, and thrust restraints and the testing of the watermain system.

The interior of all pipe, fittings, and other accessories shall be kept clean and free from undesirable material at all times.

441.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

441.07.03 Removals

Removals shall be according to OPSS 510.

441.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

441.07.05 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the works.

441.07.06 Cold Weather Work

All work shall be protected from freezing. Pipe and bedding material shall not be placed on frozen ground.

441.07.07 Transporting, Unloading, Storing, and Handling Pipe

All pipe, fittings, and gaskets that are unsound or damaged shall be rejected.

All pipe up to and including 600 mm diameter shall be delivered to the Work Area with end covers and a tamper evident seal on only the bell end. These components shall adhere sufficiently to withstand the stresses caused during shipment.

A waterproof seal is not required on the end covers.

Tamper evident seals shall display the manufacturers name or logo or both. Seals shall straddle the end cover and the pipe. Removal of the cover shall render the tamper evident seal unusable either by breaking the seal or by leaving a message such as "VOID" on the pipe. Tamper evident seals are not required for non-reusable heat shrink plastic covers or foam plugs with punch-out centres.

Pipe delivered to the construction site with damaged or missing end covers shall be field cleaned to remove all undesirable material along the entire length of the interior of the pipe and the end covers reinstalled.

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

441.07.08 Excavation

Excavation for the installation of watermain shall be according to OPSS 401.

441.07.09 Support Systems

Support systems shall be according to OPSS 404.

441.07.10 Dewatering

Dewatering shall be according to OPSS 517.

441.07.11 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

When the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling when necessary to prevent damage to such works or proposed works.

441.07.12 Temporary Potable Water Supply Services

Temporary potable water supply services shall be according to OPSS 493.

441.07.13 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

441.07.14 Installation of Pipe

Pipe shall be laid in a dry trench.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. The barrel of each pipe shall be in contact with the shaped bed throughout its full length.

When the Owner raises or lowers the invert of a watermain by up to 150 mm, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a watermain is raised or lowered by more than 150 mm, then this shall constitute a Change in the Work for the full extent of the change from the original grade.

Pipe shall be kept clean and dry as work progresses. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

441.07.15 Jointing

441.07.15.01 General

End covers shall be removed immediately prior to jointing. Joint surfaces shall be clean. Pipe ends shall be lubricated with material recommended by the pipe manufacturer.

Manufacturer's instructions for jointing pipe shall be followed.

Joints and all connections shall be made watertight.

All bolts, nuts, couplings, rubber rings, and connecting pieces shall be cleaned thoroughly before installation.

Pipe shall be aligned on centreline to previously laid pipe.

Pipe shall be pulled or pushed only by a hand-operated winch. A backhoe shall not be used for pushing pipe.

Joints shall be prevented from opening after the pipe has been laid.

441.07.15.02 Ductile Iron Pipe

Mechanical Joints:

The gland shall be positioned on the pipe with the lip extension toward the joint. The gasket shall be slipped on the pipe with the thick edge towards the gland. The spigot end shall be pushed to its seat in the bell. The gasket shall be pressed to seat it evenly around the joint.

The gland shall be positioned for bolting and the bolts shall be inserted. All nuts shall be hand tightened.

The nuts shall be tightened half a turn at a time with a calibrated torque wrench. All nuts shall be tightened uniformly to the torque specified in AWWA C111/A21.11.

Bell and Spigot Joints:

The gasket shall be placed in the groove of the bell making certain it is properly seated.

The gasket shall be lubricated.

Pipe to be joined shall be aligned and the spigot shall be carefully entered into the bell until the spigot end just makes contact with the gasket.

The entry of the spigot into the bell shall be completed by hand or by the use of a hand operated winch until the second reference mark is flush with the face of the bell.

441.07.15.03 Concrete Pressure Pipe

Bell and Spigot Joints:

A cotton or burlap diaper shall be placed around the bell end of the pipe already in place.

A rubber gasket shall be placed on the spigot end of the pipe to be laid ensuring that the stretch and volume of the gasket is equalized around the entire circumference of the pipe. The gasket and spigot shall be lubricated prior to the spigot end being inserted home into the bell end.

The pipe shall be aligned and the spigot end shall be inserted into the bell of the pipe already in place.

Steel inserts shall be placed in the joints to prevent the spigot from entering the full depth of the bell. The location of the rubber gasket shall be checked around the entire circumference of the joint. The steel insert shall be removed and the pipe pushed until the spigot enters the full depth of the socket and is retained in position.

Ensure that the diaper is carefully placed around the joint recess. Cement mortar shall be poured around the assembled joint.

441.07.15.04 Polyvinyl Chloride Pressure Pipe - PVC and PVCO

Joints shall be bell and spigot with rubber gaskets. If gaskets are supplied separately, they shall be inserted in the groove of the bell end of the pipe.

The spigot shall be lubricated. The spigot end shall be inserted and pushed into the bell up to but not beyond the depth of the stop reference mark.

441.07.15.05 Polyethylene Pressure Pipe

Polyethylene pipe 100 mm diameter and larger shall be joined by the thermal butt fusion process. Procedures recommended by the pipe manufacturer shall be followed.

Polyethylene pipe 75 mm diameter and smaller shall be joined with heat fusion or insert or compression type fittings that are recommended by the pipe manufacturer and that prevent pull-out and resist creep deformation at full test pressure.

Connections to non-polyethylene fittings and appurtenances 50 mm diameter and larger shall be made with flanged joints according to the manufacturer's recommendations. Bolts shall be tightened to the torque specified by the manufacturer for the particular size and type of stub end.

441.07.15.06 Steel Pipe

Steel pipe shall be jointed according to AWWA C200. Field welding for joints shall be according to AWWA C206.

441.07.15.07 Service Connection Pipe

Service connection pipe shall be jointed as recommended by the manufacturer.

441.07.16 Cutting of Pipe

Whenever cutting of pipe is required, the pipe shall be cut according to the recommendations of the pipe manufacturer. After cutting the pipe, the interior of the pipe shall be cleaned and the end cover replaced until the pipe is installed.

441.07.17 Change in Line and Grade

441.07.17.01 Ductile Iron Pipe

Fabricated bends shall be provided for changes in line and grade of 11.25° or more.

Deflections of less than 11.25° may be made using a series of pipe joint deflections. The manufacturer's recommendation in deflecting any single pipe joint shall not be exceeded.

441.07.17.02 Concrete Pressure Pipe

Fabricated bends, bevel adaptors, or elbows shall be used for changes in line or grade greater than 5°. Changes in line or grade less than 5° shall be made using a manufactured joint or bevel connection or may be made over several joints. The manufacturer's joint deflection recommendations shall not be exceeded.

441.07.17.03 Polyvinyl Chloride Pipe - PVC and PVCO

Polyvinyl chloride pipe joints may be deflected but shall not exceed the manufacturer's recommendations. Otherwise, fabricated bends shall be used.

441.07.17.04 Polyethylene Pipe

Use of pipe flexibility may be allowed but shall not exceed the manufacturer's recommendations.

441.07.17.05 Steel Pipe

Fabricated bends shall be used at all changes in line or grade, unless the change can be accomplished by deflections at pipe joints without exceeding the manufacturer's recommendation for deflection at pipe joints.

441.07.18 Installation of Valves and Fittings

441.07.18.01 General

The work for the installation of valves and fittings shall include the valves and couplings and valve boxes, when valve boxes are specified in the Contract Documents. Valves and fittings shall be installed in locations and be of the type specified in the Contract Documents. Valves and connecting pipe shall be aligned accurately and supported as specified in the Contract Documents. Valves and fittings do not require end covers but shall be field cleaned prior to installation.

441.07.18.02 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be installed at locations specified in the Contract Documents.

Each air release and air/vacuum valve shall be provided with an isolating valve.

441.07.19 Installation of Hydrant Sets

The work for the installation of hydrant sets shall include the placing of hydrants, hydrant isolating valves, hydrant leads, restraining devices, and support devices.

Hydrant sets shall be installed at locations specified in the Contract Documents.

The hydrant shall be plumb with the nozzles parallel to the edge of pavement or curb line and the pumper connection facing the roadway.

441.07.20 Installation of Service Connections

A service connection shall consist of a service connection pipe and a service connection appurtenance set and shall be installed at locations and be of the size specified in the Contract Documents.

Service connection pipe shall be installed by pressure tap connection or saddles. Service connections on plastic watermain shall be installed using service saddles or tapped couplings.

Curb stop valve boxes shall be installed vertically and flush with the final grade elevation.

441.07.21 Shutting Down or Charging Mains

At no time shall watermain be shut down or charged or valves operated without permission from the Contract Administrator.

441.07.22 Connections to Existing Watermain

The work of connecting to existing watermain shall include the removal of all plugs, caps, blow offs, and thrust blocks from an existing watermain or fitting, and the installation of the connection.

All connections to existing watermain shall be made under the supervision of the Contract Administrator.

441.07.23 Thrust Restraints

All connections, caps, and bends shall be restrained by concrete blocking and/or restrained joints as specified in the Contract Documents. Concrete for thrust blocks shall be placed against undisturbed ground. Joints and couplings shall remain free from concrete. Only restrained joint products specifically designed for use with the pipe material shall be used.

441.07.24 Hydrostatic Testing

441.07.24.01 General

Hydrostatic testing shall be conducted under the supervision of the Contract Administrator upon completion of the watermain, including services and backfilling.

A test section shall be either a section between valves or the completed watermain.

Test pressure shall be 1,035 kPa.

The test section shall be filled slowly with water and all air shall be removed from the pipeline. A 24-hour absorption period may be allowed before starting the test. The test section shall be subjected to the specified continuous test pressure for 2 hours.

441.07.24.02 Polyethylene Pipe

The test procedure shall consist of initial expansion and test phases.

During the initial expansion phase, the test section shall be pressurized to the test pressure and sufficient make-up water added each hour for 3 hours to return to test pressure. The test phase begins after the initial expansion phase.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the value in Table 1, leakage is not indicated.

If the amount of make-up water exceeds the Table 1 value, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

The test duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be de-pressurized and allowed to relax for at least 8 hours before bringing the test section up to pressure again.

441.07.24.03 Other Pipe

A period of 24 hours shall be allowed before starting the test.

The test section shall be subject to the specified continuous test pressure for 2 hours.

The leakage is the amount of water added to the test section to maintain the specified test pressure for the test duration. The measured leakage shall be compared with the allowable leakage as calculated for the test section. The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of pipe for the 2-hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired and the test section shall be retested until a satisfactory result is obtained.

441.07.25 Flushing and Disinfecting Watermains

Flushing and disinfecting operations shall be conducted under the supervision of the Contract Administrator. The watermain shall be flushed to achieve a minimum velocity of 0.76 m/sec otherwise the watermain shall be swabbed. The Contract Administrator shall be notified at least 2 Business Days in advance of the proposed date on which flushing and disinfecting operations are to commence.

Watermains shall be flushed in a sequence approved by the Contract Administrator. The Contract Administrator may permit or require the flushing to be carried out in stages as sections of the system are completed. Flushed sections shall be protected from contamination.

After flushing is completed, water from the existing distribution system shall be allowed to flow at a controlled rate into the new pipeline. Liquid chlorine solution shall be introduced so that the chlorine is distributed throughout the section being disinfected. The chlorine shall be applied so that the chlorine concentration is 50 mg/litre minimum throughout the section. The system shall be left charged with the chlorine solution for 24 hours.

Sampling and testing for chlorine residual shall be carried out by the Contract Administrator. The chlorine residual shall be tested in the section after 24 hours. If tests indicate a chlorine residual of 25 mg/litre minimum, the section shall be flushed completely and recharged with water normal to the operation of the system. If the test does not meet the requirements, the chlorination procedure shall be repeated until satisfactory results are obtained.

Twenty-four hours after the system has been recharged, the Contract Administrator shall take samples for bacteriological tests. Samples shall be collected from every 350 m of the new watermain plus one sample from the end of each of the line and at least one sample from each branch. If there is indication of contamination, the disinfection procedure shall be repeated.

The system shall not be put into operation until approval has been given by the Contract Administrator.

441.07.26 Site Restoration

Site restoration shall be according to OPSS 492.

441.07.27 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

All chlorinated water used for testing, flushing, or disinfecting watermains shall be disposed of safely.

The method of disposal of chlorinated water is subject to the approval of the Contract Administrator.

441.09 MEASUREMENT FOR PAYMENT

441.09.01 Actual Measurement

441.09.01.01 Watermains

Measurement of watermains shall be by length in metres along the horizontal centreline of the pipe from the point of connection to a chamber, water treatment plant, or existing watermain to a point vertically above the end of the new watermain.

441.09.01.02 Valves

For measurement purposes, a count shall be made of the number of valves installed, regardless of the type and size.

441.09.01.03 Hydrant Sets

For measurement purposes, a count shall be made of the number of hydrant sets installed, regardless of the type.

441.09.01.04 Service Connection Pipe

Measurement of service connection pipe shall be by length in metres along the horizontal centreline of the pipe from the point of connection at the watermain to a point vertically above the end of the service connection.

441.09.01.05 Service Connection Appurtenance Sets

For measurement purposes, a count shall be made of the number of service connection appurtenance sets installed.

441.09.01.06 Connections to Existing Watermains

For measurement purposes, a count shall be made of the number of connections made to existing watermains.

441.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

441.10 BASIS OF PAYMENT

- 441.10.01 Watermains - Item**
- Valves - Item**
- Hydrant Sets - Item**
- Service Connection Pipe - Item**
- Service Connection Appurtenance Sets - Item**
- Connections to Existing Watermains - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Test Phase Make-Up Amount for Pressure Polyethylene Pipe

Pipe Diameter mm	Make-Up Water litre/km
30	12.38
40	12.38
50	13.62
75	18.60
100	31.00
150	74.50
200	124.20
250	161.40
275	248.30
300	285.60
350	335.20
400	409.70
450	533.90
500	682.90
550	869.10
600	1,105.00
700	1,378.20
800	1,775.50
900	2,234.90
1,000	2,731.60
1,050	3,104.00
1,200	3,973.20
1,350	5,152.70
1,600	7,449.70



Note: The PROV published in November 2018 replaces OPSS 490 COMMON, April 2016 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
SITE PREPARATION FOR PIPELINES, UTILITIES,
AND ASSOCIATED STRUCTURES**

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490.07	CONSTRUCTION
490.08	QUALITY ASSURANCE - Not Used
490.09	MEASUREMENT FOR PAYMENT - Not Used
490.10	BASIS OF PAYMENT

490.01 SCOPE

This specification covers the requirements of site preparation for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction.

490.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Piled Boulders
OPSS 206	Grading
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 706	Temporary Traffic Control Devices

OPSS 801	Protection of Trees
OPSS 802	Topsoil
OPSS 805	Temporary Erosion and Sediment Control Measures

490.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 for a sewer system and OPSS 441 for a watermain.

490.07 CONSTRUCTION

490.07.01 General

Site preparatory work shall be performed prior to the installation of the pipelines, Utilities, and associated structures.

490.07.02 Removal of Existing Signing

Removal of existing signing shall be according to OPSS 706.

490.07.03 Clearing and Grubbing

Clearing and grubbing and related work shall be according to OPSS 201.

490.07.04 Shrub and Tree Relocation

Shrubs and trees to be relocated shall be protected according to OPSS 801 in their original and final locations.

Shrub and tree relocation shall be as specified in the Contract Documents.

490.07.05 Tree Protection and Pruning

Tree protection and pruning shall be according to OPSS 801.

490.07.06 Stripping and Stockpiling Topsoil

Stripping of topsoil shall be according to OPSS 206. Topsoil shall be removed carefully in the Work Areas and shall not be mixed with subsoil or other materials.

Stockpiling of topsoil shall be according to OPSS 802 and as specified in the Contract Documents. Topsoil shall not be placed in or near tree stands, along flood plains, and in areas containing natural wildlife habitats. Perimeter drainage ditches shall be constructed to intercept and divert run-off to adjacent settling ponds. Temporary erosion and sediment control measures shall be according to OPSS 805. Stockpiles shall be protected to ensure minimum environmental interference.

490.07.07 Removal of Fences and Guide Rails

Property owners or occupants shall be given at least 24 hours notice in advance of dismantling fences. Fences and guide rails shall be dismantled, where necessary. All components that are broken, bent, or damaged as a result of the operation shall be removed from the site and replaced with new components. All reusable components shall be stored and protected.

490.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

490.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermain and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction shall be full compensation for all labour, Equipment, and Material to do the work of site preparation.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**OPSS.PROV 491
NOVEMBER 2017**
(Formerly OPSS 491 November 2010)

Note: The PROV published in November 2017 replaces OPSS 491 COMMON, November 2010 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR PRESERVATION, PROTECTION, AND
RECONSTRUCTION OF EXISTING FACILITIES**

TABLE OF CONTENTS

491.01	SCOPE
491.02	REFERENCES
491.03	DEFINITIONS
491.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
491.05	MATERIALS - Not Used
491.06	EQUIPMENT - Not Used
491.07	CONSTRUCTION
491.08	QUALITY ASSURANCE - Not Used
491.09	MEASUREMENT FOR PAYMENT - Not Used
491.10	BASIS OF PAYMENT

491.01 SCOPE

This specification covers the requirements of preservation, protection, replacement, and reconstruction of existing services and structures during the installation or removal of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction.

491.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut

491.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 and OPSS 441.

491.07 CONSTRUCTION

491.07.01 General

The requirements and regulations of road authorities, Utility companies, and railway companies shall be adhered to at all times.

491.07.02 Notification

All road authorities, Utility companies, and railway companies shall be notified in writing at least 48 hours before approaching their facilities or entering their rights-of-way.

All owners of underground services shall be requested to locate, stake, and clearly mark in the field all underground services which are located on or near the line of the proposed work. Certificates shall be obtained from all owners of underground services having facilities in the area of the proposed work certifying that their facilities have been marked to confirm the Utility location.

Necessary arrangements shall be made with railway companies for the support and protection of their tracks.

491.07.03 Existing Services and Structures

All water or gas mains, sewers or drains, conduits, cables, service pipes, sidewalks, curbs, and all other structures or property in the vicinity of the work, whether above or underground shall be sustained in place and protected from damage. All water and gas service and flow in all sewers, drains, house or inlet connections, and all watercourses encountered during the progress of the work shall be maintained.

Excavation shall be performed with care to expose buried pipes, cables, conduits, and structures whenever trenching operations approach the indicated location of buried services.

If any Utility is broken or damaged, the Utility company shall be immediately notified.

Access to fire hydrants and water and gas valves shall be maintained at all times to the satisfaction of the local authority.

491.07.04 Reconstruction of Existing Facilities

Where an existing Utility is within the limits of or crosses an excavation and cannot be sustained in place, the existing facility shall be removed, realigned, relocated, or replaced as directed in writing by the Contract Administrator. All materials comprising the Utility shall be handled with care, cleaned, salvaged, and inspected before reconstruction commences.

491.07.05 Contamination

The contents of any sewer, drain, or inlet connection shall not be allowed to flow into an excavation.

All offensive matter shall be removed from the proximity of the work.

491.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

491.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermain and associated appurtenances, and other underground Utilities; maintenance holes, catch basins, ditch inlets or valve chambers; and any other specified subsurface construction, shall be full compensation for all labour, Equipment, and Material to do the work of the preservation, protection, or reconstruction of existing facilities.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.



Note: The PROV published in November 2018 replaces OPSS 492 COMMON, November 2015 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
SITE RESTORATION FOLLOWING INSTALLATION OF PIPELINES,
UTILITIES, AND ASSOCIATED STRUCTURES**

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492.01	SCOPE
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492.06	EQUIPMENT - Not Used
492.07	CONSTRUCTION
492.08	QUALITY ASSURANCE - Not Used
492.09	MEASUREMENT FOR PAYMENT - Not Used
492.10	BASIS OF PAYMENT
492.01	SCOPE

This specification covers the requirements for the restoration of a site following installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermains and associated appurtenances, and other underground utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction.

492.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 304	Single and Double Surface Treatment
OPSS 313	Hot Mix Asphalt - End Result
OPSS 314	Untreated Granular, Subbase, Base, Surface Shoulder, and Stockpiling

OPSS 350	Concrete Pavement and Concrete Base
OPSS 351	Concrete Sidewalk
OPSS 353	Concrete Curb and Gutter Systems
OPSS 412	Sewage Forcemain Installation in Open Cut
OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 721	Steel Beam Guide Rail and Cable Guide Rail
OPSS 771	Standard Highway Fence
OPSS 772	Chain-Link Fence
OPSS 802	Topsoil
OPSS 803	Sodding
OPSS 804	Seed and Cover

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1540	Standard Highway Fence Components
OPSS 1541	Chain-Link Fence Components
OPSS 1601	Wood - Material, Preservative Treatment, and Shop Fabrication

Canadian General Standards Board (CGSB)

138.2-96	Steel Framework for Chain Link Fence

492.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenances means as defined in OPSS 412 for a sewer system and OPSS 441 for a watermain.

492.05 MATERIALS

492.05.01 Granular Materials

Granular materials shall be according to OPSS 1010.

492.05.02 Barbed Wire

Barbed wire shall be according to CAN/CGSB-138.2.

492.05.03 Electric Fence Wire

Electric fence wire shall be 2 mm diameter hot dipped galvanized wire.

492.05.04 Wood Fence

Wood fence material shall be according to OPSS 1601.

492.05.04.01 Board or Split Rail Fence

Posts and boards shall be the same size and type as used in the original fence.

Rails shall be split cedar in good condition and of adequate lengths to build either a straight or snake fence.

492.05.04.02 Wood Braces for Wire Fence

Diagonal wood braces shall be according to OPSS 1540.

492.05.05 Highway Fence

Highway fence material shall be according to OPSS 1540.

492.05.06 Steel Posts

Steel posts shall be according to OPSS 1540.

492.05.07 Chain-Link Fence

Chain-link fence material shall be according to OPSS 1541.

492.05.08 Gates

Gates shall be fabricated from material suitable to the fence on either side of the gate opening. Material for highway fence gates shall be according to OPSS 1540. Material for chain-link fence gates shall be according to OPSS 1541.

492.05.09 Guide Rail

Guide rail material shall be according to OPSS 721.

492.05.10 Concrete

Concrete for sidewalks shall be according to OPSS 351.

Concrete for curb and gutter shall be according to OPSS 353.

492.07 CONSTRUCTION

492.07.01 General

All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

492.07.02 Grading

Rough grading shall be performed to the levels, grades, and contours as specified in the Contract Documents allowing for the placement of surface materials. Soil shall not be disturbed within the drip line of trees and shrubs during grading.

Final grading shall be performed to the lines and elevations specified in the Contract Documents. The final grading shall be according to OPSS 206.

492.07.03 Roadway Restoration

The restoration of the roadway shall be scheduled to follow closely behind trench backfilling. The roadway shall be made and maintained safe for the passage of vehicular and pedestrian traffic after

completion of backfilling and until permanent restoration takes place, as specified in the Contract Documents.

Granular subbase and base courses of the type specified in the Contract Documents shall be placed on the prepared subgrade to the dimensions specified in the Contract Documents and shall be according to OPSS 314.

The surface course of the type specified in the Contract Documents shall be placed on the prepared base course to the dimensions specified in the Contract Documents in accordance as follows:

- a) Asphalt pavement shall be according to OPSS 313 as specified in the Contract Documents.
- b) Concrete paving shall be not less than 150 mm in thickness and shall be according to OPSS 350.
- c) Gravel surface courses shall be according to OPSS 314.
- d) Surface treatment shall be according to OPSS 304.

492.07.04 Fences and Guide Rails

Fences and guide rails shall be restored with the same type of fence or guide rail that existed prior to construction along the lines and levels specified in the Contract Documents. A maximum clearance of 150 mm from ground level shall be maintained at any point along the fence line.

The installation of highway fence shall be according to OPSS 771.

The installation of chain-link fence shall be according to OPSS 772.

Posts for fences other than highway and chain-link fences shall be installed to the spacing that existed prior to construction.

Gates shall be installed at the same location and height as the gates that existed prior to construction. Gate size shall be according to the dimensions of the gate that existed prior to construction. Gates shall be secured with fittings to match the fence complete with latches, hinges, stops, and all necessary fittings.

Colour and finish material of the restored fence shall match the existing colour scheme and finish material. Where required, two coats of finish material shall be applied.

The construction of guide rails shall be according to OPSS 721.

492.07.05 Topsoil

Topsoil shall be placed after final grading operations have been completed and immediately prior to seeding or sodding operations. Topsoil shall be obtained from stockpiles prepared according to OPSS 490 or, if the required quantity is not obtainable from stockpiles, the required topsoil shall be imported.

The quality of the topsoil and the construction methods for placing topsoil shall be according to OPSS 802. Stockpile sites within or adjacent to the Contract limits shall be restored to the original condition or to a condition acceptable to the Contract Administrator.

492.07.06 Shrub and Tree Replanting

Shrubs and trees shall be replanted as specified in the Contract Documents.

492.07.07 Sodding and Seeding

Lawns and grassed areas shall be sodded or seeded and covered as specified in the Contract Documents.

Sodding shall be according to OPSS 803.

Seeding and cover shall be according to OPSS 804.

492.07.08 Sidewalk and Concrete Curb and Gutter Systems

Concrete sidewalk shall be placed according to OPSS 351. Alignment and dimensions shall match existing sidewalk on either end of the restored sidewalk. Damaged sections of any sidewalk slab shall be removed and replaced to the nearest joint on either end of the damaged section.

Concrete curb and gutter systems shall be placed according to OPSS 353. Alignment and dimensions shall match the existing curb and gutter systems on either side of the restored curb and gutter. Damaged sections of curb and gutter shall be removed and replaced to the nearest joint or neat saw cut.

Placement of Granular A shall be according to OPSS 314 with a minimum depth of 100 mm as a base for the curb and gutter and sidewalk.

492.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

492.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items for the installation of sanitary and storm pipe sewers, pipe culverts and end sections, forcemains and associated appurtenances, watermain and associated appurtenances, and other underground utilities; maintenance holes, catch basins, ditch inlets, or valve chambers; and any other specified subsurface construction shall be full compensation for all labour, Equipment, and Material to do the work of site restoration.

When the Contract contains separate items for work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.



CONSTRUCTION SPECIFICATION FOR TEMPORARY POTABLE WATER SUPPLY SERVICES

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493.07	CONSTRUCTION
493.08	QUALITY ASSURANCE - Not Used
493.09	MEASUREMENT FOR PAYMENT - Not Used
493.10	BASIS OF PAYMENT

493.01 SCOPE

This specification covers the requirements for the installation of temporary watermain, service connections, and associated appurtenances to supply potable water prior to disconnecting service of an existing watermain on a temporary basis.

493.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 441	Watermain Installation in Open Cut
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures

CSA Standards

B64.5-11	Double Check Valve (DCVA) Backflow Preventers [Part of B64 Series-11 (R2016), Backflow Preventers and Vacuum Breakers Compendium]

American Water Works Association (AWWA)

C510-17 Double Check Valve Backflow Prevention Assembly

ASTM International

D1784 - 20	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
D2241 - 20	Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D3139 - 19	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
F477 - 14	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

NSF International

61-2014a Drinking Water System Components - Health Effects

493.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit that are used in connection with a water distribution system, such as valves, hydrants, corporation cocks, services, and thrust restraints.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Temporary Hydrant means temporary fire hydrant and all associated temporary appurtenances.

Temporary Potable Water Supply Services means temporary watermains, services, hydrants, and all associated appurtenances.

Temporary Services means temporary potable water supply services installed on or just below the ground surface for the purpose of providing potable water to customers while the existing watermain is out of service.

Temporary Watermain means temporary potable water supply hose or pipe installed on or just below the ground surface for the purpose of providing potable water to temporary services and temporary fire hydrants while the existing watermain is out of service.

Watermain means an installation designed for the conveyance of water under pressure using circular pipe.

493.04 DESIGN AND SUBMISSION REQUIREMENTS

493.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator 14 Days prior to the commencement of any work requiring temporary potable water supply services:

- a) Temporary potable water supply services plans including installation, operation, testing procedures, and a list of material and equipment to be used.
- b) Temporary hydrant details.

493.05 MATERIALS

493.05.01 General

The pipe size, type, and class shall be as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe material and class with which they are used.

All materials in contact with potable water shall be NSF 61 compliant and, if being reused, shall have been used exclusively for potable water services in the past.

All materials shall be capable of withstanding 860 kPa pressure and all other conditions of use.

493.05.02 Temporary Potable Water Supply Services

The pipe, hose, and all other materials used in conjunction with the temporary potable water supply services shall be as follows:

- a) Flexible hose jackets shall be abrasion resistant, either double jacket or specially coated, and be capable of being driven over by vehicles periodically without short term effects.
- b) Hose lining shall be of material that does not impart any taste or odour to the water.
- c) Hose shall come complete with aluminium couplings with threads.
- d) Rigid pipe shall be made of class 12454-B PVC material according to ASTM D1784. Material shall have a minimum hydrostatic design stress of 14 MPa.
- e) PVC shall be formulated with impact modifiers, heat stabilizers, and ultraviolet inhibitors.
- f) Pipe extrusion shall meet or exceed all requirements of ASTM D2241.
- g) Joints and couplings shall be according to ASTM D3139.
- h) O-rings shall be according to ASTM F477.
- i) Double check valve backflow preventers shall be according to CSA B64.5 and AWWA C510.

493.05.03 Valves

Valves shall be according to OPSS 441.

493.05.04 Temporary Hydrants

Temporary hydrants shall be as specified in the Contract Documents.

493.07 CONSTRUCTION

493.07.01 General

Written notices to all affected property owners are required a minimum of 48 hours prior to any disruption of water service as a result of the temporary by-pass.

Temporary water services shall be connected to the temporary watermain for each single residential unit or other building.

Connection to the private plumbing system of a residential unit shall be via a wye at an outside tap or an existing water service as specified in the Contract Documents. The connection of single residential units in series is not permitted. Each temporary water service shall have its own valved connection to the temporary watermain.

Connection to other buildings shall be as specified in the Contract Documents.

An adequate water supply shall always be available. Emergency repairs shall be performed whenever there is a failure or cessation of the operation of any component or components of the temporary potable water system. If the temporary potable water supply service fails, it shall be reported to the Contract Administrator immediately and restored as soon as possible. Repair service shall be provided 24-7 for the duration of the Contract.

Care shall be exercised during the installation of temporary potable water supply services to avoid contamination of the services.

No work shall be done during freezing weather unless directed by the Contract Administrator. No temporary watermain or temporary water services shall be installed or operated during freezing weather. Pipes already in use shall be removed or drained and existing services restored when so directed by the Contract Administrator.

493.07.02 Shutting Down or Charging Watermains

Shutting down or charging watermains shall be according to OPSS 441.

493.07.03 Temporary Watermains

Installation of a temporary watermain shall be according to OPSS 441.

A double check valve backflow preventer shall be installed at any connection of a temporary watermain to the water supply and distribution system (e.g., at hydrants). Source connections shall be as specified in the Contract Documents.

493.07.04 Temporary Potable Water Supply Services

Temporary potable water supply services for single residential units and other users, including flow to maintain fire protection systems, shall be as specified in the Contract Documents.

The temporary potable water supply service connections shall be valved near the point of connection to the temporary watermain and near the point of connection to a private plumbing system so that both the temporary watermain and the temporary potable water supply services may be disinfected.

493.07.05 Temporary Hydrants

When a hydrant is removed from service, a temporary hydrant and the necessary valves and fittings shall be installed as specified in the Contract Documents.

Before permanently shutting down the existing watermain, the temporary hydrants shall be tested to ensure that they are in proper working order.

The hydrants that are out of service during construction operations shall be bagged and clearly marked with a "HYDRANT OUT OF SERVICE" tag.

Once in use, the temporary hydrants shall be maintained until the existing or new hydrants are restored to service.

All temporary potable water supply service attachments to fire hydrants shall be easily removable for fire protection purposes.

All temporary hydrants shall have reflective tape on the barrel for increased visibility. The temporary hydrants shall be in an upright position at all times.

493.07.06 Valves

Valves shall be installed at each branch of a temporary watermain.

Before permanently shutting down the existing watermain, the valves shall be tested to ensure that they are in proper working order.

493.07.07 Protection

Protection shall be provided to the temporary potable water supply services at locations such as road crossings, sidewalks, driveways, and walkways.

When temporary watermain cross over the roadway, the asphalt pavement shall be saw cut and removed and the temporary watermain shall be buried. Under no circumstance is a pipe road crossing to remain open and unprotected from vehicular and pedestrian traffic. If a concrete road base exists, it shall not be disturbed.

When temporary potable water supply services are used on full right-of-way reconstruction projects, the temporary potable water supply service piping shall also be buried at all sidewalks, driveways, and walkways.

When temporary potable water supply services are used on projects where the road surface is not being reconstructed, the temporary service piping shall be buried only at all road crossings. When temporary watermain or temporary potable water supply services cross a driveway or a sidewalk, asphalt or another acceptable material shall be mounded over the pipe. A polyethylene sheet shall be placed as a barrier on concrete or interlocking driveways. If the protection work performed or material used is not to the satisfaction of the Contract Administrator, action shall be taken to rectify the problem at no additional cost to the Owner. Safety flashers and barricades, as may be required, shall be furnished and maintained. In general, the temporary potable water supply service pipe shall be laid where it causes the least obstruction and is least likely to be damaged.

The temporary potable water supply services installed across all road crossings, sidewalks, driveways, and walkways shall be protected for the duration of the work. This shall include earth excavation, backfill, asphalt reinstatement, and ramping material required as directed by the Contract Administrator.

Adequate signage shall be provided at locations where hoses are exposed and may present a public safety hazard, such as blow off hoses at catchbasins.

493.07.08 Leakage Testing

The temporary potable water supply service shall be watertight. Testing of the temporary watermain and services shall be at system pressure.

Leakage testing shall be conducted in the presence of the Contract Administrator upon completion of the watermain, including services. All leaks shall be repaired prior to covering the pipe and at no cost to the Owner.

493.07.09 Flushing and Disinfecting Temporary Watermains and Services

Flushing and disinfecting temporary watermains and services shall be according to the flushing and disinfecting watermains subsection as specified in OPSS 441.

493.07.10 Removal of Temporary Potable Water Supply Services

Temporary potable water supply services may be used from approximately mid-April to mid-October. All temporary services shall be completely removed by mid-November. Any deviation from this timing window shall be approved by the Contract Administrator.

Site and roadway restoration shall be according to OPSS 492.

493.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

All chlorinated water used for testing, flushing, or disinfecting watermains shall be directed to an acceptable outlet in a manner that meets the requirements of all applicable regulations.

493.10 BASIS OF PAYMENT

493.10.01 Temporary Potable Water Supply Services - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

On completion of the supply, installation, flushing, disinfecting, and testing of the temporary potable water supply services prior to putting it in operation, a progress payment to 60% of the above item shall be made. The balance shall be prorated over the remainder of the working period.

Removal or draining of the temporary potable water supply services during freezing weather and its subsequent return to service shall be at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR COMPACTING

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501-A	Commentary

501.01 SCOPE

This specification covers the requirements for compaction of earth and granular materials.

501.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

501.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

501.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 401 Trenching, Backfilling, and Compacting

Ontario Provincial Standards Specifications, Materials

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:
LS-706 Moisture - Density Relationship of Soils Using 2.5 kg Rammer and 305 mm Drop

MTO Forms:
PH-CC-009 Field Compaction Report

ASTM International

D 6938-10 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

501.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Backfill Material means as defined in OPSS 401.

Bedding Material means as defined in OPSS 401.

Cover Material means as defined in OPSS 401.

Earth means as defined in OPSS 206.

Embedment Material means as defined in OPSS 401.

Rut means a sunken track or groove made at the surface by the passage of vehicles.

Utility Structures means maintenance holes, catch basins, valve chambers, ditch inlets, and other similar structures used to access services such as sewer, water, electric, and telephone to carry out maintenance and repair work.

501.05 MATERIALS

501.05.01 Granular Material

Granular material shall be according to OPSS 1010.

501.05.02 Water

Water shall be free of contaminants that could adversely affect fill material or the environment.

501.06 EQUIPMENT

501.06.01 Compaction

501.06.01.01 General

The type of compaction equipment used shall be suited to the material to be compacted, degree of compaction required, and space available.

Compaction equipment for control strips shall have a minimum static weight of 9,000 kg.

501.06.01.02 Hand Operated Vibratory Equipment

Hand operated vibratory equipment shall have a power output no greater than 9.9 kW.

501.06.02 Water

Equipment for applying water shall be capable of uniform distribution with proper flow control.

501.06.03 Nuclear Moisture and Density Gauge

Each nuclear moisture and density gauge (gauge) shall have been calibrated within the last 12 months either by the manufacturer or other qualified agent against certified density and moisture reference blocks. In addition, the Density Standard Count and the Moisture Standard Count shall be within 2.0% and 4.0%, respectively, of the most recent calibration values. The registered owner of the gauge shall maintain a valid Radioisotope License for each gauge.

501.07 CONSTRUCTION

501.07.01 General

The method of placing and lift thickness of earth or granular material shall be according to the specifications that govern the Work. When field tests indicate that the required degree of compaction cannot be obtained with the equipment in use or the procedure being followed, the operations shall be modified so that the equipment and procedures will produce the required results.

501.07.02 Restricted Zones

Hand operated vibratory type compaction equipment shall be used behind all retaining structures to compact fill material within restricted zones as follows:

a) Abutments and Retaining Walls

An area within a plane extending from the base of the back face of the wall where it contacts the footing upwards at a slope of 1H:1.5V to a maximum distance of 2.5 m from the wall.

b) Wingwalls

An area within 1.5 m from the back face of the wall.

501.07.03 Water for Compaction

Water shall be applied, as necessary, to achieve the degree of compaction required.

When the Contract includes a separate item for water for compaction, the water shall be applied with the approval of the Contract Administrator.

501.07.04 Quality Control

501.07.04.01 General

Quality control (QC) testing shall be carried out to ensure that earth and granular materials used in the Work are compacted according to the requirements as specified in the Contract Documents.

Field density and field moisture determinations shall be made according to ASTM D 6938.

501.07.04.02 Compaction Requirements

501.07.04.02.01 General

Compaction testing shall be based on material placed and compacted in the Work on a lot-by-lot basis according to the Lot Testing clause.

Compaction acceptance shall be according to the Acceptance clause and shall be based on target densities established according to the Target Density clause, QC compaction field test results, and, where applicable, a statistical analysis of those results.

501.07.04.02.02 Submission of Test Data

Prior to construction of a control strip, a copy of all QC laboratory test results for LS-706 required by the Control Strip clause to determine optimum moisture content (OMC) of the control strip material shall be delivered to the Contract Administrator.

All field test results and associated information relating to the control strip, including target density, lot location, lift thickness, probe depth, moisture content, wet density, and all QC lot compaction calculations shall be recorded at the time of testing on MTO form PH-CC-009. This form shall be available at any time for review, upon request, and shall be submitted to the Contract Administrator prior to placement of any subsequent lift and within 2 Business Days following the completion of a lot.

501.07.04.02.03 Test Equipment and Operator Training

501.07.04.02.03.01 General

Field density and field moisture measurements for QC compaction testing of earth and granular materials shall be carried out using gauges and ancillary equipment.

Only qualified operators using properly calibrated gauges shall conduct QC compaction testing.

501.07.04.02.03.02 Nuclear Moisture and Density Gauge Requirements

A copy of a valid calibration certificate, including the make, model number, and serial number for each gauge, shall be submitted to the Contract Administrator, prior to use of the gauge in compaction testing.

In addition, the Contract Administrator may request that the operator perform a standardization procedure according to ASTM D 6939.

If the gauge does not meet the standardization requirements or exhibits malfunctions of any kind, the gauge shall be replaced.

501.07.04.02.03.03 Operator Requirements

Each operator shall have been trained in the safe operation, transportation, and handling of the gauge.

Prior to conducting QC compaction testing, the operator shall provide acceptable proof of proficiency in the use of a gauge and the correct procedures to determine lot and subplot sizes, field dry density, percent relative compaction, mean, standard deviation, and the Quality Index of a compacted lot of material by submitting one of the following:

- a) a gauge operator certification document or card from a training program acceptable to the Owner and conducted within the Province of Ontario within the last 2 years; or
- b) a document (e.g., instruction notice or letter) signed by the Owner showing that the operator has demonstrated proficiency on a Contract either constructed or being constructed for the same Owner within the same construction year as the compaction testing being carried out for this Contract.

If the operator cannot provide either of the two documents stated above, then at the Contract Administrator's discretion, the operator shall demonstrate his or her proficiency to the Owner. In this case, arrangements shall be made with the Contract Administrator regarding the schedule, location, and materials for such demonstrations. The first 2 demonstrations may include up to 5 operators and 5 gauges and shall be carried out at no charge. Additional demonstrations shall be charged at the rate of \$500. Where a demonstration is carried out, acceptability of the operator shall be valid for the current calendar year only.

501.07.04.02.04 Target Density

New target densities shall be established for each separate component of the Work (e.g., backfilling of a trench, construction of a granular base, or placement of cover) at the following times:

- a) For earth and granular materials:
 - i. At the time of initial use of each source.
 - ii. When there is a perceptible change in the appearance or gradation of materials or both.
 - iii. At least once per calendar year on all carry-over Contracts.
- b) For earth, after each 10 QC lots of material have been completed, whether accepted or rejected, on the basis of one set of target density values.
- c) For granular materials, after each 25 QC lots of material have been completed, whether accepted or rejected, on the basis of one set of target density values.

The target density shall be established by the construction of a control strip according to the Control Strip clause.

When a control strip cannot be reasonably constructed or is impractical, with the consent of the Contract Administrator, the target density shall be based on the maximum dry density (MDD) as determined by LS-706, not more than 14 Days prior to placing the material. In this case, the MDD used for the new target density shall be based on the average of all individual MDD's calculated from a minimum of 3 independent samples selected from materials to be used in the Work.

501.07.04.02.04.01 Control Strip

Prior to construction of a control strip, the Contractor shall:

- a) Give a minimum notice of 24 hours to the Contract Administrator.
- b) Determine the optimum moisture content (OMC) according to LS-706.

Each control strip shall consist of a single uniform lift not more than 0.30 m in depth and covering at least 400 m² in area.

During construction of the control strip, the average field moisture content shall be maintained within the range of no less than 2.0% lower than and no more than 1.0% greater than the OMC of the control strip material.

After initial placement of the material, the compaction equipment for that operation shall make 6 passes over the entire surface of the control strip. The field wet density and field moisture content shall be determined at a minimum of 3 randomly selected locations. The dry density shall be calculated for each of these locations and the average dry density and moisture content values used as the initial values for dry density and moisture content.

The compaction equipment shall then make 2 additional passes over the entire surface of the control strip.

All passes of the compaction equipment for the control strip shall be carried out in vibratory mode at a speed of no more than 5 km/hour.

A minimum of 3 separate random field density and moisture content determinations shall then be made and a new average dry density and moisture content shall be calculated.

If the new average dry density exceeds the previous value by more than 0.030 t/m^3 , additional passes of the equipment shall be carried out as described above. If the new average dry density does not exceed the previous value by more than 0.030 t/m^3 , the compaction of the control strip shall be considered satisfactory and complete.

Upon satisfactory completion of the control strip, an additional 7 field wet density and moisture content tests shall be taken at random locations and the dry density and moisture content values determined. The final dry density and moisture content of the control strip shall be the average of these 7 values plus the 3 most recent values that were obtained upon completion of the control strip. If the final moisture content lies within the allowable range of the OMC specified above, then the final dry density that was determined shall be the target density of the control strip.

501.07.04.02.05 Lot Testing

For compaction control, a unique set of lots distinguished from each other by an appropriate letter or number designation, shall be established for each of the following:

- a) Each separate component of the Work (e.g., backfilling a structure or a trench or construction of a granular base).
- b) Materials from different sources.
- c) Materials with different compaction properties.
- d) When recompaction is carried out following restoration, scarification, or placement of additional material onto previously tested and accepted lots.
- e) When directed by the Contract Administrator.

The individual lots within each unique set of lots shall be consecutively numbered and with no duplication. Lot sizes shall not exceed the limits as shown in Table 1.

All visibly soft or loose areas shall be compacted prior to testing.

For the situations described in Table 1, Part IV, a minimum of 2 field density and moisture content tests shall be carried out at random locations within each lot.

For all other situations, each lot shall be divided into 4 equal sublots and a minimum of one field density and moisture test shall be carried out at random locations within each subplot and the results used to calculate the Quality Index according to the Quality Index clause.

In addition, regardless of the situation, when a lot of material is split between both sides of a pipe, sewer, or culvert, at least one field density and moisture content test shall be taken on each side of that pipe, sewer, or culvert.

The gauge probe shall extend to the full depth of the lift, unless otherwise allowed by the Modified Layer Compaction Method according to OPSS 206. The probe shall not extend beyond the lift being tested.

During the compaction process, the field wet density value and moisture content for each gauge test shall be recorded on MTO form PH-CC-009. The field dry density of each subplot shall then be calculated as a percentage of the target density to the nearest 0.1%. The mean and standard deviation and the Quality Index, where applicable, of the field dry density values shall be calculated to the nearest 0.1% and recorded on the form for each lot.

MTO form PH-CC-009 shall be constantly updated with new test data and the associated calculations completed as the testing is being done. This form shall be made available to the Contract Administrator at any time, upon request.

501.07.04.02.06 Quality Index

The Quality Index (Q_i), shall be calculated from the mean ($\bar{x}$) and standard deviation (s) of the percent target density which has been determined from all sublots within a QC compaction lot during the compaction process. The values for Quality Index, lot mean, and lot standard deviation shall be computed as follows:

- a) For materials placed in embankments within 50 m of a structure; placed as bedding, embedment cover, or backfill material to pipes, sewers, or culverts; or placed as backfill to structures, utility structures, or small foundations (e.g., anchor blocks, sign posts, and formwork):

$$\text{For earth materials: } Q_i = \frac{\bar{x} - 95}{s}$$

$$\text{For granular materials: } Q_i = \frac{\bar{x} - 98}{s}$$

- b) For materials placed in all other situations:

$$\text{For earth materials: } Q_i = \frac{\bar{x} - 90}{s}$$

$$\text{For granular materials: } Q_i = \frac{\bar{x} - 95}{s}$$

Where:

Q_i = Quality Index, calculated to two decimal places.

$\bar{x}$ = Lot mean, the statistical value that describes the arithmetic average of subplot test results (dry density expressed as a percentage of the target density). Lot mean is the sum of individual subplot test results divided by the number of test results, calculated to 0.1% as follows:

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4}{4} = \frac{1}{4} \sum_{i=1}^4 x_i$$

S = Lot standard deviation (σ_{n-1}), the statistical value that describes the distribution of subplot test results (dry density expressed as a percentage of the target density) about the lot mean. Standard deviation is the square root of the sum of the squares of the difference between each subplot test result and the lot mean divided by the number of test results minus one. It is calculated to 0.1% using the following expression:

$$s = \sqrt{\frac{\sum_{i=1}^4 (x_i - \bar{x})^2}{3}}$$

501.07.04.02.07 Acceptance

For the situations described in Table 1, Part IV, acceptance or rejection of a QC lot for compaction shall be based on 2 or more random field density and moisture content tests taken within the lot. For a lot to be acceptable, all tests shall be at least 100% and 98% of the target density established for granular and earth materials, respectively. Otherwise, the QC lot shall be rejected for compaction.

For all other situations, acceptance or rejection of a QC lot for compaction shall be established by calculation of the Quality Index, according to the Quality Index clause. When Q_i has a value equal to or greater than 1.47, the QC lot shall be accepted; otherwise, the lot shall be rejected for compaction.

Accepted QC lots damaged by vehicular traffic shall be restored prior to placement of any overlying material. Surfaces of accepted QC lots with ruts greater than 50 mm in depth in earth or 25 mm in depth in granular materials shall be regraded and the upper lift recompacted to meet the specified compaction requirements. Materials that cannot be successfully recompacted shall be removed and replaced with new material.

501.07.04.02.07.01 Rejected Lots

If a QC lot is rejected for compaction, the lot shall be recompacted with adjustment to the moisture content, as required, until satisfactory compaction is achieved. The recompacted lot shall be retested and a decision made, as described in the Acceptance clause.

When compaction of a QC lot does not meet the acceptance criteria and when the Contract Administrator has been satisfied that this is not a result of the Contractor's operation or equipment, a new target density shall be established for that operation.

501.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

501.08 QUALITY ASSURANCE

501.08.01 General

Field density and field moisture determinations shall be made in accordance with ASTM D 6938.

501.08.02 Compaction

501.08.02.01 General

The Contract Administrator shall conduct random testing or inspection of QC records or both to establish the acceptability of the QC compaction testing and verification of the field moisture content, field dry density, OMC, MDD, target density, and the Quality Index, where applicable.

The Contract Administrator may verify that the target density established for a control strip is based on the use of suitable compaction equipment. Provided that the MDD and OMC values determined by LS-706, as applicable, indicate an adequate target density is being achieved, the compaction equipment shall be considered suitable. If the compaction equipment is not capable of obtaining an adequate target density at the required moisture content, the equipment shall be considered unsuitable and shall be replaced with equipment that is able to obtain an appropriate target density.

Reasonable access to a control strip or to compacted QC lots shall be provided prior to placement of subsequent lifts of material. Subsequent lifts, including HMA, may not be placed until QA testing has been conducted or waived by the Contract Administrator.

501.08.02.02 Gauge Verification

Gauge verification QA shall consist of taking 4 random field density and moisture content measurements of a compacted lot or control strip and the subsequent calculation of the average dry density. Provided that the average dry density determined by QC test results for the same material is within 139 kg/m³ for granulars and 150 kg/m³ for earth when compared with the QA average dry density, the QC test results shall be considered valid.

501.08.02.03 Compaction

For the situations described in Table 1, Part IV, compaction QA shall consist of taking 2 or more random field density and moisture content measurements of each compacted lot and the subsequent determination of percent target density.

For all other situations, compaction QA shall consist of taking 4 random field density and moisture measurements of a compacted lot or control strip and the subsequent calculation of the Quality Index for the lot.

Provided that the lot is acceptable, according to the requirements specified in the Acceptance clause, no further action shall be taken.

However, if the lot is rejected based on compaction testing or demonstrates errors in QC reporting, an investigation shall take place to determine and resolve the discrepancies. The investigation may include, but is not limited to, any of the following:

- a) Recompaction of the lot.
- b) Retesting of the lot by the Contractor.
- c) Establishment of a new target density by control strip.
- d) Re-inspection of the gauge or operator or both by the Owner.
- e) Recalibration of the gauges.
- f) Removal of unsuitable materials.

501.08.02.04 Quality Control Records Inspections

QC records of the lot or control strip selected by the Contract Administrator shall be inspected for calculation errors, missing test data, or improper lot quantities. If errors or omissions are found that identify insufficiently compacted or improperly or untested lots, the Contractor shall make all such lots available and recompact or retest these lots or both so that they comply with the specified compaction requirements.

501.08.02.05 Charges

The Contract Administrator shall charge the Contractor \$450.00 for each lot that requires retesting which has been identified through QA compaction testing or a review of QC records. In addition, immediately following the discovery of a discrepancy or inadequate compaction, all new lots shall be subjected to QA compaction testing prior to acceptance. If any of the new lots do not meet the specified compaction requirements, the Contractor shall be charged a fee of \$450.00 for each lot. These conditions shall continue until 3 consecutive new lots have met the specified compaction requirements.

501.09 MEASUREMENT FOR PAYMENT

501.09.01 Actual Measurement

501.09.01.01 Water for Compaction

Measurement of water for compaction shall be in cubic metres using one of the following methods:

- a) The mass of the water shall be determined by weighing as specified in the Contract Documents. The mass of the water shall be converted to cubic metres using a factor of 1,000 kg to 1 m³.
- b) The water tank shall be measured and its volume computed in cubic metres.
- c) The water shall be measured through a water meter of approved design.

501.10 BASIS OF PAYMENT

501.10.01 Compaction

Payment at the Contract price of the appropriate tender item requiring compaction of earth and granular materials shall be full compensation for all labour, Equipment, and Material to do the work of compacting, including the water used for compaction, unless the Contract contains a separate tender item for Water for Compaction.

Any work required to repair or remove and replace damaged QC lots accepted shall be at no additional cost to the Owner.

Replacement of unsuitable equipment to obtain an appropriate target density shall be at no additional cost to the Owner.

Replacement of a gauge shall be at no additional cost to the Owner.

Any work required to recompact or retest material as a result of QA compaction testing or QC records inspection shall be at no additional cost to the Owner.

501.10.02 Water for Compaction - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for water for compaction, the Contract price for the tender item in which the water for compaction is used shall include full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Compaction Lot Size

Part	Construction	Lot Size
I	Earth embankments, granular base, granular subbase, and granular shoulders.	Every lift, 500 m maximum length. (Note 1)
II	Structure approach fill for earth.	Every lift, 50 m maximum length
III	Bedding, embedment, cover, or backfill material for pipe and sewer sections > 20.0 m in length that are being placed in one operation, earth or granular.	Every lift, 200 m maximum length.
IV	Bedding, embedment, cover, or backfill material for pipes and sewer sections ≤ 20.0 m in length that are being placed in one operation or backfill to utility structures or small foundations (e.g., anchor blocks, sign posts, and formwork), earth or granular.	Every lift, 20 m maximum length.
V	Structure backfill and culvert bedding, embedment, cover, or backfill material, granular.	Every lift for every stage of construction.
Note: 1. The width of the lot shall be the limits established for the placement of current material only and shall not include adjacent material to be placed at a future date.		

Appendix 501-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR REMOVAL

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510-A	Commentary

510.01 SCOPE

This specification covers the requirements for demolition, salvage, removal, and in-place abandonment, either completely or partially, of those materials and structures so designated, including the requirements for backfilling resulting excavations, trenches, holes, and pits.

510.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

510.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

510.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 410	Pipe Sewer Installation in Open Cut
OPSS 421	Pipe Culvert Installation in Open Cut
OPSS 422	Precast Reinforced Concrete Box Culverts and Box Sewers in Open Cut
OPSS 501	Compacting

Ontario Provincial Standard Specifications, Materials

OPSS 1004	Aggregates - Miscellaneous
OPSS 1150	Hot Mix Asphalt
OPSS 1151	Superpave and Stone Mastic Asphalt Mixtures
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

S6-00 Canadian Highway Bridge Design Code

510.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bridge Structure means that portion of a bridge and associated wing and retaining walls above the bridge footing, excluding modular bridges.

CIR means cold in-place recycling.

CIREAM means cold in-place recycling with expanded asphalt.

Concrete Appurtenances means as defined in OPSS 410, 421, and 422.

Culvert means a single or multiple cell structure designed to provide an opening under a roadway, pedestrian way, railway, or side entrance for the passage of surface water, livestock, or pedestrians.

Curb and Gutter means any combination of curb, gutter, curb with gutter, gutter setbacks, bullnoses, gutter outlets, and spillways.

HIR means hot in-place recycling.

Pipe means any closed conduit originally designed to convey liquid or gas.

Sundry Asphalt Pavements means paved islands, medians, boulevards, and walkways.

510.04 DESIGN AND SUBMISSION REQUIREMENTS

510.04.01 Design Requirements

Caps for capping maintenance holes, catch basins, ditch inlets, and valve chambers shall be designed according to CAN/CSA S6 and the Structural Manual.

510.04.02 Submission Requirements

510.04.02.01 Removal of Bridge Structures

Two weeks prior to commencement of the work, a work plan shall be submitted to the Contract Administrator outlining the equipment to be used, dust and debris control, and the sequence of removals for bridge demolition.

Where any portion of the bridge structure is to support traffic or equipment loading during demolition, the entire structure shall be evaluated for load carrying capacity according to the CAN/CSA S6 and the Structural Manual.

All submissions shall bear the seal and signature of the design Engineer and design check Engineer.

510.05 MATERIAL

510.05.01 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and three parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

510.05.02 Concrete

Concrete for concrete seals shall be according to OPSS 1350 with minimum specified 28-Day compressive strength of 30 MPa.

Concrete for filling abandoned pipes shall be according to OPSS 1350 with minimum specified 28-Day compressive strength of 15 MPa.

510.05.03 Grout

Grout shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

510.07 CONSTRUCTION

510.07.01 General

Removal, abandonment, demolition, or salvage of a particular item shall be as specified in the Contract Documents.

The work shall include all associated excavation, backfill, compaction, trimming, plugging, capping, filling, sealing, and right-of-way preparation.

If provided, existing drawings from the Owner pertaining to bridge structures, modular bridges, culverts, and noise barriers designated for removal shall be reviewed prior to commencement of any activities.

Stockpiling requirements shall be as specified in the Contract Documents.

Where work is done in waterbodies and on waterbody banks, the work shall be according to the Contract Documents.

510.07.01.01 Excavation

Excavation required for the removal work to be carried out shall be part of the removal operation and shall be performed in such a manner as to leave undisturbed any portions not designated for removal.

510.07.01.02 Removal

Removal shall be performed in such a manner and with such equipment as to leave undisturbed and undamaged any portion not designated for removal or salvage. All damaged or disturbed portions shall be corrected expeditiously and repaired to the satisfaction of the Contract Administrator. The broken edges of portions to be left in place that are visible after construction shall be squared and neatly trimmed.

510.07.01.03 Salvage

Any material designated for salvage shall remain the property of the Owner and shall be maintained in a reasonable condition and stockpiled in a manner acceptable to the Contract Administrator.

Salvaged materials that are surplus to the Contract requirements shall be delivered to the location specified in the Contract Documents. When designated for salvage and surplus to the Contract requirements, salvaged frames and related grates or covers shall be kept together as a unit for delivery and stockpiling.

Any material designated for salvage damaged by the Contractor's operations or lost by the Contractor at any time prior to re-use or stockpiling shall be replaced with new material.

510.07.01.04 Backfilling, Compacting, and Trimming

Where a removal or partial removal requires the filling of a resulting trench, hole, or pit, backfilling shall be to the required grade using either suitable excavated material or imported material as required or as specified in the Contract Documents, and shall include levelling and trimming of the site to match required contours and provide adequate drainage. Backfill material shall be placed in layers not exceeding 300 mm and compacted according to OPSS 501.

510.07.02 Bridge Work

510.07.02.01 Removal of Bridge Structures and Bridge Footings

The work of bridge structure removal shall include the complete removal of bridge structure components above the top of the bridge footings to the lines and grades specified in the Contract Documents.

The work of bridge footings removal shall include cutting the piles to the underside of the footing and the complete removal of the bridge footings.

510.07.02.02 Removal of Modular Bridges

The work of modular bridge removal shall include the dismantling and removal and salvage of the modular bridge components, all timber in the deck, curbs, running strips, and steel beam guide rail system attached to the bridge. The work shall include the unloading and erection of the launching nose and subsequent dismantling.

Modular bridge components that are the property of the Owner, including the dismantled launching nose, shall be loaded onto transport vehicles, supported on 100 x 100 mm timber to allow forklift access, securely fastened, and then transported to the location specified in the Contract Documents.

All components shall be delivered in good condition during normal working hours and neatly stockpiled. All small parts shall be crated to prevent loss.

The approximate weight of the modular bridge, as specified in the Contract Documents, includes the weight of the steel components of the bridge, the ramps, and the launching nose, but excludes the weight of the wooden deck, construction tools, and rollers.

Vehicles required to transport the launching nose and the modular bridge components and parts shall be provided by the Contractor and of sufficient size to fully support the modular bridge components.

510.07.02.02.01 Operational Constraints

Prior to dismantling of the modular bridge, qualification information shall be provided to the Contract Administrator to ensure that the person supervising the removal of the modular bridge is competent to successfully fulfill such duties.

The Contract Administrator shall be notified a minimum of 7 Days in advance of the date on which modular bridge removal is to commence. The Owner shall make the launching nose available to the Contractor, following such notification.

510.07.02.02.02 Removal of Modular Bridge Substructures

The work shall include the removal of modular bridge substructures, bank seats, cribs, and timber or steel bents, and any rock in the cribs.

Modular bridge substructure materials shall be removed from the right-of-way or managed as specified in the Contract Documents.

Rocks from cribs shall not be placed in any waterbody.

510.07.03 Drainage Work

510.07.03.01 General

Any sediment or deposited material required to be removed shall not be allowed to enter any waterbody.

Frames with grates or covers and watermain appurtenances, within valve chambers that are to be removed, shall be salvaged.

510.07.03.02 Removal of Curb and Gutter

The work shall include the removal of asphalt, concrete, and cut stone curb and gutter. Cut stone curb shall be salvaged.

510.07.03.03 Removal of Asphalt Curb and Gutter

The work shall include the removal of asphalt curb and gutter.

510.07.03.04 Removal of Concrete Curb and Gutter

The work shall include the removal of concrete curb and gutter.

510.07.03.05 Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

The work shall consist of the removal of maintenance holes, catch basins, ditch inlets, and valve chambers.

510.07.03.06 Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

The work shall include the partial removal of maintenance holes, catch basins, ditch inlets, and valve chambers where structures and the Utility systems therein are abandoned. Such partial removal, when within the roadway, shall be to a minimum of 1.0 m below subgrade.

Prior to backfilling, the bottom of each structure designated for partial removal shall be broken to allow for the free movement of groundwater.

As an alternative to partial removal, maintenance holes, catch basins, ditch inlets, or valve chambers may be removed in their entirety.

510.07.03.07 Capping Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

The work shall include the capping of maintenance holes, catch basins, ditch inlets, and valve chambers where the Utility systems therein are to remain in service. Such capping shall include the removal of all adjustment units. Where the structure exists within the roadbed, the upper portion of the structure shall be removed to a minimum of 1.0 m below subgrade and the walls of the structure shall be saw cut or similarly finished to produce a neat horizontal cut suitable for placing a concrete cap.

510.07.03.08 Removal of Pipes and Culverts

The work shall include the removal of pipes and culverts of 200 mm diameter and greater, including multiple cell timber culverts.

Concrete, clay, and plastic pipes may be removed by rupturing or collapsing the pipe with suitable equipment and leaving the debris in place in a manner as to eliminate all voids and so as not to be detrimental to the work.

When removing pipes that enter into a concrete culvert, maintenance hole, catch basin, ditch inlet, or valve chamber and the structure is to remain in service, the openings left in the structures from the pipe shall be sealed with concrete or brick suitable for outdoor use and mortar. Brick seals shall be a minimum thickness of one brick length. The contact surface of each brick shall be coated with mortar to provide a watertight seal. Concrete seals shall be the minimum thickness of the structure wall.

510.07.03.09 Abandonment of Pipes and Culverts

The work shall include the filling of all pipes and culverts when the Contract Documents specify abandonment.

Abandoned sections of pipes and culverts up to 1,200 mm in diameter shall be filled with grout or concrete.

Access points shall be provided to allow for confirmation that the pipe has been completely filled.

When abandoning pipes that enter into a concrete culvert, maintenance hole, catch basin, ditch inlet, or valve chamber and the structure is to remain in service, the openings in the structure shall be sealed according to the Removal of Pipes and Culverts clause.

510.07.03.10 Removal of Pipe Subdrains

The work shall include the removal of pipe subdrains smaller than 200 mm in diameter.

Excavate, as required, to remove existing pipe subdrains, backfill the resulting trenches with native material, and compact.

510.07.03.11 Removal of Hydrants, Valves, and Watermain Appurtenances

The work shall include the removal or abandonment of hydrants, valves, and watermain appurtenances.

When a hydrant is removed, the hydrant shall be removed with its boot intact and salvaged.

When the mainline is to remain in service after a removal, the work shall include capping at the tee at the mainline.

When a mainline valve is to be abandoned and the valve is not in a valve chamber, the valve box shall be removed.

When a water service connection is abandoned, the work shall include shutting off the service at the mainline.

510.07.04 Fence and Noise Barrier Work

510.07.04.01 Removal of Fence

The work shall include the removal of all fences, regardless of type.

The work shall consist of the dismantling and removal of the fence, including all posts, fence fabric, footings, gates, components, and fittings forming part of the fence designated for removal.

When the means of egress and ingress between the right-of-way and adjacent property is being controlled by an existing fence designated for removal, that control shall be maintained for the duration of the Contract.

When only part of an existing fence is removed, repairs to match the existing fence shall be made to the ends remaining.

510.07.04.02 Removal of Noise Barriers

The work shall include the dismantling of the noise barrier including posts, panels, framing, doors, fire access openings, and the removal of concrete footings to a depth of 1.3 m.

510.07.05 Delineators, Traffic Barriers, and Energy Attenuator Work

510.07.05.01 Removal of Delineator Posts

The work shall include the removal of delineator and guide posts, including wooden, metal, and flexible posts, and associated hardware.

510.07.05.02 Removal of Guide Rail Systems

The work shall include the removal of cable guide rail, steel beam guide rail, and box beam guide rail systems, including cables, steel beams, box beams, channels, hardware, posts, anchor blocks, and anchoring systems to the limits specified in the Contract Documents.

510.07.05.03 Removal of Concrete Barriers

The work shall include the removal of cast-in-place concrete barriers; the removal and salvage of precast concrete barriers; the removal of back to back installed concrete barriers, concrete or granular fill between the back to back concrete barriers, barrier transition sections; and the removal of associated pads and hardware as specified in the Contract Documents.

510.07.05.04 Removal of Energy Attenuators

The work shall include the removal of energy attenuators, including pads and anchoring devices. At specified locations, the energy attenuators shall be dismantled and salvaged as a complete system, including all hardware.

510.07.05.05 Removal of Ramp Closure Gates

The work shall include removal of ramp closure gate concrete footings, gates, signs, and all associated hardware.

The gates and associated hardware shall be salvaged and delivered to the location specified in the Contract Documents.

510.07.06 Pavement Work

510.07.06.01 General

During pavement removal operations, care shall be taken to prevent contamination with granular and other foreign materials.

Removal shall be performed in such a manner as to leave adjacent pavement and structures remaining in place undisturbed.

When the roadway is to be opened to traffic after the daily shut down and full width pavement removal is required, the following shall apply:

- a) For two-lane highways, removal shall be done to the same station for the full pavement width prior to shutdown at the end of the day.
- b) For multi-lane highways, removal shall be done to essentially the same station for the full pavement width for a specific direction prior to shutdown at the end of the day.
- c) Prior to opening the lanes to traffic, temporary ramping shall be provided as specified in the Contract Documents.

Asphalt pavement material from removal operations that is to be used on this Contract or stockpiled for future use by the Owner shall be weighed according to the Contract Documents then processed prior to stockpiling so 100% of the resultant material passes the 26.5 mm sieve. RAP shall be stockpiled according to the requirements of OPSS 1150 or OPSS 1151, as applicable to the Contract.

Removed asphalt pavement materials that are different due to the removal equipment used or pavement type shall be stockpiled separately.

510.07.06.02 Cutting Existing Pavement

Pavement shall be cut for neat removal to the depth specified in the Contract Documents.

Suitable mechanical sawing equipment or pavement milling equipment capable of producing a straight clean vertical face shall be used for cutting the pavement. The existing pavement type, thickness, and, if any, size of reinforcement shall be as specified in the Contract Documents.

510.07.06.03 Removal of Pavement, Treated Base, and Concrete Base

The work shall include the full-depth removal of asphalt pavement, concrete pavement, asphalt pavement from concrete surfaces and concrete base, cement-treated base, and asphalt-treated base. All materials shall be managed as specified in the Contract Documents.

When removed material is to remain temporarily on site due to construction operations, the removed material shall be placed on an asphalt or concrete surface until final disposition.

When the operation for full-depth asphalt removal from concrete base or concrete surfaces other than structures causes thickness reductions or surface variations exceeding 10 mm, the removal operations shall be corrected expeditiously and the damaged concrete areas repaired.

As part of the work of full-depth pavement removal, where public traffic is to be maintained throughout the work without the use of a temporary bypass, temporary granular ramping shall be constructed and maintained to convey public traffic through the area. The ramping shall be at 20H:1V. Temporary ramps shall be removed to accommodate subsequent construction after traffic has been routed off the temporary ramp.

Following pavement removal, the existing roadway granular shall be restored according to OPSS 301, when such roadway is not designated for abandonment.

Prime, surface treatments, and mulch pavements greater than 50 mm in depth are considered to be asphalt pavement.

This work shall not include removal of materials for jointing done as part of a paving operation.

510.07.06.04**Removal of Asphalt Pavement, Partial-Depth**

The work shall include the partial-depth removal of asphalt pavement. Such material shall be managed as specified in the Contract Documents.

The asphalt pavement shall be removed to the average depth specified in the Contract Documents.

Prior to commencing removal operations, all debris, deleterious material, and existing windrows shall be removed from the roadway surface, including material beyond the theoretical roadway width to provide positive drainage.

If the remaining asphalt pavement does not require further processing or if the remaining asphalt pavement is to be recycled using CIR or CIREAM or HIR processes, then the equipment used for partial depth removal shall be automatically controlled for grade and slope during removal. The surface remaining after removal shall have a constant and continuous crossfall matching the intended surface course crossfall. The surface remaining after removal shall have an even texture and be free of significantly different grooves and ridges in all directions.

Removed asphalt pavement material shall not remain on the roadway after completion of the day's operation. Placing of the material on grade other than a bituminous surface prior to hauling to a stockpile shall not be permitted.

After partial depth removal, the gap between the top of milled surface and the bottom of a 3 m straightedge placed anywhere in any direction on the milled surface shall not exceed 6 mm.

Prior to opening the lane to traffic after partial-depth pavement removal, adjacent granular shoulder material shall be reshaped and compacted to ensure proper drainage of the milled surface and adjoining shoulders.

Partial-depth asphalt pavement removal operations and the resulting surfaces from partial-depth asphalt removal operations shall not be permitted between November 16th and June 1st, unless approved by the Contract Administrator.

510.07.06.04.01**Temporary Ramping**

As part of the work of partial-depth pavement removal, at the end of each completed portion and prior to opening to traffic, temporary transverse ramping shall be constructed at a slope not steeper than 120H:1V. The temporary transverse ramping shall be removed as part of continuing the removal of asphalt pavement, partial-depth operation from the ramping location or prior to placing pavement materials at the ramping location.

If, due to unforeseen circumstances, partial depth pavement removal cannot be completed to the same station for the full pavement width prior to shut down at the end of the day, then as part of the work of partial-depth pavement removal, temporary longitudinal ramping, when permitted, shall be constructed at a slope not steeper than 10H:1V prior to opening to traffic. The temporary longitudinal ramping shall be removed within 1 Day or as agreed to by the Contract Administrator in the event of weather or access restrictions.

Temporary longitudinal ramping shall not be permitted when either of the following conditions exist:

- a) the ramping height would be greater than 50 mm, or
- b) the pavement slope would cause water to accumulate at the edge of the ramping and extend onto an adjacent lane or shoulder that will be open to traffic.

All costs associated with temporary ramping, including ramping material, shall be deemed to be included in the item price for Removal of Asphalt Pavement, Partial Depth.

510.07.06.05**Removal of Asphalt Pavement from Concrete Surfaces on Structures**

The work shall include the removal of asphalt pavement and waterproofing from the concrete surfaces on structures. All materials shall be managed as specified in the Contract Documents.

When pavement-milling equipment is used, the weight of milling equipment shall be limited to:

- a) 43 tonnes maximum weight for post-tensioned decks and rigid frame decks,
- b) 26 tonnes maximum weight for thin slab concrete bridge deck on girders. For thin slab concrete bridge deck on girders, the equipment shall not travel laterally beyond 1.0 m from the centreline of the exterior girder.

When the method of asphalt removal results in impact damage or excessive vibration is observed, operations shall be modified to eliminate these effects.

Unless the Contract Documents specify a concrete or latex-modified concrete overlay is to be placed on the existing concrete deck, the milling operation shall be controlled such that the milling teeth do not come in contact with the concrete deck surface and bridge joints. Any remaining asphalt pavement and waterproofing not removed by rotary milling equipment shall be removed by other methods.

If the milling operation damages the surface of the concrete deck, causing surface variations or concrete thickness reductions exceeding 2 mm, the milling operation shall be corrected expeditiously and the damaged concrete areas repaired. The proposed repair method shall be submitted in writing to the Contract Administrator, prior to commencing repairs. Surface preparation, placement, and curing of the repair materials shall be according to the repair material manufacturer's instructions.

510.07.06.06**Removal of Concrete Pavement, Partial-Depth**

The concrete pavement shall be removed to the depths indicated in the Contract Documents.

The equipment used for partial-depth concrete pavement removal shall be automatically controlled for grade and slope during removal. The surface remaining after removal shall have a constant and continuous cross fall matching the intended surface cross fall. The surface remaining after removal shall have an even texture free of significantly different grooves and ridges in all directions.

The removed concrete pavement material shall not remain on the roadway after completion of the day's operation.

After partial-depth removal of existing concrete pavement, the Contractor shall reshape and compact the existing shoulder material to ensure proper drainage of the remaining surface and adjoining shoulders.

Removal operations and resulting surfaces from removal operations shall not be permitted during the winter months on highways with posted speeds of 80 km/h or higher.

510.07.07**Concrete Work****510.07.07.01****Removal of Concrete**

The work shall include the removal of retaining walls; footings; foundations; concrete culverts, including associated wingwalls and retaining walls; concrete appurtenances; and similar concrete structures specified in the Contract Documents.

510.07.08 Right-of-Way Work

510.07.08.01 Preparing Right-of-Way

When preparing the right-of-way is specified in the Contract Documents, all objects and materials within the specified road allowance that interfere with the execution of the work and are not covered under separate removal items, shall be removed under this work. The work includes, but is not limited to the removal of trees less than 150 mm diameter, tree roots and stumps, brush and hedges, culverts, wooden and steel posts, signs, sidewalks, precast or poured driveway curbs, asphalt curbs, boulders, stone walls and retaining walls, and other surface materials that require removal in order to complete all parts of the Contract.

Any precast concrete slabs, bricks and stones, cut stone curbs, timbers, or similar landscaping elements that are removed shall remain the property of the adjacent property owner and shall be piled neatly on such adjacent property.

510.07.08.02 Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements

When collective work to remove driveways and sidewalks needs to be done, work shall include the removal of asphalt, concrete, stone or brick driveways and sidewalks, and sundry asphalt pavements.

510.07.08.03 Removal of Concrete Sidewalk

The work shall include the removal of concrete sidewalk.

510.07.08.04 Removal of Gabions

The work shall include the removal of gabions, including rock and wire.

510.07.09 Overhead Signs and Sign Support Structure Work

Overhead signs and sign support structures shall be salvaged.

Sign support structure footings shall be removed to a minimum of 1.3 m below subgrade.

510.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

510.09 MEASUREMENT FOR PAYMENT

510.09.01 Actual Measurement

510.09.01.01 Removal of Bridge Footings

Measurement of removal of bridge footings shall be the volume in cubic metres of the concrete removed.

**510.09.01.02 Removal of Curb and Gutter
Removal of Asphalt Curb and Gutter
Removal of Concrete Curb and Gutter**

Measurement of removal of curb and gutter shall be the length in metres horizontally along the flow lines of the curb and gutter removed, whether straight or circular, without separation into types. When the slope of the curb and gutter is 4H:1V or steeper, then the above measurement is of the slope length.

No deduction shall be made from the measured length for the spaces occupied by maintenance hole and catch basin castings. Where the removal includes runs of curb and gutter that converge to form bullnoses, each run shall be measured for payment and such measurement shall be deemed to include the concrete fillet within the bullnose.

510.09.01.03 Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

For measurement purposes, a count shall be made of the number of maintenance holes, catch basins, ditch inlets, and valve chambers removed regardless of type, depth, or size.

510.09.01.04 Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers, Partial-Depth

For measurement purposes, a count shall be made of the number of maintenance holes, catch basins, ditch inlets, and valve chambers abandoned regardless of type or size.

510.09.01.05 Capping of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers

For measurement purposes, a count shall be made of the number of maintenance holes, catch basins, ditch inlets, and valve chambers capped regardless of type or size.

510.09.01.06 Removal of Pipes and Culverts

Measurement of removal of pipes and culverts shall be the length in metres horizontally along the pipe or culvert, from one end or end section to the other end or the other end section. Where the grade of the pipe or culvert is 10% or greater, then the above measurement is of the slope length. Pipes and culverts smaller than 200 mm diameter shall be treated as part of the excavation work.

No deduction shall be made from the measured length for the spaces occupied by intermediate maintenance holes, catch basins, ditch inlets, and valve chambers.

510.09.01.07 Abandonment of Pipes and Culverts

Measurement of abandonment of pipes and culverts shall be by length in metres horizontally along the pipe or culvert, from one end or end section to the other end or the other end section. Where the grade of the pipe or culvert is 10% or greater, then the above measurement is of the slope length.

510.09.01.08 Removal of Pipe Subdrains

Measurement of removal of pipe subdrains shall be by length in metres horizontally along the centerline of the pipe subdrains, including outlets.

**510.09.01.09 Removal of Hydrants
Removal of Valves
Removal of Watermain Appurtenances**

For measurement purposes, a count shall be made of the number of hydrants, valves, and watermain appurtenances removed.

**510.09.01.10 Removal of Fence
Removal of Noise Barrier**

Measurement of removal of fence and noise barrier shall be the length in metres, horizontally along each fence or noise barrier removed.

510.09.01.11 Removal of Delineator Posts

For measurement purposes, a count shall be made of the number of delineator and guide posts removed.

**510.09.01.12 Removal of Cable Guide Rail
Removal of Concrete Barrier
Removal of Steel Beam Guide Rail
Removal of Steel Box Beam Barrier**

Measurement of removal of traffic barrier shall be the length in metres horizontally along each type of traffic barrier removed, excluding energy attenuators.

Where cable guide rail and steel box beam barrier are anchored to concrete anchor blocks, measurement shall be made between the end anchor points with no additional measurement made of the overlapping sections at intermediate anchorages.

510.09.01.13 Removal of Anchor Blocks

For measurement purposes, a count shall be made of the number of anchor blocks removed.

510.09.01.14 Removal of Energy Attenuators

For measurement purposes, a count shall be made of the number of complete energy attenuators systems removed.

510.09.01.15 Removal of Ramp Closure Gates

For measurement purposes, a count shall be made of the number of ramp closure gates removed.

510.09.01.16 Cutting Existing Pavement

Measurement of cutting of existing pavement shall be by length in metres along each cut.

**510.09.01.17 Removal of Asphalt Pavement
Removal of Asphalt Pavement from Concrete Surfaces
Removal of Concrete Pavement
Removal of Asphalt-Treated Base
Removal of Cement-Treated Base
Removal of Concrete Base**

Measurement of removal of asphalt pavement, asphalt pavement from concrete surfaces, concrete pavement, asphalt-treated base, cement-treated base, and concrete base shall be by area in square metres.

No deductions shall be made from the area for the space occupied by maintenance holes, catch basins, and valve chambers.

The full-depth removal of asphalt pavement, asphalt pavement from concrete surfaces, concrete pavement, asphalt-treated base, cement-treated base, and concrete base shall be measured for payment whether on the roadway surface or within an excavation, where such pavement or base has remained in place since its construction.

**510.09.01.18 Removal of Asphalt Pavement, Partial-Depth
Removal of Concrete Pavement, Partial-Depth**

Measurement of removal of partial-depth asphalt or concrete pavement shall be by area in square metres or by mass in tonnes as specified in the Contract Documents.

510.09.01.19 Removal of Asphalt Pavement from Concrete Surfaces on Structures

Measurement of removal of asphalt pavement from concrete surfaces on structures shall be by area in square metres.

510.09.01.20 Removal of Concrete

Measurement of removal of concrete shall be by volume in cubic metres.

When broken concrete or masonry is used as rip-rap or rock protection, deductions shall not be made from the concrete removal item.

510.09.01.21 Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements

Measurement of removal of driveways, sidewalks, and sundry asphalt pavements shall be by horizontal area in square metres.

510.09.01.22 Removal of Concrete Sidewalk

Measurement of removal of concrete sidewalks shall be by horizontal area in square metres.

510.09.01.23 Removal of Gabions

Measurement of removal of gabions shall be by volume in cubic metres.

**510.09.01.24 Removal of Sign Support Structure
Removal of Sign Support Structure Footings**

For measurement purposes, a count shall be made of the number of sign supports and sign support footings removed.

510.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

510.10**BASIS OF PAYMENT****510.10.01**

Removal of Bridge Structure - Item
Removal of Bridge Footings - Item
Removal of Modular Bridge - Item
Removal of Modular Bridge Substructure - Item
Removal of Curb and Gutter - Item
Removal of Asphalt Curb and Gutter - Item
Removal of Concrete Curb and Gutter - Item
Removal of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers - Item
Abandonment of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers Partial-Depth - Item
Capping of Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers - Item
Removal of Pipe and Culverts - Item
Abandonment of Pipes and Culverts - Item
Removal of Pipe Subdrains - Item
Removal of Hydrants - Item
Removal of Valves - Item
Removal of Watermain Appurtenances - Item
Removal of Fence - Item
Removal of Noise Barriers - Item
Removal of Delineator Posts - Item
Removal of Cable Guide Rail - Item
Removal of Concrete Barrier - Item
Removal of Steel Beam Guide Rail - Item
Removal of Steel Box Beam Barrier - Item
Removal of Anchor Blocks - Item
Removal of Energy Attenuators - Item
Removal of Ramp Closure Gates - Item
Cutting Existing Pavement - Item
Removal of Asphalt Pavement - Item
Removal of Asphalt Pavement from Concrete Surfaces - Item
Removal of Concrete Pavement - Item
Removal of Asphalt-Treated Base - Item
Removal of Cement-Treated Base - Item
Removal of Concrete Base - Item
Removal of Asphalt Pavement, Partial-Depth - Item
Removal of Asphalt Pavement from Concrete Surfaces on Structures - Item
Removal of Concrete Pavement, Partial-Depth
Removal of Concrete - Item
Preparing Right-of-Way - Item
Removal of Driveways, Sidewalks, and Sundry Asphalt Pavements - Item
Removal of Concrete Sidewalk - Item
Removal of Gabions - Item
Removal of Sign Support Structure - Item
Removal of Sign Support Structure Footings - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Imported backfill shall be paid for separately according to the tender item of the material specified in the Contract Documents.

Payment at the Contract price for the appropriate removal tender item shall be full compensation for all labour and Equipment for earth excavation required in the course of the removal operations.

Material designated for salvage but damaged by Contractor operations or lost by the Contractor shall be replaced with new material at no additional cost to the Owner.

If the Contractor elects to remove maintenance holes, catch basins, ditch inlets, and valve chambers in their entirety rather than as a partial removal, the removal shall be at no additional cost to the Owner.

When the Contract does not contain a separate item for the removal of pipe subdrain, the contract price for the items directly associated with the removal of pipe subdrain shall include full compensation for all labour, Equipment, and Materials required to do the work described in this specification.

Disturbed or damaged portions not designated for removal or salvage that result from the Contractor's operations shall be corrected or repaired at no additional cost to the Owner.

510.10.02 Excavation for Underpavement Objects

When the Contract contains separate items for the removal of concrete pavement, asphalt pavement, concrete base, cement-treated base, sidewalk, and curb and gutter, such items removed because of the removal of under-pavement objects such as sewers, culverts, Utilities, and watermains, payment shall be at the Contract prices and according to the specifications for the removal of concrete pavement, asphalt pavement, concrete base, cement-treated base, sidewalk, or curb and gutter, respectively.

510.10.03 Excavation for Removal

When excavation for removal overlaps the excavation required for other work under the Contract, the overlapping excavation for the removal shall be paid for in accordance with the specification for other work.

No deductions shall be made to the quantities of concrete base, cement-treated base, sidewalk, curb and gutter, and any other structure or portion of structure where these items removed are included within the established lines of an excavation item measured for separate payment.

Appendix 510-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATIONS**

**OPSS.PROV 511
NOVEMBER 2018**
(Formerly OPSS 511,
November 2013)

Note: The PROV published in November 2018 replaces OPSS 511 COMMON, November 2013 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
RIP-RAP, ROCK PROTECTION, AND GRANULAR SHEETING**

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511.09	MEASUREMENT FOR PAYMENT
511.10	BASIS OF PAYMENT

511.01 SCOPE

This specification covers the requirements for the installation of rip-rap, rock protection, granular sheeting, and geotextile.

511.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1860	Geotextiles

511.05 MATERIALS

511.05.01 Rip-Rap, Rock Protection, and Granular Sheeting

Rip-rap shall be according to OPSS 1004 and as specified in the Contract Documents.

Rock protection and granular sheeting shall be according to OPSS 1004.

511.05.02 Geotextile

Geotextile shall be nonwoven, Class II according to OPSS 1860, with an FOS of 75-150 µm, unless otherwise specified in the Contract Documents.

511.07 CONSTRUCTION

511.07.01 Excavation

Prior to placing any material, the area shall be excavated or filled or both to the lines and dimensions specified in the Contract Documents and fine graded to a uniform even surface.

511.07.02 Placing Material

511.07.02.01 General

Material shall be placed to the lines and dimensions specified in the Contract Documents.

When rip-rap or rock protection is being placed on slopes, the rock shall commence at the toe of the slope and progress up the slope.

When geotextile is specified in the Contract Documents, rip-rap, rock protection, and granular sheeting shall be placed in a manner so as not to damage the geotextile.

511.07.02.02 Rip-Rap

Rip-rap shall be placed in a set and stable manner, flat on the slope with the largest dimension parallel to the slope contours. The larger pieces of rip-rap shall be placed in the bottom courses. The rip-rap shall be laid closely so that a reasonable semblance of courses is achieved. Smaller pieces of rip-rap shall be used to fill the voids.

511.07.02.03 Rock Protection

Rock protection shall be placed in a random, but stable manner.

511.07.02.04 Granular Sheeting

Granular sheeting operations shall follow earth excavation operations as closely as practical and possible.

Compaction of granular sheeting material is not required.

511.07.02.05 Geotextile

Geotextile shall be free of folds, tears, and punctures and as specified in the Contract Documents. The geotextile shall be joined so that the material overlaps a minimum of 500 mm and shall be pinned together. Alternatively, the geotextile shall be joined to conform to the seam requirements of OPSS 1860.

Geotextiles shall be fixed to prevent movement during installation. Geotextile shall be wrapped down into the ground a minimum 300 mm at termination points.

511.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

511.09 MEASUREMENT FOR PAYMENT

511.09.01 Actual Measurement

511.09.01.01 Rip-Rap

Measurement of rip-rap shall be by area in square metres following the contour of the ground.

511.09.01.02 Rock Protection

Measurement of rock protection shall be by volume in cubic metres. The volume is a product of the area of the rock protection measured following the contour of the ground by its depth.

Truck box measurement shall be used when it is not possible to take an in place measurement.

511.09.01.03 Granular Sheeting

Measurement of granular sheeting shall be by area in square metres following the contour of the ground.

511.09.01.04 Geotextile

Measurement of geotextile shall be by area in square metres following the contour of the ground, without any allowance made for overlaps.

511.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

511.10 BASIS OF PAYMENT

**511.10.01 Rip-Rap - Item
Rock Protection - Item
Granular Sheeting - Item
Geotextile - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When there is not a separate tender item for geotextile, payment for the geotextile shall be included in the tender item for rip-rap, rock protection, or granular sheeting, as appropriate.



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF GABIONS

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512.08	QUALITY ASSURANCE - Not Used
512.09	MEASUREMENT FOR PAYMENT
512.10	BASIS OF PAYMENT

APPENDICES

512-A	Commentary

512.01 SCOPE

This specification covers the requirements for the installation of gabions and gabion structures not exceeding 2 metres in height.

512.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

512.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

512.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 805	Temporary Erosion and Sediment Control Measures
OPSS 902	Excavating and Backfilling - Structures

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1430	Gabion Baskets and Mats
OPSS 1860	Geotextiles

512.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Gabion means a gabion basket or a gabion mat filled with gabion stones.

Gabion Structure means a vertical or near vertical stacked installation of gabions.

512.05 MATERIALS

512.05.01 Gabion Baskets and Gabion Mats

Gabion baskets and gabion mats shall be according to OPSS 1430.

Gabion baskets shall be manufactured from galvanized steel wire mesh or PVC coated galvanized steel wire mesh as specified in the Contract Documents. When the type of mesh is not specified in the Contract Documents, the gabion baskets shall be manufactured from PVC coated galvanized steel wire mesh.

Gabion mats shall be manufactured from PVC coated galvanized steel wire mesh.

512.05.02 Gabion Stones

Gabion stones shall be according to OPSS 1004 and as specified in the Contract Documents.

512.05.03 Geotextile

Geotextile shall be non-woven, Class II according to OPSS 1860, with an FOS of 75-150 µm, unless otherwise specified in the Contract Documents.

512.07 CONSTRUCTION

512.07.01 Site Preparation

Site preparation shall be according to OPSS 490.

512.07.02 Dewatering

Dewatering shall be according to OPSS 517.

512.07.03 Temporary Erosion and Sediment Control Measures

Temporary erosion and sediment control measures according to OPSS 805 shall be implemented when gabions are placed in or along a watercourse.

512.07.04 Excavation, Bedding, and Backfill

Excavation for gabions shall be according to OPSS 206.

Corrective measures ordered by the Contract Administrator to rectify deficiencies caused by over-excavation shall be performed. Material placed in the over-excavated area shall be compacted to the density requirements of OPSS 501.

Bedding and backfill shall be as specified in the Contract Documents.

512.07.04.01 Excavation, Bedding and Backfill for Gabion Structure Not Exceeding 2.0 m Height

For gabion structures, excavation and the placing of bedding and backfill shall be according to OPSS 902.

512.07.05 Assembly of Gabions

Gabions shall be installed at the locations and to the line, grade, and dimensions specified in the Contract Documents.

Gabions shall be assembled according to the manufacturer's instructions and as specified in the Contract Documents.

Gabions shall be assembled so that wire ends do not project outside the units on any exposed surface.

Gabion stones shall be placed in a manner as not to damage the wire mesh or the PVC coating on the wire or cause deformation of the gabion. Gabion stones shall be placed to minimize the voids between the stones. When specified in the Contract Documents, the front face of exposed wall surfaces shall be hand placed gabion stone to ensure a uniform appearance.

Prior to securing the lids on the gabion basket, the gabion basket shall be slightly overfilled by 25 to 50 mm of gabion stone in order to allow for settlement of the stone within the units.

512.07.06 Placing of Internal Connecting Wires

Internal connecting wires shall be installed according to the manufacturer's recommendations. When gabions are used as a channelling revetment, internal connecting wires are not necessary.

512.07.07 Securing Lids

When the gabion has been filled, the gabion lid shall be bent over until all lid edges coincide with the front and side edges of the gabion and shall be secured to the front and sides by wire according to manufacturer's instructions and as specified in the Contract Documents.

512.07.08 Geotextile

Geotextile shall be placed uniformly, free of folds, tears or punctures and as specified in the Contract Documents. The geotextile shall be joined so that the material overlaps a minimum of 500 mm and shall be pinned together. Alternatively, the geotextile shall be joined to conform to the seam requirements of OPSS 1860. Geotextile shall be fixed to prevent movement during installation.

512.07.09 Protection Systems

The construction of all protection systems shall be according to OPSS 539. Where the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring, and the driving of piles where necessary to prevent damage to such works or proposed works.

512.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

512.09 MEASUREMENT FOR PAYMENT

512.09.01 Actual Measurement

512.09.01.01 Gabions

Measurement of gabions shall be by volume in cubic metres based on the nominal dimensions of the gabions used. When the gabion excavation overlaps excavation required for other work, the measurement shall be made as specified with no deduction for overlaps.

Geotextile used with gabions shall not be measured for payment.

512.09.01.02 Gabion Structures Not Exceeding 2.0 m Height

Measurement of gabion structures not exceeding 2.0 m height shall be by volume in cubic metres based on the nominal dimensions of the gabions used. Height is measured from the base of the gabion structure and includes embedment depth, when applicable.

Geotextile used with gabion structures not exceeding 2.0 m height shall not be measured for payment.

512.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

512.10 BASIS OF PAYMENT

512.10.01 Gabions - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Any costs associated with an unauthorized over-excavation shall be the Contractor's responsibility and at no extra cost to the Owner.

512.10.02 Gabion Structures Not Exceeding 2.0 m Height - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Granular bedding and backfill for gabion structures shall be paid under the granular item for the material specified according to OPSS 902.

For gabion structures, excavation, bedding and backfilling shall be paid under the item Earth Excavation for Structure and Rock Excavation for Structure according to OPSS 902.

Where excavation required for gabion structure overlaps excavation required for other work, payment for excavation shall be made in accordance with the specification for the other work as though no excavation were required for the gabions and the gabion structures.

Appendix 512-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR DEWATERING

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517.02	REFERENCES
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517.04	DESIGN AND SUBMISSION REQUIREMENTS
517.05	MATERIALS - Not Used
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517.10	BASIS OF PAYMENT

APPENDICES

517-A	Commentary

517.01 SCOPE

This specification covers the requirements for the design, operation, and removal of a dewatering or temporary flow passage system to control water during construction, and the control of the water prior to discharge to the natural environment and sewer systems.

517.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

517.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

517.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 404	Support Systems
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 510	Removal
OPSS 539	Temporary Protection Systems
OPSS 805	Temporary Erosion and Sediment Control Measures

517.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Automatic Transfer Switch means an electrical device that transfers power supply to a backup power source when there is an outage of the primary power source.

Cofferdam means as defined in OPSS 539.

Cut-Off Wall means a below grade wall that restricts groundwater flow and/or supports excavations, typically using soil-bentonite or cement-bentonite.

Design Flow Rate means the volume of water per unit of time expected to flow into the area of construction during or after the design storm event, and may include groundwater discharge.

Design Storm Return Period means the average number of years based upon probability, between the occurrences of a storm event of a certain severity or greater.

Dewatering System means the components required to control water to permit construction work to proceed under specified conditions, and may include a groundwater control system, impermeable barriers, pumps, and/or equipment to carry out unwatering.

Groundwater Control System means sump pumps, oversized excavations with perimeter ditches, deep wells or well points or other systems used to lower the groundwater table.

Plug means an impervious, natural, or constructed drainage work that blocks water.

Sediment means soil particles detached from an earth surface by erosion.

Sediment Control Measure means a measure to remove sediment from water prior to discharge to the natural environment and sewer systems.

Temporary Flow Control Device means a material or a group of materials that are used to control water flow into and out of a temporary flow passage system and can include a plug.

Temporary Flow Passage System means temporary flow control devices, channels, pipes, and other materials used to convey or divert water past an area under construction.

Unwatering means the removal of ponded or flowing surface water.

Vegetated Discharge Area means a sloped, open area of land with existing vegetation suitable to prevent erosion.

Waterbody means as any permanent or intermittent, natural or constructed body of water including lakes, ponds, wetlands and watercourses, but does not include sewage works as defined in the Ontario Water Resources Act.

Watercourse means a stream, creek, river, or channel including ditches, in which the flow of water is permanent, intermittent, or temporary.

517.04 DESIGN AND SUBMISSION REQUIREMENTS

517.04.01 Design Requirements

A dewatering or temporary flow passage system shall be designed to control water at the locations specified in the Contract Documents and at any other location where a system is necessary to complete the work. The design of the system shall be sufficient to permit the work at each location to be carried out as specified in the Contract Documents.

The design shall meet the requirements of the Contract Documents, and where a waterbody is present, shall include channel and inlet and outlet protection measures as required to protect the environment in the event of system failure or the design flow rate being exceeded.

The design shall not include the use of embankments and/or structures in public use, either existing or to be constructed as part of the Work, to control or stop water flow, unless approved by the Contract Administrator.

The design shall not result in displacement or damage to property, buildings, structures, utilities and other facilities adjacent to the Working Area, including from drawdown related settlement or other groundwater related effects.

The system shall be designed to prevent soil loss or erosion where water is removed, pumped, or discharged. The system shall be designed to prevent basal heave or instability.

Where the system involves the taking of water from a waterbody, the design shall maintain the flow of water and the natural functions of the waterbody upstream and downstream of the work area, and shall not interfere with other uses of the water.

Temporary flow passage systems shall be designed, as a minimum, for a 2 year design storm return period or the period specified in the Contract Documents, and groundwater discharge. A longer return period shall be used when determined appropriate for the work.

Temporary diversion channels that are part of a temporary flow passage system design shall include provision for fish passage during low flows.

517.04.02 Submission Requirements

The submission of Working Drawings is only required for the dewatering system item and temporary flow passage system item locations specified in the Contract Documents. Other locations requiring a system do not require the submission of Working Drawings.

Three (3) sets of Working Drawings shall be submitted to the Contract Administrator at least 7 Days prior to commencement of the dewatering system installation, for information purposes only. Prior to submission of Working Drawings, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

One person shall not perform both the design Engineer and design-checking Engineer roles for a system.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

The following information and details shall be shown on the Working Drawings, where applicable:

a) Plans, Elevations, and Details

- i. Type of system.
- ii. Design calculations demonstrating adequacy of the system and equipment.
- iii. Design flow rate(s).
- iv. Plan location, description, and dimensions of system components, including dams, cofferdams, cut-off walls, temporary channels, pipes, culverts, sewers, groundwater control systems employing wells and/or well points, sedimentation basins, tanks, pumps, power supply, and standby equipment.
- v. Method of management of pumped water and plan location of all dewatering discharge points.
- vi. Profile drawings shall extend through and immediately beyond the limits of the system.
- vii. Water elevations upstream and downstream of the system at design flow rate.
- viii. Dam height or crest elevation, cofferdam depth and tip elevation, cutoff wall depth or base elevation, pipe invert elevations, depths of wells and wellpoints, pump intake elevation, and sedimentation basin depth or base elevation.
- ix. Plan location, elevation, and dimensions of environmental protection measures.
- x. Pipe type, size, and length, pump capacity, and tank capacity.
- xi. Material and construction standards to be used for the work.
- xii. Method for establishing and monitoring construction site groundwater levels.
- xiii. Criteria and method of removal of the system.

b) Procedures for the system construction, operation, and maintenance, including daily start-up sequence where applicable, and operation shut down.

- c) Procedures for the removal of the system, including the removal sequence, and well decommissioning.
- d) Stand-by power or pumping system requirements and the use of automatic transfer switching, when required to protect the environment and the Work.
- e) A copy of the Permit to Take Water issued by the Ministry of the Environment and Climate Change or confirmation of registration of water taking for construction dewatering, if a permit or registration is required by provincial regulation.
- f) When applicable, a copy of the water taking report and discharge plan required by provincial regulation.
- g) A copy of any necessary permits for the discharge of water to a sanitary sewer, or stormwater sewer system, stormwater pond, or other facility.

517.04.03 Preconstruction Survey

When a groundwater control system by wells or a well point system will be used, a condition survey of property and structures that may be affected by the work shall be carried out. The condition survey shall include the location and condition of adjacent properties, buildings, underground structures, water wells, Utilities, and structures, within the preconstruction survey distance specified in the Contract Documents from the groundwater control system. In addition, all water wells used as a supply of drinking water and located within the preconstruction survey distance specified in the Contract Documents from the groundwater control system shall be tested for compliance with Ontario Drinking Water Quality Standards.

Water wells within the preconstruction survey distance can be located using the website <https://www.ontario.ca/environment-and-energy/map-well-records> or its successor site.

Copies of the condition survey and water quality test results shall be submitted to the Contract Administrator prior to the operation of the groundwater control system.

517.07 CONSTRUCTION

517.07.01 General

Dewatering systems and temporary flow passage systems shall be constructed and operated according to the Working Drawings, where applicable.

When required, support systems shall be according to OPSS 404, and temporary protection systems shall be according to OPSS 539.

Temporary erosion and sediment control measures, including to control the discharge of water, shall be according to OPSS 805. Measures not specified in OPSS 805 shall be according to the Working Drawings. Temporary erosion and sediment control measures and cover material to protect exposed soils, as required by the Working Drawings, shall be installed as soon as is practical.

Stranded fish shall be managed as specified in the Contract Documents.

Unwatering shall be carried out as necessary.

Water suspected of being contaminated as indicated by visual or olfactory observations shall be reported to the Contract Administrator.

517.07.02 Dewatering System

The dewatering system shall be continuously operational to control buoyancy forces until such forces can be resisted by backfill and structure self-weight, to keep excavations stable, to avoid erosion impacts from the release of accumulated water, and to keep the work area in the condition required to complete the associated work as specified in the Contract Documents.

The dewatering shall be discontinued in a manner that does not disturb any structure, pipeline, or flow channel. Operation of the dewatering system shall be shut down according to the procedures specified in the Working Drawings, where applicable.

517.07.03 Temporary Flow Passage System

517.07.03.01 General

Installation and removal of temporary flow passage systems shall be according to this subsection, and the Working Drawings if applicable.

The temporary flow passage system shall be revised or realigned as required by construction staging.

When a temporary flow passage system is to remain operational through a seasonal shutdown period, the Contractor shall be responsible for any maintenance or repair costs due to the temporary flow passage system during the seasonal shutdown period.

517.07.03.02 Activation

517.07.03.02.01 Outside of a Waterbody

Temporary flow passage systems outside of a waterbody shall be activated according to the following sequential steps:

- a) The temporary flow passage system shall be constructed in its entirety, with upstream and downstream plugs separating the original waterbody channel and the temporary flow passage system remaining in place.
- b) The downstream plug shall be opened to allow water into the temporary flow passage system and water pressure shall be allowed to equalize between the original waterbody channel and the temporary flow passage system.
- c) The upstream plug shall be opened to allow water to flow through both the original waterbody channel and the temporary flow passage system.
- d) A plug shall be installed in the original waterbody channel, at the inflow confluence of the original waterbody channel and the temporary flow passage system, to fully divert the water to flow through the temporary flow passage system.
- e) A plug shall be installed in the original waterbody channel, at the outflow confluence of the temporary flow passage system and the original waterbody channel, to prevent backflow into the original waterbody channel.

517.07.03.02.02 Within a Waterbody

Temporary flow passage systems within a waterbody shall be activated according to the following sequential steps:

- a) An upstream temporary flow control device shall be installed to divert water flow into the temporary flow passage system.

- b) A plug shall be installed in the original waterbody, at the inflow confluence of the original waterbody channel and the temporary flow passage system, to fully divert the water to flow through the temporary flow passage system.
- b) A plug shall be installed in the original waterbody, at the outflow confluence of the temporary flow passage system and the original waterbody, to prevent backflow into the original waterbody channel.

517.07.04 Discharge of Water

Water from dewatering and unwatering operations shall be directed to a sediment control measure and/or a vegetated discharge area 30 m away from waterbodies or as far away as practicable from the top of the bank of any waterbody, prior to discharge to the natural environment.

Equipment and materials shall not be used or stored in vegetated discharge areas.

The discharge of water to the natural environment shall not be directed across pavements, sidewalks, curb and gutter or similar hard surfaces except through appurtenances as specified in the Contract Documents.

517.07.05 Monitoring

The Contract Administrator shall be notified of any complaints and any action taken or proposed to be taken in response to complaints.

Daily external visual monitoring of the surrounding area and property and structures on the preconstruction survey, if applicable, for impacts such as settlement and erosion shall be completed. Any observed impacts shall be immediately reported to the Contract Administrator. When public safety, the environment, or property is impacted or potentially impacted, the design Engineer shall, without delay, make a full assessment and direct changes to the system to eliminate impacts or potential impacts. Any changes shall be documented according to the System Amendments subsection.

When a groundwater control system is observed to negatively impact water supplies obtained from any adequate sources that were in use prior to groundwater control system operation, then water shall be supplied to the affected water users. The water shall be equivalent in quantity and quality to the normal water takings of the users. Supply shall continue until the negative impacts on the water supplies are removed, or until Contract Completion, whichever occurs first.

517.07.06 System Amendments

When displacement or damage to embankments and/or structures, or property adjacent to the Working Area, occurs due to the operation of the system, or soil loss or erosion occurs where water is removed, pumped, or discharged, the dewatering or temporary flow passage system design shall be amended to stop the displacement, damage, soil loss, or erosion.

When Working Drawings are required for the work, amendments shall be submitted to the Contract Administrator within two Business Days of the system being amended, on revised Working Drawings bearing the seal and signature of the design Engineer and design-checking Engineer.

517.07.07 Temporary Flow Passage System Deactivation

517.07.07.01 Outside of a Waterbody

Deactivation of temporary flow passage systems outside of a waterbody shall be according to the following sequential steps:

- a) The downstream plug in the original waterbody channel shall be opened to allow water into the original waterbody channel and water pressure shall be allowed to equalize between the original waterbody channel and the temporary flow passage system.
- b) The upstream plug in the original waterbody channel shall be opened to allow water to flow through both the original waterbody channel and the temporary flow passage system.
- c) A plug shall be installed at the inflow confluence of the original waterbody channel and the temporary flow passage system, to fully divert the water to flow through the original waterbody channel.
- d) A plug shall be installed at the outflow confluence of the original waterbody channel and the temporary flow passage system, to prevent backflow into the temporary flow passage system.

517.07.02 Within a Waterbody

Deactivation of temporary flow passage systems within a waterbody shall be according to the following sequential steps:

- a) The downstream plug shall be removed.
- b) The upstream plug shall be removed.

517.07.08 Removal

Dewatering and temporary flow passage system components shall be removed when no longer required. Removal of system components shall be according to the procedures specified on the Working Drawings, where applicable, and as specified in the Contract Documents.

Removal of temporary drainage work shall be according to OPSS 510.

Environmental protection measures and cut-off walls shall be removed, unless approved otherwise by the Contract Administrator.

Sedimentation basins and other excavations shall be backfilled with the original soil excavated, unless approved otherwise by the Contract Administrator. All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

Site restoration shall be according to OPSS 492.

517.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

517.10 BASIS OF PAYMENT

517.10.01 Dewatering System – Item Temporary Flow Passage System - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for the above tender items shall be based on the following percentages of the Contract price:

- a) 40% for system installation,

- b) 40% for system operation, prorated over the duration of the system operation, and
- c) 20% for system removal.

When the system is passive and does not require active operation of pumps or other equipment or ongoing maintenance, the 40% prorated payment for system operation shall be paid after system installation.

When the Contract does not contain separate tender item(s) for dewatering system or temporary flow passage system; or when dewatering is required outside the specified limits of the dewatering system or temporary flow passage system tender items, the Contract price for the items directly associated with the required dewatering shall include full compensation for all labour, Equipment, and Material to do the work.

Appendix 517-A, November 2010
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR TEMPORARY PROTECTION SYSTEMS

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539.01 SCOPE

This specification covers the requirements for the design, construction, maintenance, monitoring, and removal of a temporary protection system made necessary by excavation, embankment construction, dewatering, or other work.

539.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

539.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

539.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 906	Structural Steel for Bridges
OPSS 942	Prestressed Soil and Rock Anchors

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1601	Wood Material, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

S6-06	Canadian Highway Bridge Design Code

Ontario Ministry of Labour

Occupational Health and Safety Act, R.S.O. 1990, c.O.1, as amended

American Association of State Highways Transportation Officials (AASHTO)

AASHTO Guide Design Specification for Bridge Temporary Works, 1st Edition with Interim Revisions

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025 General Requirements for the Competence of the Testing and Calibration Laboratories

539.03 DEFINITIONS

For the purpose of this specification, the following definitions apply.

Anchor means:

- a) A system consisting of prestressed tendons or non-prestressed rods installed in predrilled holes and encapsulated in grout or concrete. A system that derives its load carrying capacity in bond between the grout and concrete body and the surrounding soil or rock; or
- b) A tie back to a deadman.

Bracing means the system of walers, struts, anchorages, and like members that connect frames, shores, or panels of a sheathing system to resist external pressures and to provide stability against lateral movement.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in General Conformance with the requirements of the Contract Documents.

Cofferdam means a watertight enclosure.

Dredge Line means the exposed lower limit of the protection system.

Erector means a supervisory person that undertakes the construction of a protection system.

Protection System means the construction necessary to mechanically support existing or proposed work so that its function shall not be affected or construction necessary to support work such as open excavations during actual construction operations for safety and convenience.

Quality Verification Engineer means an Engineer retained by the Contractor qualified to provide the services as specified in the Contract Documents.

Raker means a structural member inclined to the front of the shoring wall providing lateral support.

Shoring Wall means a structural wall consisting of wood, steel, or concrete or any combination of these materials that supports earth or rock and any structure, materials, Utilities, or other facility contained in or on the supported earth or rock mass.

Top of Shoring Wall means the upper limit of the protection system.

539.04 DESIGN AND SUBMISSION REQUIREMENTS

539.04.01 Design Requirements

539.04.01.01 General

The protection system shall be designed for the performance level as specified in the Contract Documents.

Except for Owner designed protection systems, the Contractor shall be responsible for the complete detailed design of the protection system required to carry out the work as specified in the Contract Documents.

Protection systems that are not as specified in the Contract Documents shall be assigned an appropriate performance level for design by the design Engineer. The Contract Administrator shall review the performance level selected at the time of submission of the specified Working Drawings.

The geotechnical and foundation portions of the design shall be based on a method published in AASHTO Guide Design Specification for Bridge Temporary Works and in general conformance with CAN/CSA-S6. The design shall be appropriate for the specific site conditions. Design methods not meeting the AASHTO and CSA design specifications may only be used on this Contract, if approved by the Owner.

A protection system shall be designed to provide protection for excavations at the locations as specified in the Contract Documents and at any other location where the stability, safety, or function of an existing structure or Utility may be impaired by construction work.

The temporary slope geometry used to determine requirements of the protection system shall be according to the Occupational Health and Safety Act.

Performance levels for protection systems are as follows:

Performance Level	Maximum Angular Distortion	Maximum Horizontal Displacement
1a	1:1000	5 mm
1b	1:1000	10 mm
2	1:200	25 mm
3	1:100	50 mm

Where:

Angular Distortion = $\pm \Delta/H$

Δ = Horizontal displacement in mm at height H

H = Height in mm above dredge line to point of measurement or height above the nearest system restraining support.

When performance level 1a is specified, the bracing system shall be preloaded.

Where the bracing systems are preloaded, the effects of the preload shall not cause damage to adjacent facilities.

Protection systems with a face within a horizontal distance of $1/3H$ of any part of a structure foundation shall be designed for performance level 1a.

539.04.01.02 Designer Qualifications

The design Engineer and design-checking Engineer shall have demonstrated expertise for the work. As well, the design Engineer and design-checking Engineer shall have a minimum of 5 years experience in designing protection systems of similar nature and scope to the required work.

One person shall not perform both the design Engineer and design-checking Engineer roles for a protection system.

539.04.01.03 Design Assumptions

The design assumptions shall accurately represent the subsurface conditions prevalent at the site and shall be specific to the type of protection system used. The design shall address the subsurface conditions at the project site as specified in the Contract Documents.

539.04.01.04 Vertical and Horizontal Loadings

Vertical and horizontal design loadings used shall represent existing conditions and accepted design practice. Future loadings that are known and may affect the protection system during its useful life shall be considered.

539.04.02 Submissions

539.04.02.01 Working Drawings

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to commencement of the protection system installation, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

Prestressed anchor submissions shall be according to OPSS 942.

When other authorities are involved, 1 set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction. The requirements of each authority shall be satisfied prior to commencement of the protection system installation.

The Contractor shall have a copy of the Working Drawings at the site during protection system installation.

For protection systems that are not specified in the Contract Documents, the Contractor shall submit the Working Drawings for these systems to the Contract Administrator at least 3 weeks prior to the commencement of any construction.

The following information and details shall be shown on the Working Drawings:

a) Plans, Elevations, and Details

- i. Location of protection system and station limits.
- ii. Plan and elevation of shoring showing the extent of the protection system.
- iii. Details of the shoring system, including cross-sections.
- iv. Details of internal bracing.

b) Design Criteria

- i. Pressure diagrams including values of horizontal and vertical loads, dead load, and live load surcharge.
- ii. Design assumptions and parameters.
- iii. Anchor bond stresses.
- iv. Pile design.
- v. Anchor system stressing schedule specifying working loads, stressing loads, and lock in loads.
- vi. Details of preload, when required.
- vii. For protection systems not specified in the Contract Document, the performance level shall be designated.

c) Materials

- i. Grade of structural steel and grade and species of structural wood.
- ii. Concrete strengths.
- iii. Grout strengths.
- iv. Details of protection from rain and frost action.
- v. Wood lagging and size.
- vi. Mill certificates or test reports from an independent organization certified by the Standards Council of Canada certifying that the steel meets the requirements of the grade, where specified.
- vii. Details of patented accessories, including load test data.

d) Installation Procedure

- i. Installation sequence and procedure, including to the installation of piling, lagging, anchor systems, and rakers.

e) Monitoring Method

- i. The proposed method of monitoring the performance of the protection system during installation and use. The method of monitoring shall be consistent with the requirements specified in the Quality Control subsection.

f) Removal of Protection System

- i. The details of the procedures associated with the removal of the protection system indicating: method, sequence of work, and removal limits, except when the protection system is specified in the Contract Documents to be left in place.

539.04.02.02 Amendments to Protection Systems

Work shall not proceed on amendments to the protection system until the Contractor has received sealed and signed approval to proceed from the design Engineer and design-checking Engineer and has submitted a copy of the approval to the Contract Administrator.

Amendments to the protection system shall be submitted to the Contract Administrator on revised Working Drawings bearing the seal and signature of the design Engineer and design-checking Engineer.

539.04.02.03 Preconstruction Survey

Prior to commencing the work, the Contractor shall submit to the Contract Administrator, a condition survey of property and structures that may be affected by the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site within a horizontal distance of $2H_w$ from the face of the protection system, where H_w is the height of the wall from the ground surface to the dredge line.

539.04.02.04 Materials

539.04.02.04.01 Structural Steel

539.04.02.04.01.01 Mill Certificates

The Contractor shall submit to the Contract Administrator at the time of delivery 1 copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, casings, and sheet piles.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificates verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

For Contractor designed protection systems using previously used structural steel that a mill test certificate is not available and coupons have not been tested to verify the steel's material properties, a mill test certificate is not required when the yield strength specified on the Working Drawings does not exceed 250 MPa. If the yield strength specified exceeds 250 MPa, the Contract Administrator may request that the material be tested to confirm the material properties indicated on the Working Drawings. The costs of this testing shall be at the expense of the Owner if the test results indicate that the material is according to the Working Drawings, and at the expense of the Contractor if the test results indicate that the material is not according to Working Drawings.

539.04.02.05 Milestone Inspections

539.04.02.05.01 Excavation Depths Less Than or Equal to Three Metres

The Quality Verification Engineer shall witness interim inspections of the following work:

- a) Installation of protection system, including excavation to dredge line.
- b) Removal of protection system.

A copy of the written permission to proceed shall be submitted to the Contract Administrator prior to commencement of the successive operation.

539.04.02.05.02 Excavation Depths Exceeding Three Metres

The Quality Verification Engineer shall witness interim inspections of the following work:

- a) Layout and extent of protection system.
- b) Piling.
- c) Installation of protection system, including excavation to dredge line.
- d) Removal of protection system.

A copy of the written permission to proceed shall be submitted to the Contract Administrator prior to commencement of the successive operation.

539.05 MATERIALS

539.05.01 Wood

Wood shall be according to OPSS 1601.

Wood shall be of the size, grade, and species shown on the Working Drawings and shall be in sound condition, free from defects that may impair its strength. Wood lagging does not have to be grade-stamped.

539.05.02 Proprietary Shoring and Patented Accessories

Where proprietary shoring or patented accessories are to be used, the Contractor shall follow the manufacturers' recommendations for load carrying capacity. The recommended load carrying capacities shall be supported by test results from an accredited testing laboratory approved by the Owner.

539.05.03 Concrete

Concrete shall be according to OPSS 1350.

539.05.04 Other Materials

The design Engineer may consider other suitable materials when sufficient information is available to quantify the allowable design loads or when the manufacturer's recommendations regarding load carrying capacities are supported by test results from an independent organization accredited by the Standards Council of Canada.

539.07 CONSTRUCTION

539.07.01 General

The Contractor shall be responsible for the design, materials, construction, maintenance, monitoring, and removal of a temporary protection system.

The erector shall be experienced in the method of construction of protection systems. Such experience shall have been obtained within the preceding 5 years on projects of similar nature and scope to the required work.

Protection systems shall be built according to the specifications and the Working Drawings.

Piling shall be according to OPSS 903 and the Working Drawings.

Concrete construction shall be according to OPSS 904. Concrete shall be placed in the dry. Where cofferdams are used, they shall be sealed sufficiently to permit concrete to be placed in the dry.

The Contractor shall carry out dewatering, as required, to facilitate the installation of the protection system.

Tremie concrete shall be placed according to the requirements of OPSS 904.

Structural steel shall be according to OPSS 906 and the Working Drawings.

Prestressed anchors shall be supplied, installed, and stressed according to OPSS 942.

The protection system shall be protected from the detrimental effects of rain and frost action.

Material used in the protection system shall remain the property of the Contractor.

Loss of soil from behind the shoring shall be prevented during and following the installation of the lagging.

539.07.02 Removal of Protection Systems

Protection systems may be left in place, unless otherwise specified.

Where protection systems are left in place, the top shall be removed to at least 1.2 m below the finished grade or ground level or at least 0.6 m below the streambed.

Where protection systems are specified for removal or the Contractor elects to remove, the method and sequence of removal shall be so that there shall be no damage to the new work, existing work, and facility being protected.

All disturbed areas shall be restored to an equivalent or better condition than existed prior to the commencement of construction.

539.07.03 Quality Control

539.07.03.01 General

In addition to the quality control measures instituted by the Contractor, the Contractor shall complete a preconstruction condition survey and monitor the protection system installation as specified herein, and as shown on the Working Drawings.

539.07.03.02 Inspection of Welds

The Contractor shall be responsible for visual inspection of all welds. Any required testing of welds shall be as specified by the design Engineer of the protection system.

539.07.03.03 Monitoring

539.07.03.03.01 General

Monitoring shall be conducted by a Registered Ontario Land Surveyor or an Engineer according to the program submitted with the Working Drawings.

The minimum requirements for monitoring shall include the survey measurements of scaled targets attached to the shoring wall at the elevations specified. The scaled targets shall be placed at a maximum spacing of 6 m with targets placed at the extreme ends and the targets distributed between the outer limits. The survey targets shall be monitored for horizontal displacement from the vertical at the frequency specified.

All test results, observations, and records, including the preconstruction survey, taken during construction and operation of the protection system shall be available on the site for review by the Contract Administrator.

If movement of the protection system is more rapid than is expected, or if movement approaches the allowable limit, the Contract Administrator shall be notified immediately and suitable measures shall be taken to ensure stability of the protection system and to ensure movement does not exceed the performance level specified in the Contract Documents.

539.07.03.03.02 Excavation Depths Less Than or Equal to Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top of the protection system at each construction stage during the installation. After installation, the above readings shall be taken every two weeks.

539.07.03.03.03 Excavation Depths Exceeding Three Metres

The protection systems shall be monitored during construction. Readings shall be taken during installation of the protection system at the top, at each restraint point, at the dredge line, and halfway between the restraint points at each construction stage during the installation of the protection system. After installation, the above readings shall be taken weekly.

539.07.03.04 Certificates of Conformance

539.07.03.04.01 Excavation Depths Less Than or Equal to Three Metres

For protection systems to facilitate excavation depths less than or equal to 3 m and provided that surcharge loading due to vehicular traffic, construction equipment and materials, or other is beyond a horizontal distance defined by a 1H:2V line projected from the dredge line at the face of the protection system to the roadway surface, a completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the operation of the protection system and removal of the protection system. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the protection system was installed, monitored, and subsequently removed in general conformance with the Working Drawings and as specified in the Contract Documents.

Should traffic be within a horizontal distance defined by a 1H:2V line projected from the dredge line at the face of the protection system to the roadway surface, the Certificate of Conformance requirements as specified in the Excavation Depths Exceeding Three Metres clause shall apply.

539.07.03.04.02 Excavation Depths Exceeding Three Metres

For protection systems to facilitate excavation depths that exceed 3 m or should traffic, construction equipment and materials, or other be within a horizontal distance defined by a 1H:1V line projected from the dredge line at the face of the protection system to the roadway surface, a completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the operation of the protection system and removal of the protection system. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the materials have been supplied and installed in general conformance with the Working Drawings and that the protection system was installed, monitored, and subsequently removed in general conformance with the Working Drawings and as specified in the Contract Documents.

539.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

539.10 BASIS OF PAYMENT

539.10.01 Protection System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate item for protection systems, the Contract price for the items directly associated with the protection system shall include full compensation for all labour, Equipment, and Material to do the work described in this specification.

Appendix 539-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR THE PLACEMENT OF UNSHRINKABLE FILL

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578.01 SCOPE

This specification covers the requirements for the placement of unshrinkable fill.

578.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

578.01.02 Appendices Significance and Use

Appendices are not for use in provincial Contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner.

Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their Contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

578.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 350	Concrete Pavement and Concrete Base
OPSS 517	Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1001	Aggregates - General
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-407	Method of Test for Compressive Strength of Moulded Cylinders
LS-610	Organic Impurities in Concrete Sands
LS-618	The Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-619	The Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

MTO Forms:

PH-CC-322	Concrete Construction Report

CSA Standards

A23.1	Table 3, Additional requirements for concrete subjected to sulphate attack*
A23.2-3B	Total or Water-Soluble Sulphate Ion Content of Soil*
A23.2-8B	Water-Soluble Sulphate Ion Content of Recycled Aggregates Containing Crushed Concrete*
A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens*
A23.2-5C	Slump and Slump Flow of Concrete *
A3001	Cementitious Materials for Use in Concrete**
*	[Part of CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
**	[Part of CSA A3000-13 Cementitious Materials Compendium]

ASTM International

D 1411-09	Standard Test Methods for Water-Soluble Chlorides Present as Admixtures in Graded Aggregate Road Mixes

578.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Unshrinkable Fill means a self-compacting cement treated aggregate with flowable consistency and controlled low strength properties.

578.04 DESIGN AND SUBMISSION REQUIREMENTS

578.04.01 Design Requirements

Unshrinkable fill shall be according to the following:

- The mix shall be designed to provide appropriate strength and performance characteristics for the intended use, and to meet the requirements as specified in the contract documents.
- The unshrinkable fill shall contain 25 kg/m³ of Type GU or GUL cement according to CSA A3001 and may contain additional supplementary cementing materials to aid in placement.
- The mix may contain foaming agents to aid in placement.
- Slump at point of discharge shall be a minimum of 150 mm and the unshrinkable fill shall be uniformly mixed throughout.
- The material shall be designed such that it can flow into the excavation and fill the entire space without vibration, and without segregation.
- The 28-Day compressive strength shall be a maximum of 0.40 MPa.

578.04.02 Submission Requirements

The Contractor shall be responsible for designing the unshrinkable fill mix and shall submit the unshrinkable fill mix design according to OPSS 1350 except the use of reclaimed concrete material and the amount used expressed in percent by mass of the total aggregate shall be identified on Forms A and B.

578.05 MATERIALS

578.05.01 Cementing Materials

Cementing materials shall be according to OPSS 1301.

578.05.02 Water

Water shall be according to OPSS 1302.

578.05.03 Aggregates

Aggregates shall be according to OPSS 1001 and this specification.

Except as noted below or elsewhere in the Contract Documents, aggregates may be sands, gravel, quarried rock or reclaimed concrete material provided the source is of such a nature and extent as to ensure acceptable processed aggregates of a consistent grading and quality. When any change in the character of the aggregate occurs or when the performance of aggregate meeting the requirements of OPSS 1001 and this specification is found to be unsatisfactory, use of the aggregate shall be discontinued until a reappraisal by the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory or another source is selected.

Fine and coarse aggregates shall meet the grading requirements of Table 1 and the physical property requirements of Table 2.

578.05.03.01 Reclaimed Concrete Material

Reclaimed concrete material may be used up to a maximum of 25 % by mass of the total aggregate. Reclaimed concrete material shall not be used in unshrinkable fill to be placed in contact with sulphate-bearing soil or ground water with sulphate.

578.06 EQUIPMENT

578.06.01 Mixing Equipment

A central mixing, dry batch plant, capable of accurately proportioning aggregate, cement, and water shall be used. The plant shall be certified according to OPSS 1350.

578.06.02 Transport Equipment

Unshrinkable fill shall be transported to the site by means of ready mix trucks.

578.07 CONSTRUCTION

578.07.01 Operational Constraints

Where vehicular traffic, including construction equipment, is to be accommodated, the unshrinkable fill shall be protected by covering it with a steel plate suitable for the traffic loading for a minimum of 24 hours.

Hot mix asphalt or any other material shall not be placed on unshrinkable fill until a minimum of four hours after the placing of unshrinkable fill.

578.07.02**Unshrinkable Fill Placement Requirements**

Individual loads of unshrinkable fill shall be placed within 2 hours from the time of batching.

When placed into excavations, unshrinkable fill shall be placed so that it fills the entire excavation without voids beneath horizontal projections or in other locations within the excavation. When unshrinkable fill is to be placed in an excavation subject to the entry of flowing water, the excavation shall be dewatered according to OPSS 517 prior to placement of the unshrinkable fill.

When placed adjacent to culverts, arches, rigid frames, integral abutments and piers, the unshrinkable fill shall be placed in alternating layers on each side of the structure to balance the earth pressure forces. Unless specified in the Contract Documents, the unshrinkable fill layers shall not exceed 500 mm in thickness and the height of the layers shall be approximately the same. At no time shall the elevation difference between the sides be greater than 500 mm. Each layer shall set for a minimum of four hours before a new layer is placed.

When shoring, bracing, or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, and this support system is to be removed, it shall be removed as filling proceeds to ensure stability of the excavation.

The unshrinkable fill material shall be protected from cold weather according to OPSS 350 with the exception that unshrinkable fill shall be protected from freezing after placement but need not be monitored with thermocouples nor maintained above 15° C.

578.07.03**Field Sampling and Testing**

The Contractor shall be responsible for testing of slump, casting, initial storage and transportation of cylinders for compressive strength determination by the Owner.

Field sampling and testing of concrete shall be performed by a person holding either of the following certifications:

- a) CCIL Certified Concrete Testing Technician, or
- b) ACI Concrete Field Testing Technician, Grade 1.

Such persons shall have a valid original card issued by the certifying agency in their possession at all times.

Unshrinkable fill shall be tested for slump according to CSA A23.2-5C when directed by the Contract Administrator. Unshrinkable fill that does not meet the slump requirement shall be adjusted to meet the slump requirement or rejected and removed from the Working Area.

For the determination of compressive strength, a set of two cylinders, 150 mm diameter 300 mm long, shall be cast each Day of production and placement, when directed by the Contract Administrator. When there is more than one supplier of unshrinkable fill, a separate set of two cylinders for each supplier shall be cast each Day of production and placement.

Cylinders shall be cast and transported according to CSA A23.2-3C except that only cardboard moulds shall be used to cast the test cylinders. A disc of wax paper matching the inside diameter of the cylinder mould shall be placed at the base of the cylinder mould prior to casting. The interior sidewalls of the cardboard mould shall be treated with a light coating of release agent.

For the first 24 hours after casting, test cylinders shall be stored within the Working Area either covered or in a shaded area.

Test information shall be recorded on MTO form PH-CC-322, a copy of which shall be submitted with each set of compressive strength cylinders.

The Contractor shall transport the cylinders to the designated quality assurance laboratory specified in the Contract Documents, for testing.

578.08 QUALITY ASSURANCE

578.08.01 Testing Requirements

Compressive strength testing shall be according to LS-407. The results of the set of two cylinders cast each Day shall be averaged to provide the test result for the Day.

578.08.02 Acceptance

Unshrinkable fill shall be accepted when:

- a) The material does not deform under traffic loading.
- b) The compressive strength requirements are met.
- c) Materials used comply with the requirements of this specification.

578.09 MEASUREMENT FOR PAYMENT

578.09.01 Actual Measurement

Measurement of unshrinkable fill shall be by volume in cubic metres.

578.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

578.10.0 BASIS OF PAYMENT

578.10.01 Unshrinkable Fill – Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Aggregate Gradation Requirements, LS-602 (Note 1)

Sieve Designation	Percent Passing
26.5 mm	100
75 µm	0-5
Notes: 1. Test samples shall be prepared by blending all aggregate components based on their individual percentages stated in the mix design.	

TABLE 2
Aggregate Physical Property Requirements

Test Number	Laboratory Test	Acceptance Limit
LS-610	Organic Impurities, Organic plate number (Note 1)	3
LS-619	Micro-Deval Abrasion, fine aggregates, maximum (Note 2)	30%
LS-618	Micro-Deval Abrasion, coarse aggregates, maximum (Note 2)	25%
CSA A23.2-3B CSA A23.2-8B	Sulphate content (SO ₄), maximum (Note 3)	1.5%
ASTM D1411	Water soluble chloride maximum, (Note 4)	0.010%
Notes: 1. For the natural sand component only. An aggregate that produces a colour darker than standard colour No. 3 shall be considered to have failed this requirement. 2. Test samples shall be prepared by blending all aggregate components based on their individual percentages stated in the mix design. The blended aggregate shall be split on the 4.75 mm sieve and the individual coarse and fine aggregate fractions set aside for testing as required. 3. For unshrinkable fill in contact with permanent concrete elements, the limit of SO ₄ shall be a maximum of 0.20% unless the permanent concrete element meets the requirements of S1, S2, or S3 of CSA A23.1-14 Table 3 as appropriate. 4. This requirement is specified where the unshrinkable fill will be in direct contact with concrete or steel pipe.		



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF ELECTRICAL CHAMBERS

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602.01 SCOPE

This specification covers the requirements for the installation, adjustment, and rebuilding of electrical chambers.

602.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 402	Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 403	Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404	Support Systems
OPSS 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation

OPSS 408	Adjusting or Rebuilding Maintenance Holes Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1103	Emulsified Asphalt
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1351	Precast Reinforced Concrete Components for Maintenance Holes, Catch Basins, Ditch Inlets, and Valve Chambers
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe (CSP) Products
OPSS 1850	Frames, Grates, Covers, and Gratings
OPSS 2401	Electrical Handholes

CSA Standards

C22.2 No. 42-10 (R2015)	General Use Receptacles, Attachment Plugs and Similar Wiring Devices
C83-96 (R2016)	Communication and Power Line Hardware
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles

ASTM International

A 48/A 48M-03 (2016)	Grey Iron Castings

Bureau de Normalisation du Quebec (BNQ)

3624-115-2007-05-04	Polyethylene (PE) Pipe and Fittings - Flexible Pipes for Drainage - Characteristics and Test Methods

602.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Electrical Chamber means a structure or chamber for placing and maintaining conductors, cables, ducts, or electrical equipment. Electrical chamber is a general name for electrical maintenance holes and handholes.

Rock means as defined in OPSS 206.

602.05 MATERIALS

602.05.01 Concrete

Concrete for cast-in-place electrical maintenance holes shall be according to OPSS 1350 with a nominal 28-Day compressive strength of 30 MPa.

602.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

602.05.03 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

602.05.04 Precast Concrete Electrical Maintenance Holes

Precast concrete electrical maintenance holes shall be according to OPSS 1351 and the Contract Documents. The requirement for a Prequalification Certificate issued under the Plant Prequalification Program stated in OPSS 1351 does not apply to precast concrete electrical maintenance holes.

602.05.05 Electrical Handholes

Electrical handholes shall be according to OPSS 2401 and the Contract Documents.

602.05.06 Steps

Steps for electrical maintenance holes shall be according to OPSS 1351.

602.05.07 Adjustment Units

Precast adjustment units shall be according to OPSS 1351 and as specified in the Contract Documents.

602.05.08 Frames with Covers

Maintenance hole frames with covers shall be according to OPSS 1850 and the Contract Documents.

Frames with covers for handholes shall be cast ferrous alloy according to ASTM A 48, Class No. 30 C, and the Contract Document.

602.05.09 Pulling Irons

Pulling irons for cast-in-place maintenance holes shall be galvanized wrought steel according to CSA C83, Item C83.48.

Pulling irons for precast concrete maintenance holes shall be 20 mm diameter, 200 mm long galvanized steel straight thimble eye bolts with heavy square nuts, and 100 x 100 x 10 mm square washers according to CSA C83, Items C83.65 and C83.30, No. 3.

602.05.10 Drain Pipe and Fittings

Drain pipe and fittings shall be 100 mm diameter non-perforated, corrugated high density polyethylene, according to BNQ 3624-115.

Plugs shall be polyethylene according to C22.2 No. 42.

Corrugated steel end sections and fittings shall be according to OPSS 1801.

Rodent gates shall be galvanized according to CSA G164.

602.05.11 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302. Air entrainment shall be 12%.

602.05.12 Waterproofing

Waterproofing material shall be emulsified asphalt, anionic slow-setting type according to OPSS 1103.

602.05.13 Grounding Materials

Grounding materials shall be according to OPSS 609.

602.05.14 Granular Material

Granular material for bedding and backfill shall be according to OPSS 1010.

602.05.15 Flexible Utility Marker

Flexible utility marker shall be according to the Contract Documents.

602.07 CONSTRUCTION

602.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Electrical chambers of the type specified in the Contract Documents shall be installed on firm foundations at the locations and to the elevations specified in the Contract Documents and shall be constructed plumb and true to alignment.

The top of structures shall be installed below the final grade to allow for the placing of adjustment units to facilitate the placing of the top of the frame with grate or cover to the final grade.

Flexible utility markers for electrical chambers shall be installed at locations specified in the Contract Documents.

602.07.02 Removals

Removals shall be according to OPSS 610.

602.07.03 Site Preparation

Site preparation shall be according to OPSS 490.

602.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

602.07.05 Cold Weather Work

All work shall be protected from freezing. Structures shall not be installed on frozen ground.

602.07.06 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

Materials that are unsound or damaged shall be rejected.

602.07.07 Excavating, Backfilling, and Compacting

Excavating, backfilling, and compacting for the installation of electrical chambers shall be according to OPSS 402.

Earth shall be excavated to accommodate at least 300 mm of granular backfill around the outer walls of the unit. When specified in the Contract Documents, a drainage pocket or drainage facilities lower than the electrical chamber floor shall be excavated and backfilled with 19 mm clear crushed rock.

Earth shall be excavated for separate drainage pockets and drain pipes as specified in the Contract Documents.

Backfill around the walls of units shall be according to OPSS 402, except that acceptable native material may be used when any part of the electrical chamber is 1.5 m or more beyond the outside edge of the shoulder.

Backfill for electrical chambers installed in grassed areas shall be native backfill.

Granular backfill or unshrinkable backfill, or material approved by the Contract Administrator shall be used for electrical chambers within 1.5 m of the outside edge of the shoulder.

602.07.08 Support Systems

Support systems shall be according to OPSS 404.

602.07.09 Dewatering

Dewatering shall be according to OPSS 517.

602.07.10 Electrical Chamber Drains

Drainage facilities shall be as specified in the Contract Documents.

The drain pipe shall be installed as specified in the Contract Documents and according to OPSS 401. Holes in electrical chamber drains shall be formed by core drilling or other approved methods.

Ends of cut steel bars shall be coated with epoxy paste and the drain pipe shall be mortared in place so that it does not protrude into the structure cavity.

The drain pipe shall have a formed trap in all cases when drainage is connected to a storm sewer system.

The drain pipe shall be provided with a 150 mm diameter corrugated steel end section and rodent gate in all cases when drainage is connected to an embankment slope or ditch is specified. The drain pipe shall be inserted at least 300 mm into the end section.

Drain pipes shall be laid in a trench between 300 and 400 mm wide, with a minimum grade of 400H 1V. Sand bedding and backfill of 150 mm each shall be placed when the drain pipe is installed in rock.

602.07.11 Installation

602.07.11.01 Electrical Maintenance Holes

Maintenance holes shall be oriented so that ducts and duct bank entries have an angle of 90° between the maintenance hole wall and the axis of the ducts and duct bank. If this is not possible, the angle shall not be less than 45°.

Maintenance holes shall be oriented so that maintenance hole steps are placed on the maintenance hole wall nearest to the travelled edge of pavement.

All inside wall protuberances shall be ground smooth prior to installation of wiring baffles and mechanical supports for cables.

All liquid and debris shall be cleaned from the electrical chambers upon completion and prior to the acceptance of work by the Contract Administrator.

When the Contract Documents specify that a maintenance hole is to be constructed on existing runs of rigid duct, either direct buried, in steel liner, or concrete encased; the ducts, concrete encasement, reinforcing steel, and steel liners shall be cut back and removed to suit the maintenance hole dimensions. The Contractor may,

- a) construct a cast-in-place electrical maintenance hole around the duct structure and modify the duct after placing the maintenance hole, or
- b) cut the duct structure back to a minimum of 300 mm beyond the outer maintenance hole walls, install a precast unit, and reinstate ducts into the maintenance hole.

Pulling irons shall be mounted on all maintenance hole walls opposite to the rigid duct entry and, when specified in the Contract Documents, in the floor of the units, and centred under the cover opening. Pulling irons shall be installed as specified in the Contract Documents and before waterproofing the unit. When pulling irons are installed after concrete has been poured, a 22 mm diameter hole shall be drilled in the wall and an eyebolt installed with a square washer and nut on each side of the wall.

602.07.11.01.01 Precast Electrical Maintenance Holes

Precast maintenance holes shall be supplied to the depth specified in the Contract Documents or to the depths necessary to accommodate the depths of ducts, duct banks, or cable required to enter the precast unit. When the vertical location of ducts are adjusted for Utility clearance or drainage and a deeper maintenance hole is required, the additional depth may be obtained by additional courses of brick or precast adjustment units up to 255 mm depth.

Precast maintenance holes shall be installed on a level surface and then backfilled and compacted to maintain the specified unit plumb and true to the required alignment and grades.

Precast or mono bases shall be placed level. Subsequent sections, complete with joint seal systems, shall be installed according to the manufacturer's recommendations.

During installation, all duct openings and drainage facilities shall be fitted to the required orientation and location and all segmental sections, gaskets, and PVC waterstops shall be firmly seated.

Adjustment of the structure shall be carried out by lifting the affected sections free of the excavation, re-leveling the base, if necessary, and re-installing the sections. Damaged sections and gaskets shall be replaced.

Lift holes shall be plugged with mortar.

602.07.11.01.02 Cast-In-Place Electrical Maintenance Holes

Cast-in-place maintenance holes shall be cast plumb and true to the alignment and grades specified in the Contract Documents.

Concrete shall be placed, cured, protected, and finished according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905.

Formwork for duct openings shall be accurately located to the dimensions specified in the Contract Document and shall consist of either non-metallic or removable forms. Ducts, duct banks, duct end bells, and liners shall be set in the framework prior to pouring concrete and shall be installed to provide an opening for later installation of these items.

602.07.11.02 Electrical Handholes

Electrical handholes shall be cast-in-place concrete handholes, precast concrete handholes, or prefabricated handholes made of semi-concrete or non-concrete materials.

Electrical handholes shall be installed plumb, true to alignment and grade, and firmly bedded on the drainage pocket backfill.

During installation, the duct entry holes shall be oriented in the required direction. The enlarging of duct entry holes is prohibited.

602.07.11.02.01 Cast-In-Place Concrete Electrical Handholes

Formwork for cast-in-place electrical handholes shall be secured to form a concrete envelope of uniform wall thickness and shall be set plumb and firmly bedded on the drainage pocket backfill. The cast iron frame and all ducts shall be installed in the formwork prior to pouring concrete.

Concrete shall be poured, cured, protected, and finished according to OPSS 904.

Outside formwork shall be removed to at least 150 mm below finished grade.

602.07.12 Duct Entry Holes

Duct entry holes shall be provided in the walls of electrical chambers in the orientation and number specified in the Contract Documents.

Any unused duct entry holes shall be firmly plugged from the inside with plastic plugs or, when waterproofing is specified, with mortar to the full thickness of the concrete walls.

When concrete encased duct banks are installed in maintenance hole units, the steel reinforcement of the duct bank shall be inserted 75 mm into the maintenance hole wall. The duct bank encasement shall be completely surrounded and bonded to the concrete wall. When direct buried rigid ducts, rigid ducts by subsurface installation or steel liners are installed in maintenance hole units, they shall be completely surrounded with concrete or grouted in place with mortar to the full thickness of the maintenance hole wall.

602.07.13 Grounding

Grounding shall be according to OPSS 609.

Metal cable racks and maintenance hole frames shall be connected to the system ground wire. When a ground rod is required at a maintenance hole, the system ground wire shall exit and re-enter the maintenance hole to enable ground rod connection as specified in the Contract Documents.

Grounding for handhole and maintenance hole covers shall be as specified in the Contract Documents.

602.07.14 Waterproofing

When specified in the Contract Documents, waterproofing material shall be applied to the outside walls, top, and adjustment units of concrete electrical chambers. For precast electrical chambers, the underside of the floor slab shall have a similar application. For cast-in-place electrical chambers, 300 µm polyethylene sheeting shall be installed between the underside of the floor and the bedding prior to pouring concrete. All holes not used shall be grouted with mortar.

Waterproofing material shall be applied at the rate of 0.8 L/m² of surface.

602.07.15 Installation of Adjustment Units

The installation of precast adjustment units shall be according to OPSS 407 and as specified in the Contract Documents.

602.07.16 Installation of Frames and Covers

Frames with covers shall be installed according to OPSS 407 and as specified in the Contract Documents.

Maintenance hole covers and gaskets shall be secured as specified in the Contract Documents.

Cast iron frames for handhole covers shall be adjusted to the required elevation and crossfall. Mortar shall be used to smooth out any edges protruding above the concrete envelope.

Cast iron covers for handholes shall be secured as specified in the Contract Documents.

Covers for prefabricated handholes shall be firmly seated according to the manufacturer's instructions.

602.07.17 Adjusting and Rebuilding Electrical Chambers

The adjusting and rebuilding of existing electrical chambers shall be according to OPSS 408 and as specified in the Contract Documents.

602.07.18 Quality Control

602.07.18.01 Pre-Installation Testing and Inspection

Electrical chambers and chamber drain components shall be inspected prior to installation to ensure that they are according to the Contract Documents.

Certification from the manufacturer that the product is according to the Contract Documents shall be submitted to the Contract Administrator.

602.07.18.02 Pre-Installation Strength Testing of Semi-Concrete and Non-Concrete Handholes

Ten percent of the handholes shall be selected for strength testing. For each handhole selected, the handhole shall be placed on a flat surface with only the bottom of the handhole in contact with the ground. No external support shall be provided for the sides of the handhole. A weight of 2,000 kg shall be placed on top of the handhole for ten minutes. At the end of each test, the handhole shall be inspected. The handhole shall not exhibit any signs of cracking or deformation. If the handhole is deformed, cracked, or damaged in any way, it shall be considered failed and shall be replaced. If one or more handholes fail, then another 10% of the handholes shall be selected and tested. If one or more of those handholes fail, then all of the handholes shall be tested.

The results of the strength testing shall be submitted to the Contract Administrator.

602.07.18.03 Electrical Chamber Installations

The Contractor shall ensure that the following are according to the requirements specified in the Contract Documents:

- a) Properly seated and aligned to a plumb position.
- b) Type of backfill.
- c) Compaction of backfill.
- d) All unused holes and spaces are filled.
- e) Waterproofing has been correctly applied.
- f) All frames and covers are secured and adjusted to grade.

602.07.19 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

602.07.20 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

602.09 MEASUREMENT FOR PAYMENT

602.09.01 Actual Measurement

**602.09.01.01 Electrical Maintenance Holes
Electrical Handholes**

For measurement purposes, a count shall be made of the number of complete electrical chambers installed.

602.09.01.02 Adjusting and Rebuilding Electrical Chambers

For measurement purposes, a count shall be made of the number of electrical chambers adjusted or rebuilt.

602.09.01.03 Electrical Chamber Drains

Measurement of electrical chamber drains shall be by length in metres along the horizontal centreline of the drain pipe from the centre of the electrical chamber to the centre of the drainage pocket, storm sewer structure, storm sewer pipe, or concrete culvert or outlet end of the drain terminating at an embankment slope or ditch.

602.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

602.10 BASIS OF PAYMENT

**602.10.01 Electrical Maintenance Holes - Item
Electrical Handholes - Item
Adjusting and Rebuilding Electrical Chambers - Item
Electrical Chamber Drains - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

**602.10.02 Electrical Maintenance Holes, Temporary - Item
Electrical Handholes, Temporary - Item
Electrical Chamber Drains, Temporary - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

602.10.03 Rock Excavation for Trenches and Associated Structures

Payment for rock excavation for trenches and associated structures shall be according to OPSS 403.



Note: The PROV published in November 2017 replaces OPSS 603 COMMON, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF DUCTS

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603.01 SCOPE

This specification covers the requirements for the installation of flexible ducts, rigid ducts concrete encased, rigid ducts direct buried, rigid ducts by subsurface installation, rigid ducts steel encased by subsurface installation, and surface mounted duct systems. This specification also covers the requirements for rock excavation for all electrical work.

603.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1359	Unshrinkable Backfill
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1802	Smooth Walled Steel Pipe

CSA Standards

B137.1-13	Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services
C22.2 No. 45.1-07 (R2012)	Electrical Rigid Metal Conduit - Steel
C22.2 No. 211.1-06 (R2011)	Rigid Types EB1 and DB2/ES2 PVC Conduit
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 227.1-06 (R2011)	Electrical Nonmetallic Tubing
C22.2 No. 2515-09 (R2014)	Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

ASTM International

F 2160-10	Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)

Underwriters Laboratories (UL)

UL 651A - 10/26/2011	Type EB and Rigid PVC Conduit and HDPE Conduit

National Electrical Manufacturers Association (NEMA)

TC 7-2013	Smooth Wall Coilable Electrical Polyethylene Conduit

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code - 2012

603.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Electrical Junction Boxes means surface mounted or embedded boxes for use with electrical wirings or devices.

Horizontal Directional Drilling (HDD) means directional boring or guided horizontal boring.

Rock means as defined in OPSS 206.

603.05 MATERIALS

603.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal 28-Day compressive strength of 20 MPa.

603.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

603.05.03 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

603.05.04 Fish Line and Trace Wire

Fish line shall be nylon or polypropylene material with a minimum test strength of 400 N. Trace wire shall be minimum #12 AWG copper wire, green insulation.

603.05.05 Steel Liner

Steel liner shall be according to OPSS 1802.

603.05.06 Mortar

Mortar shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302. Air entrainment shall be 12%.

603.05.07 Unshrinkable Backfill

Unshrinkable backfill shall be according to OPSS 1359.

603.05.08 Ducts and Fittings

Ducts and fittings shall be according to the applicable standards shown in Table 1.

For surface mounted duct systems when runs of ducts exceed 50 m, rigid ducts and fittings shall be of regular wall thickness with watertight reinforced thermosetting resin conduit (RTRC) duct. Hanger support systems shall consist of galvanized steel supports and fibreglass tubular spacers with galvanized steel hardware. Support systems shall allow for multiple sizes of duct in each horizontal layer.

For surface mounted duct systems when runs of ducts are 50 m and under, they shall be rigid polyvinyl chloride (PVC) conduit or rigid galvanized steel conduit.

Ducts for HDD shall be solvent-free, mechanical spline connected with hydraulic seal, and rigid PVC ducts certified to CSA C22.2 No. 211.2.

603.05.09 Marker Tape

Marker tape shall be 75 mm wide polyethylene (PE) or copolymer material, colour red, with repeating black lettering "Caution - Buried Electric Line" or a similar message.

603.05.10 Concrete Anchors

Concrete anchors for surface mounted duct systems shall be of the epoxy resin system type when runs of ducts exceed 50 m. When runs are 50 m or less, the anchors shall be either of the epoxy resin type or metal expansion anchors. Each anchor shall have a minimum pullout strength of 60 kN for an embedment depth of 200 mm or less.

603.07 CONSTRUCTION

603.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Ducts shall be installed as specified in the Contract Documents.

Ducts for communication cables shall be installed in trenches with varying depth so that drainage is provided. A minimum depth of cover of 450 mm may be used in flat terrain in order to ensure that the ducts slope towards a maintenance hole. When the terrain allows natural drainage due to its slope, the depth of cover shall be 550 mm.

Non-metallic ducts installed and used when exposed to direct rays of the sun shall be specifically approved for the purpose and be marked (e.g., "SR," "Outdoor," "RTRC Type AG") according to the Ontario Electrical Safety Code.

Wobble joint fittings with expanded polystyrene bedding shall be installed when direct buried rigid ducts terminate at concrete structures such as electrical maintenance holes, footings, bridge structures, retaining walls, and duct banks.

603.07.02 Protection During Construction

When ducts are installed prior to placing roadbed granular materials, the ducts shall be protected with a minimum cover of 300 mm of compacted backfill material.

603.07.03 Removals

Removals shall be according to OPSS 610.

603.07.04 Locating Existing Ducts

The Contractor shall locate all existing ducts requiring modification or usage.

603.07.05 Excavation

603.07.05.01 General

Trenches shall be excavated to the widths, depths, and alignment as specified in the Contract Documents. Such dimensions may be adjusted to obtain proper clearances with Utilities or other works.

The trench bottom shall be free of sharp rock fragments or debris and uniformly graded to support the ducts.

603.07.05.02 Earth Excavation

When unsuitable earth material is encountered in the trench bottom, it shall be removed and replaced with suitable material, as directed by the Contract Administrator.

The trench bottom shall be undisturbed earth or suitable imported material compacted according to OPSS 501.

When trenches are to be constructed prior to the completion of final grades, the Contractor may excavate trenches to give a minimum temporary cover of 300 mm for the ducts.

603.07.05.03 Rock Excavation for Electrical Installations

Rock excavation for the installation of ducts shall be according to OPSS 206.

603.07.06 Flexible Ducts

Flexible ducts shall be laid loosely in the trench to allow for expansion and contraction. Ducts shall be installed free of kinks or flattening and without sharp objects in the trench.

Couplings used for flexible ducts made of PE shall be PVC serrated couplings or shall consist of a 450 mm piece of the duct, one size larger than the flexible duct, slotted, and centred over the butted joint and securely fastened using stainless steel strapping. When PE pipe is used, pulling points for cable shall be similarly constructed.

For the PE flexible ducts for communication fibre-optic cable, installation of runs between maintenance holes up to 120 m in length shall be done with a single run of non-spliced duct. For runs up to 240 m in length, one splice is allowed. For runs exceeding 240 m, one splice per 120 m maximum is allowed. Such duct splices shall be fully waterproofed using silicon sealant and plasticized waterproofing sealant and shall be inspected by the Contract Administrator prior to backfilling.

Couplings used for flexible ducts made of electrical non-metallic tubing (ENT) shall be according to manufacturer's drawings or instructions. When ENTs are used, pulling points for cable shall be at the electrical chambers.

High density polyethylene (HDPE) couplings shall be used for HDPE duct and shall be according to manufacturer's drawings or instructions. When HDPE ducts are used, pulling points for cable shall be at the electrical chambers.

Flexible ducts shall be installed so that stacking or crossovers within the trench are not required, except for the purpose of entering concrete encased rigid ducts or electrical chamber sleeves.

Flexible ducts shall be installed within all underpavement crossings not having an electrical chamber on each end.

At direct buried poles, flexible ducts shall be inserted into the wiring aperture and turned up to within 450 mm of the pole handhole.

At concrete footings for base mounted poles, flexible ducts shall be inserted through the sleeves to at least 750 mm above the foundation.

At entries to pad mounted substations and to pad mounted traffic signal controllers, flexible ducts shall be installed within the sleeves and cut off flush with the top of the sleeves. The void between the duct and the sleeve shall be sealed with an electrical sealant for pad mounted controllers.

When it is required to join flexible ducts with rigid ducts, serrated adapter couplings shall be installed.

When flexible ducts are brought into electrical chambers, the ducts shall remain free in the entry holes of handholes and grouted into entry holes of maintenance holes.

When flexible ducts are specified in the Contract Documents, the Contractor shall have the option of using rigid ducts of the same inside diameter.

603.07.07 Rigid Ducts, Concrete Encased

Plastic spacers, suitable to the size and type of ducts and the duct separation specified in the Contract Documents, shall be installed along the trench bottom at 1.5 m maximum intervals. When transitions in grade are required, the trench bottom shall be adjusted to allow the spacers to seat firmly and hold any required duct bends.

Steel reinforcement shall be installed according to OPSS 905. Rods shall overlap by at least 60 mm and shall be tied to the plastic spacers. Lengths of duct shall be connected using couplings suitable to the size and type of duct. Couplings shall be staggered to obtain a minimum of 50 mm clearance between ducts or couplings. Ducts shall be tied to the spacers. The assembly shall be anchored securely to prevent shifting during placing of concrete.

Concrete may be poured directly into the trench or form work installed along the sides of the duct bank. The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation. Concrete placing and transporting devices shall not be supported by the steel reinforcement. Concrete shall be deposited within 1.5 m of its final position. Chutes shall have sufficient slope to deliver concrete of the approved consistency and shall have a maximum length of 15 m. When concrete is to be dropped more than 1.5 m, fully enclosed vertical drop chutes extending to the point of deposit shall be used. Concrete shall be placed at a steady rate such that a monolithic concrete is obtained without the formation of cold joints. The finish shall be raked or trimmed to produce a flat surface.

Rigid ducts shall be installed with a minimum slope of 400H:1V. Where deviations in vertical grade are required to avoid Utilities or other works, ducts shall be installed so that water cannot accumulate in the ducts.

Except where connections to electrical maintenance holes are required, rigid ducts and casing crossing paved areas shall extend 1.0 m beyond the back face of the curb or to the back edge of the shoulder.

When it is required to install transition sections between different types of rigid duct installations, the Contractor shall use deflection couplings or bend the ducts as required over a maximum of two standard duct lengths to obtain the required configuration.

603.07.08 Rigid Ducts, Direct Buried

The trench bottom shall be shaped and uniformly graded to support the entire duct. Lengths of duct shall be connected using couplings suitable to the size and type of duct supplied.

603.07.09 Flexible and Rigid Ducts by Subsurface Installation

Pits required for subsurface installation operations shall be set back a minimum distance from the edge of pavement or back of curb so that excavation is not done within a 1H:1V slope from the edge of pavement or back of curb to the bottom of the pit.

Bore holes shall only be 50 mm larger in diameter than the rigid duct being installed. When rigid ducts are being installed using the push-pull method, the steel rod shall be accurately aligned and pushed through the target pit. The push cap shall be replaced by a suitably sized expander unit and pulled back to the operating pit.

Lengths of duct shall be connected using couplings suitable to the size and type of duct supplied.

All temporary piling or supports used for boring or jacking equipment shall be removed or cut off to a minimum of 1.0 m below finished grade. All excavations or holes shall be backfilled and all temporary fill shall be removed.

When steel encasements are being installed using the boring and jacking method, the steel encasement shall be advanced so that the bore hole wall is supported by the steel encasement to within 300 mm of the head of the auger.

For HDD method, no drilling pit is required. Installation shall be according to the HDD machinery and duct manufacturers' guidelines and recommendations.

603.07.10 Surface Mounted Duct Systems

The Contractor shall not drill through bridge reinforcing steel. The Contractor shall locate reinforcing steel with a cover meter and position anchors accordingly.

For surface mounted duct systems, when the runs exceed 50 m horizontally:

- a) The installation of the support systems and ducts shall be carried out according to the duct manufacturer's installation procedures.
- b) Rigid ducts shall be installed parallel to the structural surfaces, either horizontally or vertically, using offset bends or fittings where changes in alignment are necessary.

For surface mounted duct systems, when runs are 50 m or less horizontally:

- a) Conduit fittings and junction boxes shall be installed in neat straight lines in the locations specified in the Contract Documents
- b) Rigid conduits shall be installed parallel to the structural surfaces, either horizontally or vertically, using offset bends or fittings where changes in alignment are necessary.

Appropriate fittings and deflection couplings shall be used for the installation. PVC boxes shall be mounted to provide the least interference with at least two stainless steel bolts and expansion anchors. Duct connection shall be cemented to the PVC box adapters.

Conduits shall be secured at intervals using conduit straps according to the Ontario Electrical Safety Code.

Conduit straps and junction boxes shall be fastened to concrete surfaces by drilling and inserting concrete anchors and securing the equipment with stainless steel bolts.

Conduit straps and junction boxes shall be fastened to steel structural members using stainless steel hardware.

603.07.11 Utility Clearance

When Utilities interfere with the specified elevation of any ducts, the Contractor shall notify the Contract Administrator to arrange inspection of the crossing point. The Contractor shall adjust the location of the ducts to obtain the clearance required and shall construct any concrete saddle or alternative protection approved by the Utility company.

603.07.12 Breaking Into Concrete Structures

When specified in the Contract Documents, the Contractor shall break into existing electrical chambers and existing substation or controller pads for installing ducts.

The space between the duct and the opening shall be filled with mortar.

603.07.13 Extension of Existing Duct Bank

Extension of existing duct banks shall be as specified in the Contract Documents.

603.07.14 Cable and Duct Protection and Marking

The Contractor shall install cable bricks or concrete protection at locations specified in the Contract Documents. Marker tape shall be installed along the centreline of the trench approximately 250 mm below finished grade or asphalt or concrete surfaces.

Cable brick shall be seated on uniformly graded and compacted material and butted end to end. Multiple rows of bricks shall be installed in trenches with direct buried high-voltage cables and when the width of the trench exceeds 300 mm.

Concrete protection shall be poured on uniformly graded and compacted material occupying the full width of the excavated trench to a minimum depth of 50 mm.

603.07.15 Termination

All ducts shall be temporarily plugged or sealed until wiring is installed. All ducts with wiring installed that terminate in traffic signal control cabinets, Advanced Traffic Management Systems (ATMS) control cabinets, or distribution assemblies shall be sealed.

When ducts are specified in the Contract Documents as spare or intended for future use, the duct ends shall be plugged with plastic plugs.

603.07.16 Backfilling

Except when unshrinkable backfill is used, backfilling shall be according to OPSS 401. Backfill material containing rock fragments and stone larger than 50 mm in diameter shall not be placed within 300 mm of the duct.

Sand bedding shall be placed in trenches for flexible duct when the trench bottom contains sharp rock fragments and when crossover of flexible ducts is required.

Backfill for concrete encased rigid ducts shall be placed at least 24 hours after pouring concrete.

Unshrinkable or granular backfill in trench for rigid ducts crossing paved areas shall extend to the wall of maintenance hole when maintenance holes are required; otherwise, 1.0 m beyond the back face of curb or, when there is no curb, to the back edge of shoulder.

603.07.17 End Marking

The location of the ends of all ducts not terminating in electrical chambers or pole foundations shall be marked by a concrete marker that is flush with the finished grade and located 300 mm beyond the shoulder edge or by a 50 x 50 mm cut cross on curbs, sidewalks, or barriers. The marker shall have an impressed arrow indicating the position of the ducts.

Concrete 400 x 300 x 50 mm markers shall be installed over runs of ducts for communication cables deviating from a straight line. A marker shall be installed wherever a tangent section meets a circular section. When the circular section is more than 20 m in length, an intermediate marker shall be installed.

Concrete markers shall be installed within 72 hours of backfilling of the trench.

603.07.18 Fish Line and Trace Wire

Fish line and trace wire shall be installed in all ducts specified in the Contract Documents as being spare or intended for future use. A 1.5 m length of fish line and trace wire shall extend out of each end of the duct beside the plastic plug, remain coiled, and tied in an accessible location.

603.07.19 Quality Control

603.07.19.01 Pre-Installation Testing and Inspection

All ducts shall be inspected to ensure that they are as specified in the Contract Documents.

All ducts shall be inspected to ensure they are stamped with the appropriate CSA designation, strength, and type. During installation, all ducts shall be inspected to ensure they are properly bedded, have sufficient depth of cover, and are coupled or connected to electrical chambers, poles, or other devices as specified in the Contract Documents.

603.07.19.02 Proof of Performance Testing and Inspection

All ducts shall be inspected and tested to ensure that they are as specified in the Contract Documents. All ducts shall be tested to ensure that they are free of debris, water, breakage, or distortion.

603.07.20 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

603.07.21 Site Restoration

Site restoration shall be according to OPSS 492.

603.07.22 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

603.08 QUALITY ASSURANCE

The Owner may perform field tests required for concrete according to OPSS 1350.

The Owner may perform tests for compaction according to OPSS 501.

603.09 MEASUREMENT FOR PAYMENT

603.09.01 Actual Measurement

- 603.09.01.01 Flexible Ducts**
- Rigid Ducts, Concrete Encased**
- Rigid Ducts, Direct Buried**
- Rigid Ducts by Subsurface Installation**
- Rigid Ducts, Steel Encased by Subsurface Installation**
- Flexible Ducts by Subsurface Installation**

Measurement of ducts shall be by length in metres horizontally along the longitudinal axis of the duct or trench; from centre to centre of poles, pole footings, electrical chambers, junction boxes, sign footings, and traffic signal controller cabinet pads; and to the face of bridge structures, retaining walls, and substation pads.

603.09.01.02 Rock Excavation for Electrical Installations

Measurement of rock excavation shall be by volume in cubic metres based on the quantity of rock below the upper limit and within the theoretical lines specified in the Contract Documents. The upper limit is the existing rock surface as measured after removal of overburden, but prior to rock excavation or the lowest elevation of all other excavation specified in the Contract Document, whichever is lower.

The volume of boulders in an excavation shall be based on 3 maximum rectilinear dimensions. When boulders classified as rock are measured for payment, only the amount removed shall be considered for payment. The total volume of rock considered for payment shall not exceed the volume of excavation within the theoretical lines.

603.09.01.03 Surface Mounted Duct Systems

Measurement of surface mounted duct systems shall be by length in metres horizontally along the duct, without deductions for junction boxes, from one point of attachment to other points of attachment.

603.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurements.

603.10 BASIS OF PAYMENT

- 603.10.01 Flexible Ducts - Item**
- Rigid Ducts, Concrete Encased - Item**
- Rigid Ducts, Direct Buried - Item**
- Rigid Ducts by Subsurface Installation - Item**
- Rigid Ducts, Steel Encased by Subsurface Installation - Item**
- Rock Excavation for Electrical Installation - Item**
- Surface Mounted Duct Systems - Item**
- Flexible Ducts by Subsurface Installation - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

If the Contractor chooses to substitute flexible ducts with rigid ducts, payment for those rigid ducts shall be at the unit price bid for the tender item Flexible Ducts.

When drilling and blasting are required as a part of the work, progress payment shall be made according to OPSS 206.

The work of providing clearance for required Utility crossing shall be administered as Change in the Work.

- 603.10.02 Flexible Ducts, Temporary - Item**
- Rigid Ducts, Concrete Encased, Temporary - Item**
- Rigid Ducts, Direct Buried, Temporary - Item**
- Rigid Ducts by Subsurface Installation, Temporary - Item**
- Rigid Ducts, Steel Encased by Subsurface Installation, Temporary - Item**
- Surface Mounted Duct Systems, Temporary - Item**

Flexible Ducts by Subsurface Installation, Temporary - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

TABLE 1
Ducts and Fittings

Duct and Fitting Description	Type	Direct Buried	Concrete Encased	Subsurface Installation		Embedded Work	Surface Mounted	Standard
				In Ground	In Liner			
PE	Flexible	X	-	-	-	-	-	CSA B137.1 Series 75
ENT	Flexible	X	X	X	X	X	-	CAN/CSA C22.2 No. 227.1
HDPE	Flexible	X	-	X (Note 1)	-	-	-	UL 651A; ASTM F 2160, Schedule 40; and NEMA TC 7 for type EPEC
PVC	Rigid	X	X	X	X	X	X	CSA C22.2 No. 211.2
Polymeric PVC	Rigid	-	X Type DB2	-	-	X Type DB2	-	CSA C22.2 No. 211.1
RTRC	Rigid	X standard or heavy wall (Note 2)	X standard or heavy wall	X standard or heavy wall (Note 2)	X standard or heavy wall	X standard or heavy wall	X standard or heavy wall	CSA C22.2 No. 2515
Galvanized Steel	Rigid	X	-	X	X	-	X	CSA C22.2 No. 45.1
Notes: 1. HDPE duct may be used for subsurface installation for extra low-voltage cables only when ducts are 50 mm diameter or smaller. 2. Heavy wall shall be used when ducts are 100 mm diameter or greater.								



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF CABLE

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604.01 SCOPE

This specification covers the requirements for the installation of high-voltage, low-voltage, and extra low-voltage cables, including cable splicing and terminations.

604.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Material

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 2409	Traffic Signal Cable

OPSS 2410 Extra Low Voltage Cable

CSA Standards

C22.2 No. 38-14	Thermoset-Insulated Wires and Cables
C22.2 No. 65-13	Wire Connectors
C22.2 No. 129-10 (R2014)	Neutral-Supported Cable
C22.2 No. 197-M1983 (R2013)	PVC Insulating Tape
C22.2 No. 239-09 (R2014)	Control and Instrumentation Cables
C22.3 No. 1-15	Overhead Systems
C57-16	Electric Power Connectors for Use in Overhead Line Conductors
C83-96 (R2016)	Communication and Power Line Hardware
G12-14	Zinc-Coated Steel Wire Strand

Insulated Cable Engineers Association (ICEA)

S-81-570-2005	600 Volt Rated Cables of Ruggedized Design for Direct Burial Installations as Single Conductors or Assemblies of Single Conductors
S-93-639-2000/NEMA WC 74-2006	5 - 46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electrical Energy
S-94-649-2004	Concentric Neutral Cables Rated 5 - 46 kV
S-95-658-2000/NEMA WC70-2009	Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy
S-96-659-2000/NEMA WC71-1999	Non Shielded Power Cables Rated 2001 - 5000 V
S-97-682-2007	Utility Shielded Power Cables Rated 5 - 46 kV
S-105-692-2011	600 Volt Single Layer Thermoset Insulated Utility Underground Distribution Cables

International Municipal Signal Association (IMSA)

19-2-1997	Paired Polyethylene-Insulated Polyvinyl Chloride-Jacketed Communication Cable with Electrical Shield

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Others

Electrical and Utilities Safety Association of Ontario Rule Book

604.05 MATERIALS

604.05.01 General

All cables exposed to direct rays of the sun shall be approved for exposure to direct rays of the sun and shall be marked as such according to the Ontario Electrical Safety Code (e.g., SR and Sunlight Resistant).

604.05.02 High-Voltage Cables

604.05.02.01 General

High-voltage cables shall be as specified in the Contract Documents.

604.05.03 Low-Voltage Cables

604.05.03.01 General

Low-voltage multiconductor cables shall be according to CAN/CSA C22.2 No. 239.

Low-voltage single conductor cables shall be type RWU90 according to CSA C22.2 No. 38.

Low-voltage neutral supported cables with one, two, or three insulated aluminum conductors and ACSR neutral shall be 600 V type NS-90 and shall be according to CSA C22.2 No. 129.

Low-voltage multiconductor traffic signal cable shall be according to OPSS 2409.

604.05.03.02 Conductors

Conductors shall be insulated stranded copper and be according to CAN/CSA C22.2 No. 239.

604.05.04 Extra Low-Voltage Cables

Extra low-voltage cables for use with traffic signal interconnection systems shall be according to IMSA No. 19-2.

Extra low-voltage cables for use with traffic signal actuation devices shall be according to OPSS 2410.

604.05.05 Messenger Cables

Messenger cables shall be stranded galvanized steel according to CAN/CSA G12.

604.05.06 Hardware and Fittings

Hardware and fittings for aerial cable installations shall be according to CAN/CSA C83.

604.05.07 Connectors

Cable connectors shall be according to CSA C22.2 No. 65 and CSA C57.

604.05.08 Electrical Insulating Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197 and rated for 600 V and -10 to 90 °C working temperatures.

604.05.09 High-Voltage Splices and Terminations

High-voltage splices, stress relief termination kits, potheads, and cable terminations shall be suitable for indoor or outdoor application as required; shall suit the size, type, and rating of cable used; and shall be according to the requirements of the power supply authority.

604.05.10 Low-Voltage Splices

Low-voltage splices shall be of the type specified in the Contract Documents.

604.05.11 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

604.05.12 Fish Line

Fish line shall be nylon or polypropylene material with minimum test strength of 400 N.

604.05.13 Cable Marking

Minimum markings shall consist of manufacturer's name, size of conductor, voltage rating, temperature rating, and type of insulation.

Coloured coded SR rated cables shall be solid coloured or tri-stripe coloured cable and shall be approved according to the Ontario Electrical Safety Code.

604.07 CONSTRUCTION

604.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

604.07.02 Removals

Removal shall be according to OPSS 610.

604.07.03 Excavation, Sand Bedding, Backfill, and Compaction

Earth and rock excavation, sand bedding, backfill, and compaction for the installation of direct buried cables shall be according to OPSS 603.

604.07.04 Cable Protection Bricks

Cable protection bricks for direct buried cables shall be installed according to OPSS 603.

604.07.05 Fish Line

A fish line shall be installed in all ducts or conduits when traffic signal cables are installed. A 1.5 m length of fish line shall remain coiled, tied, and accessible in each pole handhole, electrical maintenance hole, junction box, and controller.

604.07.06 Coils and Slack Cable

When specified in the Contract Documents, coils of cable and slack cable shall remain for future extension by others. Coils shall be neatly taped and remain in a readily accessible location. Cable ends shall be sealed with heat shrink tubing boots.

A minimum 300 mm length of lighting and power cables shall remain at all accessible pulling points, splicing points, or cable termination points. A coil length of low-voltage, traffic signal, and extra low-voltage cables shall remain at all electrical maintenance holes and underground junction boxes so that a minimum of 1.0 m total length of cable may be pulled out above finished grade.

604.07.07 Mechanical Support

High-voltage cables passing through electrical maintenance holes shall be wall-mounted on porcelain saddles with galvanized steel cable racks and installed in locations specified in the Contract Documents.

Low-voltage and extra low-voltage cables passing through electrical maintenance holes shall be wall-mounted on galvanized steel cable racks where unsupported lengths of cable exceed 1.2 m. Bend radii shall be kept greater than the minimum recommended by the cable manufacturer and fastened with

mechanical supports, where required. All cable and duct expansion joints shall be accurately formed and mechanically supported as specified in the Contract Documents.

Cable splices shall be supported in a similar manner with racks positioned approximately 150 mm on each side of the splice and mounted between 400 and 600 mm below finished grade.

All cables shall be trained to the maintenance hole walls and supported on cable racks. Sufficient rack arms shall be provided to adequately support the cables. All cables shall be bundled neatly with black outdoor nylon cable ties and each circuit identified with vinyl marking bands.

Nylon or stainless steel mesh cable grips shall be installed to support vertical cable runs when the unsupported cable mass exceeds 25 kg.

604.07.08 Barriers

When specified in the Contract Documents, barriers shall be installed between high-voltage and low-voltage cables, between communication and power cables, and between cables with different disconnecting means. Barriers shall be according to the Ontario Electrical Safety Code.

604.07.09 Low Temperature Handling

Cables shall be warmed to at least 0 °C at point of installation prior to installation. Cable shall not be installed when the ambient temperature is below -25 °C.

604.07.10 Cables in Ducts

Cable shall be pulled through ducts using compatible cable lubricant, mechanical aids, and pulling cables or ropes as required. The pulling tension and sidewall bearing pressure (SWBP) shall not exceed the safe tension recommended by the cable manufacturer.

When intermediate pulling points are required for the installation of cables in flexible duct, the flexible duct shall be cut and spliced according to OPSS 603.

604.07.11 Cables, Direct Buried

Cables shall be installed in sand bedding using the cable spacing and depth specified in the Contract Documents. When it is necessary for cables to cross over other cables, a minimum depth of 100 mm of sand bedding material shall be placed between the cables at the point of crossing. When it is necessary for cables to cross Utilities, a minimum separation of 300 mm shall be maintained, above or below the Utility. Such separation shall be backfilled with sand bedding material and a minimum of three cable protection bricks shall be installed over the cables according to OPSS 603.

Marker tape shall be installed along the centreline of all trenches.

604.07.12 Cables, Aerial

Cables shall be tensioned to obtain the sag, clearance, and tension values specified in the Contract Documents for the particular installation temperature.

When specified in the Contract Documents, cables shall be installed on messenger cables. When lashing of cable to a messenger strand is required, a mechanical lashing machine shall be used to install single wound 1.14 mm diameter stainless steel lashing wires. In lieu of lashing wires, and when specified in the Contract Documents, black outdoor nylon cable ties may be used.

Drip loops and expansion loops shall be formed at each pole or conduit entry and held free of the pole or other cables and connections.

Cables shall be re-tensioned, as necessary, to maintain the required cable clearances.

All work shall be according to CAN/CSA C22.3 No. 1, the Ontario Electrical Safety Code, and the Electrical and Utilities Safety Association of Ontario Rule Book.

604.07.13 Splices and Terminations

Cable splices and terminations shall be made at locations specified in the Contract Documents.

Ends of all insulated cables shall be sealed or capped to prevent the ingress of moisture prior to splicing or termination.

High-voltage cable splices and terminations shall be according to the manufacturer's recommendations for the rating and type of cable used.

Low-voltage cable splices for single-stranded conductors installed in electrical chambers shall be made with compression connectors and protected with waterproof covers. Waterproof splices shall be installed according to the manufacturer's recommendations.

Low-voltage and extra low-voltage cable splices for cable installed aerially or above ground shall be made with compression connectors protected with insulating covers.

Low-voltage and extra low-voltage cable splices shall be made by twisting the conductors together with a minimum 12 mm length overlap and connected by the installation of solderless connectors as specified in the Contract Documents. For inductive loop applications, connections shall be soldered. Above ground soldered splices shall be insulated with insulated boots.

All conductors, insulation, and jackets shall be carefully cleaned prior to installing connections, splices, or terminations. All ground shields, braids, or tapes shall be securely connected to a ground wire according to OPSS 609.

Low-voltage and extra low-voltage splices shall be made only in accessible locations such as electrical maintenance holes, junction boxes, and pole handholes.

Traffic signal conductors terminated in pole handholes shall be twisted together and provided with a watertight spring connector. Stranded conductors shall be connected to the terminal strips using the insulated fork tongue compression connectors. Solid conductors shall be connected directly to the terminal board.

604.07.14 Cable Systems

The work of cable systems shall be as described in the Cables in Ducts; Cables, Direct Buried; Cables, Aerial; and Splices and Terminations subsections.

604.07.15 Quality Control

604.07.15.01 General

The Contract Administrator shall be given 24 hours notice of when tests are to be performed. The Contract Administrator may witness all tests and all splice installations.

Tests shall be performed at 500 V for cable insulation rated at less than 600 V and at 1,000 V for cable installation rated 600 V or greater.

604.07.15.02 Pre-Installation Testing and Inspection

Cables, splicing, and connection components shall be inspected prior to installation to ensure that they meet the requirements of the Contract Documents.

604.07.15.03 Proof of Performance Testing and Inspection

The Contractor shall ensure that all cables are installed, tested, and spliced as specified in the Contract Documents and that all cables are energized and in working order.

The test results shall be submitted to the Contract Administrator.

604.07.15.04 High-Voltage Systems

All high-voltage cable systems shall be checked upon completion of the installation of cables, splices, and terminations and prior to connection to switch gear or the source of energy. High potential tests shall be performed on all cables according to Table 1.

604.07.15.05 Low-Voltage Systems

Tests shall be limited to approximately 10% of the total cable system and shall be completed at random locations selected by the Contract Administrator. In the event of failure of any test, the Contract Administrator may choose another 10% of the system for further testing.

The following tests shall be performed prior to energizing the system:

- a) The continuity of selected cables shall be checked by means of an ohmmeter test.

Accumulated resistance shall not exceed the nominal resistance of the cable length, as specified by the cable manufacturer, plus an allowable resistance of 20% per splice or connection.

- b) Resistance to ground tests.

Leakage to ground of selected cables shall be checked by means of a megger test. Resistance to ground shall be 10 megohm or greater.

604.07.15.06 Extra Low-Voltage Systems

Continuity of all cables and connections shall be checked by means of an ohmmeter test prior to energizing the system. This test shall be completed with temporary jumpers installed to by-pass any active system elements or any passive DC blocking devices.

Cables shall be tested for leakage to ground by means of a megger test. Resistance to ground shall be 10 megohm or greater.

604.07.16 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

604.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

604.07.18 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

604.09 MEASUREMENT FOR PAYMENT

604.09.01 Actual Measurement

604.09.01.01 Cable

Measurement for cable shall be by length in metres horizontally along the longitudinal axis of the duct, trench, or aerial cable; from centre to centre of poles, pole footings, electrical chambers, junction boxes, sign footings, and traffic signal controller cabinet pads; and to the face of bridge structures, retaining walls, and substation pads.

604.09.01.02 High-Voltage Terminations and Splices

For measurement purposes, a count shall be made of the number of high-voltage splices and terminations completed, regardless of the type, size, or rating.

604.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

604.10 BASIS OF PAYMENT

- 604.10.01**
- High-Voltage Cables, Direct Buried - Item**
 - Low-Voltage Cables, Direct Buried - Item**
 - Extra Low-Voltage Cables, Direct Buried - Item**
 - Traffic Signal Cables, Direct Buried - Item**
 - Co-Axial Cables, Direct Buried - Item**
 - High-Voltage Cables, in Ducts - Item**
 - Low-Voltage Cables, in Ducts - Item**
 - Extra Low-Voltage Cables, in Ducts - Item**
 - Traffic Signal Cables, in Ducts - Item**
 - Co-Axial Cables, in Ducts - Item**
 - Communication Cables, in Ducts - Item**
 - Low-Voltage Cables, Aerial - Item**
 - Low-Voltage Cables, Aerial with ACSR Neutral - Item**
 - Low-Voltage Cables, Aerial on Messenger Cable - Item**
 - Extra Low-Voltage Cables, Aerial - Item**
 - Extra Low-Voltage Cables, Aerial on Messenger Cable - Item**
 - Traffic Signal Cables, Aerial - Item**
 - Traffic Signal Cables, Aerial on Messenger Cable - Item**
 - Co-Axial Cables, Aerial - Item**
 - Co-Axial Cables, Aerial on Messenger Cable - Item**
 - Communication Cables, Aerial - Item**
 - Steel Messenger Cables, Aerial - Item**
 - ACSR Cables, Aerial - Item**
 - Cable Systems - Item**
 - High-Voltage Terminations and Splices - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

604.10.02

High-Voltage Cables, Direct Buried (Temporary) - Item
Low-Voltage Cables, Direct Buried (Temporary) - Item
Extra Low-Voltage Cables, Direct Buried (Temporary) - Item
Traffic Signal Cables, Direct Buried (Temporary) - Item
Co-Axial Cables, Direct Buried (Temporary) - Item
High-Voltage Cables, in Ducts (Temporary) - Item
Low-Voltage Cables, in Ducts (Temporary) - Item
Extra Low-Voltage Cables, in Ducts (Temporary) - Item
Traffic Signal Cables, in Ducts (Temporary) - Item
Co-Axial Cables, in Ducts (Temporary) - Item
Communication Cables, in Ducts (Temporary) - Item
Low-Voltage Cables, Aerial (Temporary) - Item
Low-Voltage Cables, Aerial with ACSR Neutral (Temporary) - Item
Low-Voltage Cables, Aerial on Messenger Cable (Temporary) - Item
Extra Low-Voltage Cables, Aerial (Temporary) - Item
Extra Low-Voltage Cables, Aerial on Messenger Cable (Temporary) - Item
Traffic Signal Cables, Aerial (Temporary) - Item
Traffic Signal Cables, Aerial on Messenger Cable (Temporary) - Item
Co-Axial Cables, Aerial (Temporary) - Item
Co-Axial Cables, Aerial on Messenger Cable (Temporary) - Item
Communication Cables, Aerial (Temporary) - Item
Steel Messenger Cables, Aerial (Temporary) - Item
ACSR Cables, Aerial (Temporary) - Item
High-Voltage Terminations and Splices (Temporary) - Item
Cable Systems (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

604.10.03 Rock Excavation

Payment for rock excavation shall be according to OPSS 603.

TABLE 1
High-Voltage System Testing Requirements

Voltage Rating (V)	Cable Type	Test Specification
0 - 2,000	Nonshielded	ICEA S-95-658/NEMA WC70
2,001 - 5,000	Nonshielded	ICEA S-96-659/NEMA WC71
5,000 - 46,000	Shielded	ICEA S-93-639/NEMA WC74
5,000 - 46,000	Concentric Neutral	ICEA S-94-649
5,000 - 46,000	Utility Shielded	ICEA S-97-682
600	Single Layer Thermoset Insulated Utility Underground Distribution	ICEA S-105-692
600	Ruggedized Insulated Direct Burial	ICEA S-81-570
Notes: A. The AC high-voltage test shall be according to ICEA publications, except that the applied test voltage and duration of the test shall be as specified by the power supply authority. B. The DC high-voltage test shall be according to ICEA publications, except that the applied test voltage and duration of the test shall be as specified by the power supply authority and the cumulative testing time shall not exceed the time limit specified by the power supply authority. If re-testing is required, approval and re-test voltage value shall be obtained from the power supply authority.		



CONSTRUCTION SPECIFICATION FOR GROUNDING

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609.05	MATERIALS
609.06	EQUIPMENT - Not Used
609.07	CONSTRUCTION
609.08	QUALITY ASSURANCE - Not Used
609.09	MEASUREMENT FOR PAYMENT
609.10	BASIS OF PAYMENT

609.01 SCOPE

This specification covers the requirements for the installation of electrical grounding equipment and grounding systems.

609.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous

CSA Standards

C22.2 No. 38-18 Thermoset-Insulated Wires and Cables
C22.2 No. 41-13 (R2017) Grounding and Bonding Equipment
G40.20/G40.21- 13 (R2018) General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-18 Hot Dip Galvanizing of Irregularly Shaped Articles

ASTM International

B 3-13 (R2018) Soft or Annealed Copper Wire

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

Underwriters Laboratories (UL)

UL 467-March 2013 Grounding and Bonding Equipment

Others

IEEE 837-2002 Standard for Qualifying Permanent Connections Used in Substation Grounding

609.05 MATERIALS

609.05.01 Ground Rods

Ground rods shall be solid steel, 19 mm diameter, 3 m long, copper clad for the full length and shall be according to CSA C22.2 No 41.

609.05.02 Ground Plates

Ground plates shall be hot dip galvanized solid steel, 600 x 600 x 10 mm minimum dimensions. Steel shall be according to CAN/CSA G40.20/G40.21, Grade 260W, and shall be galvanized according to CAN/CSA G164.

609.05.03 Bare Ground Wire

Bare ground wire shall be soft drawn stranded copper and shall be according to ASTM B 3.

609.05.04 Insulated Ground Wire

Insulated ground wire shall be stranded copper, insulation colour green and shall be according to CSA C22.2 No. 38, type RWU 90 - cross-link.

609.05.05 Ground Connectors

Moulded connectors shall consist of metallic alloys and fusible powder mixtures held in place by suitable moulds and connected using an exothermic type welding process. Physical requirements of the connection shall be according to CSA C22.2 No. 41.

Mechanical connectors shall be according to CSA C22.2 No. 41 or UL 467.

High pressure irreversible compression connectors shall be:

- a) Made of pure wrought copper extrusion.
- b) Made of the same material as the conductors.
- c) According to CSA 22.2 No. 41, UL 467, and IEEE 837.
- d) Connected according to the manufacturer's recommendations.
- e) Connected using a minimum compressive force of 100 kN and a minimum compressive pressure of 70 MPa.

High pressure irreversible compression connectors shall have crimp verification for the inspection and verification of CSA and UL compliance markings.

609.05.06 Solder

Solder shall be 60/40, tin/lead mix, resin core type.

609.05.07 Sand Bedding

Sand bedding shall consist of sand conforming to the gradation requirements of mortar sand according to OPSS 1004.

609.05.08 Ducts and Fittings

Ducts and fittings shall be as specified in the Contract Documents and approved according to the Ontario Electrical Safety Code.

609.07 CONSTRUCTION

609.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

All metallic components shall be connected to system ground.

All compaction shall be according to OPSS 501.

609.07.02 Removals

Removals shall be according to OPSS 610.

609.07.03 Excavation and Backfill

Earth and rock excavation and backfill shall be according to OPSS 603.

609.07.04 Ground Wire in Ducts

Ground wire shall be pulled through ducts using cable lubricant, mechanical aids, and pulling cables or ropes as required. The pulling tension shall be according to the cable manufacturer's specifications.

609.07.05 Ground Wire, Direct Buried

When ground wire crosses over direct buried cables, a minimum depth of 100 mm of sand bedding material shall be placed between the ground wire and the buried cables at the point of crossing.

When ground wire does not share a common trench with ducts or direct buried cable, the ground wire shall be installed at a minimum depth of 600 mm below finished grade.

609.07.06 Ground Wire on Poles or Open Surfaces

Ground wire installed on concrete or metal poles shall be run in rigid duct. Ground wire installed on wooden poles shall be run in protective moulding or in rigid duct. In both cases, the conduit or moulding shall be aligned in straight runs complementing the taper of the pole.

Conduit shall be mechanically fastened to wooden poles using PVC conduit clamps and galvanized lag screws. Moulding shall be mechanically fastened to wooden poles using galvanized steel staples. Stainless steel strapping shall be installed to secure conduit on concrete or metal poles.

When ground wire is to be installed on a concrete surface, the concrete shall be drilled to accommodate expandable metal anchors for nylon cable clamps held in place with stainless steel bolts. For installation on wooden surfaces, galvanized steel staples shall be installed. For installation on metal surfaces, nylon cable clamps and stainless steel screws or bolts, nuts, and washers shall be installed. The ground wire shall be installed in straight, neat lines and shall be supported at maximum intervals of 450 mm.

609.07.07 Ground Wire in Electrical Chambers or Enclosures

Ground wires in electrical chambers and enclosures shall be trained towards the structure walls with bend radii greater than the minimum recommended by the cable manufacturer. Ground wires shall be fastened with mechanical supports when required.

Ground wire in electrical chambers shall be connected to ground lugs attached to the frame. For electrical chambers with metallic covers and non-metallic frames, the ground wire shall be connected to the ground lugs attached to the cover. Ground wire in electrical enclosures shall be connected to the ground lug provided.

609.07.08 Ground Wire Connections

Ground connectors shall be used on all ground wire connections. All surfaces shall be cleaned to bare metal prior to making ground connections.

Moulded connectors or high pressure irreversible compression connectors shall be used at pad mounted electrical-electronic equipment, power supply locations, and all locations where the ground connectors are direct buried or inaccessible.

Messenger cables shall be grounded using compression connectors.

609.07.09 Coils of Ground Wire

Coiled ground wire shall be left at the locations shown in the Contract Documents. Coils shall be neatly taped and left in a safe readily accessible location.

609.07.10 Ground Electrodes

609.07.10.01 General

The installation of ground electrodes shall be according to the Ontario Electrical Safety Code.

The work for ground electrodes shall include the work to install ground rods, ground plates, and the associated work described in this specification.

When bedrock, rock fill, or similar materials unsuitable for driving ground rods are encountered at depths of 450 mm to 2.0 m below finished grade, the ground rod shall be replaced with a ground plate.

When bedrock, rock fill, or similar materials are encountered at less than 450 mm below finished grade, the ground electrode shall be installed at a different location when driving of a ground rod or installation of a ground plate is possible.

609.07.10.02 Ground Rods

Ground rods shall be driven in a vertical position when soil conditions allow. When rocks, stones, or similar materials are encountered, ground rods may be driven at a maximum angle of 45° to the vertical.

609.07.10.03 Ground Plates

Ground plates shall be installed on a minimum 150 mm thick compacted bed of suitable native earth material over rock.

609.07.11 Bonding Jumpers

The work for bonding jumpers shall include the work described for ground wire on poles or open surfaces, and ground wire connections.

609.07.12 Grounding Systems

The work included shall be as described for ground wires, ground electrodes, and bonding jumpers.

609.07.13 Quality Control

609.07.13.01 Pre-Installation Testing and Inspection

Grounding cables, bonding jumpers, ground electrodes, and connection components are to be inspected prior to and during installation to ensure that they meet the requirements of the Contract Documents.

609.07.13.02 Proof of Performance Testing and Inspection

All system and components grounding shall be inspected and tested to ensure that they meet the requirements of the Contract Documents. All electrical grounding connections and splices shall be inspected to ensure they have been properly installed.

At pad and pole mounted power supply locations, the resistance to ground of the grounding grid shall be tested and measured in the presence of the Contract Administrator. A written notice shall be submitted to the Contract Administrator five Business Days prior to the testing with the date, time and location for each testing.

The measurements shall be undertaken under dry soil conditions and when frost penetration does not exceed 150 mm. Readings shall not exceed 25 ohms. In soils of low conductivity, additional ground rods, ground plates, and ground wires shall be added, as required. Copies of all test documentation shall be submitted to the Contract Administrator.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the proof of performance testing and inspection.

The next operation after the proof of performance testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

609.07.14 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

609.07.15 Restoration

Site restoration shall be according to OPSS 492.

609.07.16 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

609.09 MEASUREMENT FOR PAYMENT

609.09.01 Actual Measurement

609.09.01.01 Ground Wires

Measurement for ground wire shall be by length in metres horizontally along the longitudinal axis of the duct or trench, or open surface, from centre to centre of poles, pole footings, electrical chambers, or enclosures; sign footings; controller cabinet pads, and ground electrodes; or the face of bridge structures, retaining walls, and substation pads.

609.09.01.02 Ground Electrodes

For measurement purposes, a count shall be made of the number of ground electrodes installed.

609.09.01.03 Bonding Jumpers

For measurement purposes, a count shall be made of the number of bonding jumpers installed.

609.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

609.10 BASIS OF PAYMENT

**609.10.01 Ground Wires - Item
Ground Electrodes - Item
Bonding Jumpers - Item
Grounding Systems - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

609.10.02 **Ground Wires (Temporary) - Item**
 Ground Electrodes (Temporary) - Item
 Bonding Jumpers (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal

609.10.03 **Rock Excavation for Electrical Installation**

Payment for rock excavation for electrical installation shall be according to OPSS 603.



CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS

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610.01	SCOPE
610.02	REFERENCES
610.03	DEFINITIONS - Not Used
610.04	DESIGN AND SUBMISSION REQUIREMENTS
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610.08	QUALITY ASSURANCE - Not Used
610.09	MEASUREMENT FOR PAYMENT - Not Used
610.10	BASIS OF PAYMENT

APPENDICES

610-A	Commentary

610.01 SCOPE

This specification covers the requirements for demolition, salvage, and removal, either completely or partially, of electrical equipment and materials.

610.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

610.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

610.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipes, Utilities, and Associated Structures
OPSS 510	Removal

610.04 DESIGN AND SUBMISSION REQUIREMENTS

610.04.01 Submission Requirements

610.04.01.01 Operations Plans

An operations plan shall be submitted to the Contract Administrator a minimum of 3 weeks prior to the commencement of polychlorinated biphenyl (PCB) related activities. The plan shall describe the overall approach to the work and include the following:

- a) Operational methodologies.
- b) Work area delineation and security details.
- c) Environmental impact management, such as spill prevention and containment and emergency response plan.
- d) Contamination control.

- e) Equipment and area decontamination procedures.
- f) Ontario Ministry of the Environment and Climate Change (MOECC) Compliance Approval numbers as applicable for transportation and transfer facilities.

PCB wastes and PCB related wastes to be moved to a transfer facility shall be included in the operations plan with details regarding their eventual transport to a disposal facility for destruction.

610.07 CONSTRUCTION

610.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Demolition, salvage, and removal of electrical equipment and materials shall be as specified in the Contract Documents.

The Contractor shall acquire all releases and agreements necessary to do the work.

610.07.02 Timing of Work

Existing electrical systems required to continue in-service shall remain functional during construction operations until new or modified systems are operational.

610.07.03 Removal

Removal of non-electrical material and objects required for the removal of electrical equipment and material shall be according to OPSS 510.

Electrical concrete structures shall be removed to a minimum of 1.0 m below finished grade.

Where partial removal of pavement, sidewalk, curb and gutter, or other structures is required for removal of electrical equipment, the broken edges of the object to remain in place shall be squared up and trimmed along straight lines at a minimum distance of 300 mm from any area disturbed by removal operations.

Steel reinforcement, conduits, ducts, wires, and debris associated with the removed portions of such structures shall be removed for disposal.

610.07.04 Demolition

Demolition of concrete, brick, timber, and masonry structures, including pole footings, equipment pads, concrete poles, and substation buildings shall be carried out in such a manner and with such equipment as not to disturb adjacent pavement, Utilities, other works, or electrical equipment and material to remain in place and with such care as to leave material designated to be salvaged in an undamaged condition.

610.07.05 Luminaires

Prior to removing luminaires, all lamps and glass shall be removed.

610.07.06 Cables and Conduits

Underground cables shall be completely removed and conduit systems shall be cut back to a depth of 600 mm below finished grade and abandoned in place.

610.07.07 Transformers

Transformers containing PCBs, including all internal components, and all PCB related wastes shall be removed and managed as subject waste as specified in the Contract Documents.

Transformers not containing PCBs shall be removed, salvaged, and transported to storage sites specified in the Contract Documents.

610.07.08 Temporary Installations

Equipment and materials supplied by the Contractor for use with temporary installations shall be removed. Equipment and materials supplied by the Owner for use with temporary installations shall be removed and salvaged as specified in the Contract Documents.

610.07.09 Salvage of Equipment

610.07.09.01 Damages

Prior to removal operations, the Contract Administrator shall be notified of any equipment that is broken or deteriorated to the point where salvage is not practical.

Equipment and materials damaged through improper handling or through loss after removal shall be repaired or replaced at no additional cost to the Owner.

610.07.09.02 Packaging of Electrical Equipment and Materials

Electrical equipment and materials that has been removed shall be packed for protection against damage.

All equipment or material in excess of 100 kg shall be securely mounted on wooden pallets suitable for handling by forklift trucks.

610.07.09.03 Shipping of Salvaged Electrical Equipment and Materials

All salvaged equipment and materials shall be loaded, transported, and unloaded at the sites specified in the Contract Documents.

Delivery to any Owner unloading sites shall be made between 09:00 and 15:30, local time. The Contract Administrator shall be notified 3 Business Days in advance of delivery to the Owner's unloading sites.

610.07.10 Quality Control

610.07.10.01 Pre-Removal Testing and Inspection

Components specified for removal shall be inspected prior to removal. If the components are to be salvaged for reuse within the Working Area or for storage at the Owner's premises, the Contractor shall make a list of any imperfections of those components and shall submit the list to the Contract Administrator 3 Business Days prior to the commencement of removal.

610.07.10.02 Proof of Performance Testing and Inspection

The removal work shall be inspected to ensure that all electrical removals have been carried out and that all components requiring disposal at approved sites have been completed so that no such materials remain on the Owner's lands.

610.07.11 Site Restoration

Site restoration shall be according to OPSS 492.

610.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

610.10 BASIS OF PAYMENT

610.10.01 Removal of Electrical Equipment - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Work required to salvage and transport liquid type transformers shall be administered as a Change in the Work.

Appendix 610-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF UNDERPASS LUMINAIRES

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611.04	DESIGN AND SUBMISSION REQUIREMENTS
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611.07	CONSTRUCTION
611.08	QUALITY ASSURANCE - Not Used
611.09	MEASUREMENT FOR PAYMENT
611.10	BASIS OF PAYMENT

611.01	SCOPE

This specification covers the requirements for the installation, replacement, and relamping of underpass luminaires.

611.02	REFERENCES

This specification refers to the following standards, specifications, and publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 604	Cable Installation
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 2434	Underpass Luminaires

CSA Standards

C22.2 No. 49-10	Flexible Cords and Cables
C22.2 No. 248.8-11	Low-Voltage Fuses - Part 8: Class J Fuses
C22.2 No. 65-13	Wire Connectors
C22.2 No. 197-M1983 (R2008)	PVC Insulating Tape
C22.2 No. 227.2.1-04 (R2009)	Liquid-Tight Flexible Nonmetallic Conduit
G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles

American National Standards Institute (ANSI)

C78.380-2007	Electric Lamps - High Intensity Discharge Lamps, Method of Designation

Illuminating Engineering Society of North America (IESNA)

LM-63-02	Standard File Format for Electronic Transfer of Photometric Data and Related Information
LM-79-08	Electrical and Photometric Measurements of Solid-State Lighting Products

611.04 DESIGN AND SUBMISSION REQUIREMENTS

611.04.01 Submission Requirements

A photometric test report shall be submitted for each photometric curve used in the luminaires to be installed under the Contract. The testing and test reports for high intensity discharge (HID) luminaires (e.g., high pressure sodium) shall be according to IESNA LM-63. The testing and test reports for LED luminaires shall be according to IESNA LM-79. The testing and test reports shall be completed by an independent laboratory or a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory, which is accredited for testing the type of luminaire to be installed under the Contract (i.e., accredited for IESNA LM-63 for HID luminaires or IESNA LM-79 for LED luminaires). Each test report shall be dated and signed. The test reports shall be submitted to the Contract Administrator prior to the commencement of fabrication.

611.05 MATERIALS

611.05.01 Luminaires

Underpass luminaires shall be according to OPSS 2434 and the Contract Documents.

611.05.02 Lamps

Lamps shall be clear or coated as specified in the Contract Documents and shall meet the requirements of ANSI C78.380.

611.05.03 Low-Voltage Cables

Single conductor low-voltage cables for use in conduit systems shall be according to OPSS 604.

Low-voltage cable for entry to luminaires shall be single conductor stranded copper and shall be according to CSA C22.2 No. 49, Type GTF.

611.05.04 Wire Connectors

Wire connectors shall be of the insulated spring or compression type and shall be according to CAN/CSA C22.2 No. 65.

611.05.05 Ground Wire

Ground wire shall be Type GTF.

611.05.06 Fuses

Fuses shall be according to CSA C22.2 No. 248.8, 600V, 10 amps rating.

611.05.07 Ducts and Fittings

Non-metallic flexible liquid-tight ducts and connectors shall be according to CAN/CSA C22.2 No. 227.2.1.

611.05.08 Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197 rated for 600 V and -10 to 90 °C working temperature.

611.05.09 Luminaire Mounting Brackets

Luminaire brackets shall be steel according to CSA G40.20/G40.21, Grade 260W, and shall be hot dip galvanized according to CSA G164.

Welding of members shall be carried out according to CSA W59.

611.05.10 Protective Guard

The luminaires shall be supplied with the luminaire manufacturer's protective guard as specified in the Contract Documents.

611.07 CONSTRUCTION

611.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

The work for the installation, replacement, or relamping of the luminaires shall include all required hardware and fixtures to ensure operation of the unit.

611.07.01.01 Ordering Luminaires

Immediately following the award of the Contract, the Contractor shall order the luminaires as required for this Contract.

The Contractor shall obtain verification of the delivery dates of the luminaires from the supplier and notify the Contract Administrator of the delivery dates within 72 hours after the award of the Contract.

The Contractor shall ensure timely and accurate communication with both the Owner and the supplier regarding the delivery, schedules, and requirements for the luminaires.

Delivery and off-loading of the luminaires shall be completed in a timely and efficient manner.

611.07.02 Removals

Removals shall be according to OPSS 610.

611.07.03 Surface-Mounted Ducts

Non-metallic, flexible, liquid-tight ducts and connectors shall be used for connecting the underpass luminaires to the closest junction boxes as specified in the Contract Documents.

Surface-mounted ducts shall be installed according to OPSS 603.

611.07.04 Luminaire Mounting Brackets

When specified in the Contract Documents, the luminaries shall be installed on mounting brackets.

Luminaire mounting brackets shall be fastened to concrete surfaces by drilling and inserting metal expansion anchors and securing the bracket with 10 mm diameter stainless steel machine bolts and lock washers.

Luminaire mounting brackets shall be fastened to steel structural members as specified in the Contract Documents, using stainless steel hardware.

The luminaire mounting bracket shall be fastened to the surfaces to allow the level installation of the luminaire.

611.07.05 Wiring

Wiring shall be installed according to OPSS 604. Each luminaire shall be individually protected with a fuse. The fuse shall be located either in the junction box or in the luminaire. All connectors shall be insulated and secured with tape.

Each luminaire shall be wired with Type GTF conductors connected to the ballast leads with insulated spring connectors secured with tape. GTF conductors shall be connected to the underpass lighting circuits in the junction box with insulated spring connectors secured with tape.

611.07.06 Grounding

Underpass luminaires shall be connected to the system ground according to OPSS 609.

611.07.07 Installation of Luminaires

Luminaires shall be protected from conditions where moisture or dirt could damage the ballasts or reflecting surfaces of the optical system.

Luminaires shall be mounted on concrete surfaces specified in the Contract Documents by drilling and inserting metal expansion anchors and securing the luminaires with 10 mm diameter stainless steel machine bolts, lock washers, and PVC spacers.

Luminaires shall be mounted on the steel structural members specified in the Contract Documents, using stainless steel hardware.

All underpass luminaires are to be installed level using stainless steel hardware.

The luminaire reflector and refractor shall be thoroughly cleaned prior to installing lamps.

The wire guard and housing hardware shall be securely fastened in place.

611.07.08 Replacing Luminaires

When specified in the Contract Documents, existing luminaires, associated flexible conduit, and wiring shall be removed and new luminaires, associated flexible conduit, fittings, and wiring shall be installed.

When new luminaires are of a different style than the existing luminaires, new concrete anchors or mounting hardware shall be installed.

611.07.09 Relamping

Existing lamps shall be removed, the luminaires thoroughly cleaned, and new lamps installed.

611.07.10 Quality Control

611.07.10.01 Pre-Installation Testing and Inspection

Luminaires, brackets, socket setting, refractor type, and ballast type shall be inspected to ensure they meet the requirements of the Contract Documents.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the pre-installation testing and inspection.

The next operation after the completion of the pre-installation testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

611.07.10.02 Proof of Performance Testing and Inspection

Luminaires shall be inspected and tested to ensure that they meet the requirements of the Contract Documents. All luminaires shall undergo a minimum burning-in period of 100 consecutive nighttime hours prior to acceptance of the work by the Contract Administrator. For daytime tunnel illumination systems, the burning-in period shall be 100 consecutive daytime hours.

Low-voltage system tests required on the wiring system shall be performed according to OPSS 604.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the proof of performance testing and inspection.

The next operation after the completion of the proof of performance testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

611.07.11 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

611.07.12 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

611.09 MEASUREMENT FOR PAYMENT

611.09.01 Actual Measurement

**611.09.01.01 Underpass Luminaires
LED Underpass Luminaires**

For measurement purposes, a count shall be made of the number of underpass luminaires installed.

**611.09.01.02 Replace Underpass Luminaires
Replace LED Underpass Luminaires**

For measurement purposes, a count shall be made of the number of underpass luminaires replaced.

611.09.01.03 Relamp Underpass Luminaires

For measurement purposes, a count shall be made of the number of underpass luminaires relamped.

611.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

611.10 BASIS OF PAYMENT

**611.10.01 Underpass Luminaires - Item
LED Underpass Luminaires - Item
Replace Underpass Luminaires - Item
Replace LED Underpass Luminaires - Item
Relamp Underpass Luminaires - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract prices and according to the specifications for such work.

**611.10.02 Underpass Luminaires, Temporary - Item
LED Underpass Luminaires, Temporary - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments for temporary installation of the above tender item shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF POWER SUPPLY EQUIPMENT

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614.01	SCOPE

This specification covers the requirements for the installation of distribution assemblies and supply control cabinet assemblies.

614.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 616	Footings and Pads for Electrical Equipment

Ontario Provincial Standard Specifications, Material

OPSS 2414	Power Supply Equipment
OPSS 2485	Photoelectric Controllers

Electrical Safety Authority (ESA)

Ontario Electrical Safety Code

614.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Service Box means an approved assembly consisting of an enclosure designed and constructed so that it can be effectually locked or sealed, contain either service fuses and a service switch or a circuit breaker, and allow the switch or circuit breaker to be manually operated.

614.04 DESIGN AND SUBMISSION REQUIREMENTS

614.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator:

- a) Actual breakdown cost of Utility work, such as hook up, transformation, etc.
- b) Utility company contact person's name, title, address, and telephone and mobile phone numbers.

Working drawings shall be submitted according to OPSS 2414.

A Manufacturer's Certificate of Conformance and Request to Proceed shall be submitted to the Contract Administrator upon completion of the fabrication of the power supply equipment.

The power supply equipment shall not be delivered to the site until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

614.05 MATERIALS

614.05.01 Distribution Assemblies

Distribution assemblies shall be according to OPSS 2414 and the Contract Documents.

614.05.02 Supply Control Cabinet Assemblies

Supply control cabinet assemblies shall be according to OPSS 2414 and the Contract Documents.

Supply control cabinet assemblies shall include an Arc Flash and Shock Hazard warning label according to Figure 1. The warning sign shall be prominently displayed on the outside of each exterior door. The Contractor shall enter the location information in Figure 1 as indicated by the local MTO electrical coordinator.

The AC arc flash analysis and results in Figure 1 are applicable to ministry highway electrical systems with the following characteristics:

- a) Single phase.
- b) Nominal system voltage of 240 VAC or less.

- c) Continuous current rating of main breaker of 100 A or less.
- d) Size of upstream transformer of 100 kVA or less.
- e) Condition of electrical plant shall be in good condition and well maintained.

614.05.03 Service Boxes

Non-metallic enclosures for service boxes shall be certified or approved and marked Suitable for Use as Service Equipment.

614.05.04 Photoelectric Controllers

Photoelectric controllers shall be according to OPSS 2485.

614.05.05 Cables and Cable Connectors

Cables and cable connectors shall be according to OPSS 604.

614.05.06 Grounding Materials

Grounding materials shall be according to OPSS 609.

614.05.07 Conduit and Fittings

Rigid ducts and fittings shall be according to OPSS 603.

614.07 CONSTRUCTION

614.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Concrete pads shall be according to OPSS 616 and as specified in the Contract Documents.

614.07.02 Distribution Assemblies

Equipment enclosures shall be installed squarely and symmetrically on concrete pads.

A neoprene gasket shall be attached squarely and symmetrically on the bottom base H-beam of the enclosure prior to installation. Base H-beam anchor bolts shall be secured in place at locations specified in the Contract Documents.

614.07.03 Supply Control Cabinet Assemblies

Supply control cabinet assemblies shall be mounted securely on poles using stainless steel strapping.

Rigid ducts and fittings shall be installed on wooden poles using two-hole galvanized pipe straps one trade size larger with galvanized lag screws and on metal or concrete poles using stainless steel strapping, at intervals specified in the Ontario Electrical Safety Code. The conduit system shall be installed in straight lengths to follow the taper of the pole. Offset bends, meter hubs, terminal adapters, and fittings shall be used when required to avoid pole attachments and be kept free of kinks or scorch marks.

When specified in the Contract Documents, a meter socket, acceptable to the power supply authority, shall be installed.

614.07.04 Cables and Fuses

Cables, terminations, and connections shall be installed according to OPSS 604. Service cables from the point of service connection to the main disconnecting means shall be installed according to the Ontario Electrical Safety Code and the requirements of the power supply authority.

Only high-voltage fuses that have a current rating approved by the power supply authority shall be installed.

614.07.05 Grounding

All grounding work shall be according to OPSS 609.

All concrete pad mounted equipment shall be bonded by means of bonding jumpers connected between the equipment ground bus and the exterior ground grid. Lightning arrestors shall have the ground cable connected securely to the equipment ground bus. The neutral bus of the main disconnecting means or the secondary neutral terminal of the transformer shall be grounded.

The system ground wire and the service ground wire shall be connected to the neutral bus in supply control cabinet assemblies.

614.07.06 Photoelectric Controllers

614.07.06.01 General

Photo-conductive cell windows shall be set to face in a northerly direction and away from any nearby light sources.

614.07.06.02 Distribution Assemblies

Photoelectric controllers shall be installed according to the Contract Documents.

614.07.06.03 Supply Control Cabinet Assemblies

Photoelectric controllers shall be installed on poles with twist lock mounting sockets and brackets. Brackets shall be mounted on metal or concrete poles with stainless steel strapping or on wooden poles with galvanized lag screws.

614.07.07 Quality Control

614.07.07.01 Pre-Installation Testing and Inspection

Power supply equipment shall be inspected prior to installation to ensure that it meets the requirements of the Contract Documents. A visual inspection of all the power supply equipment shall be performed prior to its delivery. The following components shall be inspected to ensure that they meet the requirements of the Contract Documents:

a) Barriers and raceways	k) Grounding connections
b) Breakers	l) Insulation
c) Cabinet materials	m) Labels

d) Conduits and tubings	n) Lightning arrestors
e) Contactors	o) Panelboards
f) Disconnect switches	p) Photoelectric controllers
g) Doors and latching mechanisms	q) Switches
h) Enclosure materials	r) Transformers
i) Cabinet general appearance	s) Wires and connectors
j) Grounding and bonding materials	

A Request to Proceed shall be submitted to the Contract Administrator after completion of the pre-installation testing and inspection.

The next operation after the completion of the pre-installation testing shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

614.07.07.02 Proof of Performance Testing and Inspection

The installed power supply equipment shall be inspected and tested. All components listed under the Pre-Installation Testing and Inspection clause shall be inspected. Low voltage system tests shall be performed on wiring of the equipment according to OPSS 604. Grounding of equipment shall be tested according to OPSS 609.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the proof of performance testing and inspection.

The next operation after the completion of the proof of performance testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

614.07.08 As Constructed Drawings

In the event changes to the accepted Working Drawings are necessary, as constructed drawings bearing the stamp and signature of an Engineer shall be submitted to the Contract Administrator.

614.07.09 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

614.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

614.09 MEASUREMENT FOR PAYMENT

614.09.01 Actual Measurement

**614.09.01.01 Distribution Assemblies
Supply Control Cabinet Assemblies**

For measurement purposes, a count shall be made of the number of assemblies installed.

614.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

614.10 BASIS OF PAYMENT

**614.10.01 Distribution Assemblies - Item
Supply Control Cabinet Assemblies - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

**614.10.02 Distribution Assemblies, Temporary - Item
Supply Control Cabinet Assemblies, Temporary - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, Material to do the work.

Progress payment for temporary installation of the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal

Additional payment shall not be made for the electrical energy and service required to do the work.

Figure 1
Arc Flash and Shock Hazard Warning Label

	
Arc Flash and Shock Hazard	
Location: _____	
Arc Flash	Shock
Working distance: 460 mm (19 inches)	Nominal system voltage: 240 VAC
Incident energy: 2.1 cal/cm ²	Limited approach: 1000 mm (40 inches)
Arc Flash Boundary: 635 mm (26 inches)	Restricted approach: 300 mm (12 inches)
Minimum PPE Requirements: PPE according to CSA Z462 Arc Flash PPE Category 2	
Analysis Date: October 2015	



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF POLES

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615.01 SCOPE

This specification covers the requirements for the installation of poles used for the mounting of lighting equipment, traffic signals and control equipment, low-voltage aerial cables, and extra low-voltage aerial cables.

615.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

615.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

615.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Material and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 2420	Wood Poles
OPSS 2421	Spun Concrete Poles
OPSS 2422	Heavy Class Steel and Sectional Steel Poles, Base Mounted
OPSS 2423	Steel Poles, Base Mounted
OPSS 2452	Aluminum Poles, Base Mounted
OPSS 2453	Sectional Steel Poles

CSA Standards

C83-96 (R2011)	Communication and Power Line Hardware
G12-14	Zinc Coated Steel Wire Strand

Others

Ontario Electrical Safety Code

615.05 MATERIALS

615.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

615.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

615.05.03 Poles

Concrete poles shall be according to OPSS 2421.

Steel poles for base mounting shall be according to OPSS 2423.

Aluminum poles for base mounting shall be according to OPSS 2452.

Sectional steel poles for direct burial or base mounting shall be according to OPSS 2453. Where sectional steel poles have heights not listed in OPSS 2453, the sectional steel poles shall be according to OPSS 2453 in all other respects.

Wooden poles shall be according to OPSS 2420.

Heavy class steel poles and heavy class sectional steel poles shall be according to OPSS 2422. This class is required for poles with mast arms longer than 5.5 m.

Heavy class steel sectional poles and heavy class steel poles of the same height may be substituted for one another provided that the poles are fully compatible with the installation and all other associated work is according to the Contract Documents.

615.05.04 Frangible Bases

Frangible bases shall be as specified in the Contract Documents.

615.05.05 Pole Hardware and Accessories

Pole line hardware shall be according to CSA C83.

Steel guy cable shall be according to CAN/CSA G12.

Guy anchors shall be of the helical power driven or direct buried expandable type with a minimum diameter of 250 mm and a minimum anchor rod ultimate strength of 50 kN.

The hardware and accessories for wood pole anchors installed in rock shall be according to Table 1.

615.07 CONSTRUCTION

615.07.01 General

The general requirements for electrical work shall be as specified in the Contract Documents.

Concrete, wooden, and metal poles shall be installed at locations specified in the Contract Documents.

All compaction shall be according to OPSS 501.

Grounding of poles shall be according to OPSS 609 and the Contract Documents.

615.07.01.01 Pole Orientation

Concrete and metal poles shall be installed with the handhole location on the pole as specified in the Contract Documents and such that the top wiring aperture is at right angles to the centreline of the road being served.

615.07.01.02 Pole Handling

Poles shall be handled using suitable non-abrasive slings at the pole pick up points as specified by the pole manufacturer.

615.07.01.03 Removals

Removals shall be according to OPSS 610.

615.07.02 Sectional Steel Poles

615.07.02.01 Assembly

Sectional steel poles shall be assembled in order of section number, taper, and diameter. Sections with wiring apertures shall be set with consideration given to the handhole location.

All sections shall be assembled by compression according to the manufacturer's instructions such that each section meets the normal overlap limits marked on the pole or refusal. Seam welds shall be slightly offset during assembly. The finished length of the pole shall be less than or equal to the nominal pole length.

Pole lengths of 5.64 m or more shall be assembled using three self-tapping screws or impact inserted pins. Screws and pins shall be installed in the overlap of all sections below the signal bracket so that they are spaced equally around the pole.

615.07.03 Direct Buried Poles

615.07.03.01 Installation in Earth

Excavation shall be by auger or by other suitable means to obtain a hole large enough to accommodate concrete encasement and backfill. Where the excavation extends beyond the neat limits specified in the Contract Documents, and, where concrete encasement is specified in the Contract Documents, concrete may be placed to the undisturbed earth or the encasement may be formed with the remainder of the backfill made up of native material.

615.07.03.02 Installation in Rock

Where rock is encountered, the method of installation shall be chosen from those specified in the Contract Documents and be based on the depth of rock below finished grade. Each method of installation in rock shall be approved by the Contract Administrator prior to construction.

Rock anchors, bolts for rock mounts, and steel dowel bars shall be installed in drilled holes and grouted in place with non-shrink grout. Poles shall be cut off at the top end to provide the correct top of pole elevation. Wooden poles that have been cut off shall have the ends treated with preservative according to the pole manufacturer's specifications.

Concrete levelling pads, concrete backfill up to the top of the rock grade, and formed concrete encasement shall be placed according to OPSS 904.

Native or imported earth material shall be used as backfill above or around the concrete encasement and compacted.

Rock excavation shall be according to OPSS 603.

615.07.03.03 Pole Alignment

Direct buried poles shall be held plumb by using a suitable temporary support assembly during concrete setting time and during backfilling operations.

615.07.04 Base Mounted Poles

615.07.04.01 Preparation

Anchorage templates shall be removed prior to installation of poles and frangible bases.

All studs, bolts, and nuts shall be cleaned and coated with white lithium-based grease.

615.07.04.02 Installation of Frangible Bases

When frangible bases are specified in the Contract Documents, they shall be installed according to manufacturer's specifications.

615.07.04.03 Pole Installation

When specified in the Contract Documents, poles shall be installed on frangible bases.

Poles shall be set plumb.

615.07.05 Apertures

Drilled apertures shall be accurately aligned to suit pole attachments or equipment. Wiring apertures in metal poles shall be provided with rubber grommets. Apertures in metal poles shall be deburred, and in galvanized steel poles, be coated with grey zinc-rich paint and allowed to dry before placing rubber grommets in them.

Unused pole apertures shall be plugged with rubber, neoprene, or plastic plugs.

615.07.06 Guy Anchors

Guy anchors and associated hardware shall be installed as specified in the Contract Documents and the Ontario Electrical Safety Code. Anchorage plates shall be installed at the specified guy lead distance and

adjusted to remain clear of any existing guy anchors by a minimum distance of 600 mm and then backfilled with native material and compacted.

Guy anchors shall be installed with single or double guy cable sets as specified in the Contract Documents.

All guy cables shall be installed to a snug condition prior to aerial cable stringing and readjusted upon completion to maintain poles in a plumb position.

Guy cables shall be tightened to maintain pole alignment and aerial cable clearances.

615.07.07 Quality Control

615.07.07.01 Pre-Installation Testing and Inspection

Poles shall be inspected for any obvious flaws, prior to installation.

Heavy class steel and sectional steel poles shall be certified that they are according to the supplier's design and drawings as specified in OPSS 2422. The certification shall reference the supplier's drawing numbers.

Sectional steel poles shall be certified that they are according to the supplier's design and drawing numbers as specified in OPSS 2453. The certification shall reference the supplier's drawing numbers.

615.07.07.02 Proof of Performance Testing and Inspection

The work of pole installation shall be inspected to ensure that it is according to the Contract Documents. The inspection shall ensure that:

- a) Poles and appurtenances have been properly installed.
- b) Poles are plumb.
- c) Anchorage assemblies and frangible bases are installed correctly.

615.07.08 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

615.07.09 Site Restoration

Site restoration shall be according to OPSS 492.

615.07.10 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

615.09 MEASUREMENT FOR PAYMENT

615.09.01 Actual Measurement

615.09.01.01 Poles

For measurement purposes, a count shall be made of the number of poles installed regardless of the type and size of the poles, and shall include any frangible bases and guy anchors installed with the poles.

615.09.01.02 Sectional Steel Poles, Direct Buried in Earth

For measurement purposes, a count shall be made of the number of sectional steel poles direct buried in earth.

615.09.01.03 Concrete Poles, Direct Buried in Earth

For measurement purposes, a count shall be made of the number of concrete poles direct buried in earth.

615.09.01.04 Wooden Poles, Direct Buried in Earth

For measurement purposes, a count shall be made of the number of wooden poles direct buried in earth.

615.09.01.05 Sectional Steel Poles, Direct Buried in Rock

For measurement purposes, a count shall be made of the number of sectional steel poles direct buried in rock.

615.09.01.06 Concrete Steel Poles, Direct Buried in Rock

For measurement purposes, a count shall be made of the number of concrete poles direct buried in rock

615.09.01.07 Wooden Poles, Direct Buried in Rock

For measurement purposes, a count shall be made of the number of wooden poles direct buried in rock.

615.09.01.08 Sectional Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted sectional steel poles installed.

615.09.01.09 Heavy Class Sectional Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted heavy class sectional steel poles installed.

615.09.01.10 Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted steel poles installed.

615.09.01.11 Heavy Class Steel Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted heavy class steel poles installed.

615.09.01.12 Aluminum Poles, Base Mounted

For measurement purposes, a count shall be made of the number of base mounted aluminum poles installed.

615.09.01.13 Frangible Bases

For measurement purposes, a count shall be made of the number of frangible bases installed.

615.09.01.14 Guy Anchors

For measurement purposes, a count shall be made of the number of guy anchors installed, regardless of the size and type.

615.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

615.10 BASIS OF PAYMENT

615.10.01 Poles - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Materials to do the work.

615.10.02 **Sectional Steel Poles, Direct Buried in Earth - Item**
Concrete Poles, Direct Buried in Earth - Item
Wooden Poles, Direct Buried in Earth - Item
Sectional Steel Poles, Direct Buried in Rock - Item
Concrete Poles, Direct Buried in Rock - Item
Wooden Poles, Direct Buried in Rock - Item
Sectional Steel Poles, Base Mounted - Item
Heavy Class Sectional Steel Poles, Base Mounted - Item
Steel Poles, Base Mounted - Item
Heavy Class Steel Poles, Base Mounted - Item
Aluminum Poles, Base Mounted - Item
Frangible Bases - Item
Guy Anchors - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

615.10.03 **Sectional Steel Poles, Direct Buried in Earth (Temporary) - Item**
Concrete Poles, Direct Buried in Earth (Temporary) - Item
Wooden Poles, Direct Buried in Earth (Temporary) - Item
Sectional Steel Poles, Direct Buried in Rock (Temporary) - Item
Concrete Poles, Direct Buried in Rock (Temporary) - Item
Wooden Poles, Direct Buried in Rock (Temporary) - Item
Sectional Steel Poles, Base Mounted (Temporary) - Item
Steel Poles, Base Mounted (Temporary) - Item
Aluminum Poles, Base Mounted (Temporary) - Item
Frangible Bases (Temporary) - Item

Guy Anchors (Temporary) - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

Progress payment for the above tender items shall be based on the following percentages of the Contract price:

- a) 80% for supply and installation.
- b) 20% for removal.

615.10.04 Rock Excavation

Payment for rock excavation shall be according to OPSS 603.

Rock excavation shall not include holes drilled in rock for the placement of steel dowel bars.

TABLE 1
Hardware and Accessories for Wood Pole Anchors in Rock

Manufacturer	Product Identity	Model	Assembly #	Product Notes
Locweld Inc 50 Iberville Candiac, QC J5R 1J5 Tel: 450.659.9661 Fax: 450.444.3111 OR 2159 Vincent Massey Drive P.O. Box 1900 Cornwall, Ontario, K6H 6N6 Tel: 613.936.9190 Fax: 613.936.9217 Email: sales @locweld.ca Homepage: www.locweld.ca Canadian Source: Poltec Industries Ltee 10, 440 Henault, Montreal, QC H1G 5R4 Tel: 514.326.6030 Fax: 514.326.9923	Anchor for Pole Butt Diameter 200 to 305 mm	P-9UT	Assembly 9-3 for 3 Anchor Configuration	Rock Drill 50 mm. Use drilling template for 3- Anchor Configuration.
	Anchor for Pole Butt Diameter 280 to 406 mm	P-9UT	Assembly 9-4 for 4 Anchor Configuration	Rock Drill 50 mm. Use drilling template for 4- Anchor Configuration
	Anchor for Pole Butt Diameter 355 to 508 mm	P-9UT	Assembly 9-5 for 5 Anchor Configuration	Rock Drill 50 mm. Use drilling template for 5- Anchor Configuration



CONSTRUCTION SPECIFICATION FOR FOOTINGS AND PADS FOR ELECTRICAL EQUIPMENT

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616.01 SCOPE

This specification covers the requirements for the installation of footings and pads required for mounting electrical equipment.

616.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1308	Joint Filler in Concrete
OPSS1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

G40.20/G40.21-13	General Requirements for Rolled or Welded Steel/Structural Quality Steel/Structural Quality Steel
G164-M92 (R2003)	Hot Dip Galvanizing of Irregularly Shaped Articles
W59-13	Welded Steel Construction (Metal Arc Welding)

ASTM International

A 53/A 53M-12	Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded, and Seamless
A 193/A 193M-17	Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Services and Other Special Purpose Applications
A 563M-15	Carbon and Alloy Steel Nuts

American National Standards Institute (ANSI)

B18.22.1-1965 (R2008) Plain Washers

Society of Automobile Engineers (SAE)

J403 - Dec 2014 Chemical Composition of SAE Carbon Steels

616.05 MATERIALS

616.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

616.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

616.05.03 Granular Material

Granular materials shall be Granular A or B according to OPSS 1010.

616.05.04 Ducts and Fittings

Ducts and fittings shall be according to OPSS 603.

616.05.05 Anchorage Assemblies and Hardware

All steel components shall be hot dipped galvanized according to CAN/CSA G164.

616.05.05.01 Anchor Assembly Struts

Anchor assembly struts shall be grade SAE 1030 steel according to SAE J403.

616.05.05.02 Studs, Nuts, and Washers

Studs shall be grade SAE C1541 steel according to SAE J403, high tensile stress proof with a yield strength of 690 MPa, and a tensile strength of 860 MPa.

Hex nuts shall be steel grade B steel according to ASTM A 563.

Washers shall be according to ANSI B18.22.1.

616.05.05.03 Ferrules

Steel ferrules shall be grade AISI C12L14 rotoprobed bar according to SAE J403.

616.05.06 Steel Footings and Hardware

Steel footings and hardware shall be grade SAE 1020 steel according to SAE J403.

Steel top plates and steel equipment base plate shall be according to CSA G40.20/G40.21, Grade 260WT minimum.

Steel for footing shafts smaller than 150 mm in diameter shall be according to ASTM A 53.

Steel for footing shafts 150 mm and larger in diameter shall be hollow structural sections according to CSA G40.20/G40.21, Grade 350 W minimum.

Welding of the top plate shall be according to CSA W59 minimum.

Steel footings, steel equipment base plate, and mounting hardware shall be hot dip galvanized according to CSA G164.

Stainless steel bolts, nuts, and flat washers shall be according to ASTM A 193.

616.05.07 H-Section Assemblies and Hardware

H-section assemblies and hardware shall be grade SAE 1020 steel according to SAE J403.

Steel plate for H-section and the H-section shall be according to CSA G40.20/G40.21, Grade 260WT minimum.

H-section shall be HP200x54.

All welding shall be according to CSA W59 minimum.

H-section anchorage assemblies and mounting hardware shall be hot dip galvanized according to CAN/CSA G164.

616.05.08 Joint Filler

Expansion joint filler shall be type A or B according to OPSS 1308.

616.05.09 Grout

Grout shall consist of a mixture of one part Portland cement according to OPSS 1301 and two parts mortar sand according to OPSS 1004, wetted with sufficient water to make the mixture plastic. Water shall be according to OPSS 1302.

616.05.10 Wooden Pads

Wooden pads for controller cabinet shall be as specified in the Contract Documents.

616.06 EQUIPMENT

Equipment for the installation of steel footings shall be according to the following minimum requirements:

- a) Boom truck complete with hydraulic take-off.
- b) Hydraulically operated torque head with a minimum torque rating of 16,000 N·m complete with Kelly bar drive.
- c) Kelly bar adapter and universal driving plate.
- d) Torque indicator.

616.07 CONSTRUCTION

616.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

616.07.02 Removal

Removals shall be according to OPSS 610.

616.07.03 Concrete Footings and Pads

616.07.03.01 General

616.07.03.01.01 Excavation

Earth excavation for footings shall be carried out by mechanical excavation or by hand digging. When additional excavation is required beyond the neat limits, such excavation shall be a minimum of 300 mm width beyond the neat dimensions of the footing to accommodate granular backfill.

When unsuitable material is encountered in the excavation, it shall be removed and replaced with material approved by the Contract Administrator.

Rock excavation shall be according OPSS 206.

616.07.03.01.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905.

616.07.03.01.03 Concrete

Concrete shall be placed, finished, cured, and protected according to OPSS 904. Concrete shall be sampled and tested according to OPSS 1350.

Concrete in earth shall be placed directly against the undisturbed walls of the excavation or may be formed in place, provided that a minimum of 300 mm width is available for placing granular backfill. The upper portion of the footing shall be formed to a minimum of 75 mm below grade level.

When concrete is placed immediately adjacent to other concrete structures or pavement, expansion joint filler shall be installed around the abutting edge of the footing.

Concrete finish for footings installed in concrete barrier wall shall match the barrier wall finish.

616.07.03.01.04 Grading

Fill material shall be excavated and placed to the finished grade elevation according to OPSS 206.

616.07.03.02 Concrete Footings

616.07.03.02.01 Sleeves and Ducts

Sleeves for footings shall be accurately located to suit incoming ducts or cable systems and shall be securely tied to the steel reinforcement prior to placing concrete.

All sleeves or ducts shall be cut off cleanly above the footing at the height specified in the Contract Documents.

Sleeves or ducts shall be temporarily plugged or sealed until wiring is installed. Where ducts or sleeves are specified as spare or intended for future use, the ducts or sleeves shall be plugged with plastic plugs.

Location of sleeves or ducts shall be marked on the top of the concrete footing with a 50 x 50 mm cut or formed cross.

616.07.03.02.02 Anchorage Assemblies

Anchorage assemblies shall be installed using studs as specified in the Contract Documents.

Anchorage assemblies of the size and type specified in the Contract Documents shall be accurately positioned in the pole and sign footings. The alignment of the studs shall be parallel to the edge of the driving lane. Anchorage assemblies shall be securely tied to the steel reinforcement.

Studs shall be factory inserted in the ferrules and held in place with a pre-applied thread locking compound. A wooden template shall be provided. Nuts and washers shall be installed hand tight by the fabricator. Studs shall have the exposed threads above the ferrule coated with factory applied white lithium grease. The integrity of the compound shall be maintained throughout the installation and no attempt shall be made to remove or adjust the studs.

The anchorage assembly shall be installed and adjusted level in all directions on the wooden template using a carpenter's level. Upon initial concrete set, the wooden template shall be removed and the drainage channels and other surface features shall be completed.

When the removal of the studs for repair or replacement purposes is required, the ferrules and the studs shall be cleaned to remove the old thread locking compound. New thread locking compound shall be applied to the insertion length of the studs prior to tightening to full depth.

616.07.03.02.03 H-Section Assemblies

H-section for barrier walls shall be accurately positioned in the concrete footings under the concrete barrier. The alignment of the studs shall be parallel to the edge of the driving lane. The plumb position of the anchorage assemblies shall be maintained during the placing of concrete.

616.07.03.02.04 Concrete

Concrete pole footings shall be placed so that the top of the footing is within ± 25 mm of the elevation specified in the Contract Documents.

616.07.03.02.05 Granular Backfill

When granular backfill is specified in the Contract Documents or, when granular backfill is placed around footings, it shall be compacted according to OPSS 501.

616.07.03.02.06 Concrete Footings in Earth

Concrete footings in earth shall be placed at locations specified in the Contract Documents.

616.07.03.02.07 Concrete Footings in Rock

The work for concrete footings in rock shall include placing dowels and concrete. Concrete footings in rock shall to be placed at locations specified in the Contract Documents.

616.07.03.02.07.01 Dowels in Rock

When specified in the Contract Documents, steel dowel bars shall be installed. Dowel bars shall be grouted in holes drilled into rock using non-shrink grout.

616.07.03.03 Concrete Pads

Concrete pads shall be placed at locations specified in the Contract Documents.

616.07.03.03.01 Granular Bases

Granular material shall be placed as foundation for concrete pads. Granular material shall be placed in conjunction with the installation of ducts under the concrete pads. The granular base shall be compacted according to OPSS 501.

616.07.03.03.02 Sleeves and Ducts

Sleeves and ducts shall be located within the concrete pads as specified in the Contract Documents so that cables may be installed vertically to the cable terminations in the pad mounted equipment.

Ducts shall be installed below pads according to OPSS 603 and shall be suitably aligned for connection to exterior duct or cable systems.

616.07.04 Steel Footings

616.07.04.01 Installation

Steel footings larger than 150 mm diameter shall be installed using the equipment as outlined in the Equipment section. Alternate methods of applying torque are permitted for 150 mm diameter or smaller steel footings.

During installation, the steel footing shall be maintained in a plumb position by use of a carpenter's level or a survey instrument. In all cases, the steel footing shall be installed so that the final location of the top plate rests on or is slightly below final grade. Steel footings to be used for poles shall be oriented such that the top plate is either perpendicular to or parallel to the edge of pavement, as required by duct orientation. Steel footings for other equipment mounting shall be oriented to suit the equipment to be mounted.

Steel footings shall be installed by turning the units into the earth at locations specified in the Contract Documents. Torque on footings larger than 150 mm in diameter shall be monitored and recorded during the turning operation and shall show a consistent and gradually increasing torque as the footing advances in depth.

When difficulties are encountered installing the steel footing due to the presence of boulders or rock fragments; or where the torque required to install the footing exceeds 20,000 N·m; or where the torque is less than 5,000 N·m when the shaft is fully driven into the ground, the footing shall be withdrawn and relocated 1.0 m minimum away from the original position, as directed by the Contract Administrator. If turning of the footing proves impractical, a pilot hole of 150 mm diameter may be pre-drilled and the footings then turned into the pilot hole. If this method proves impractical, a hole of 300 mm maximum diameter may be augured and the footing then installed into the hole. Compacted limestone screenings or expandable foam backfill shall be placed around the shaft to the bottom of the wiring aperture. Backfill of native material shall be placed above this level and compacted according to OPSS 501.

If the steel footings cannot be installed due to local conditions, a concrete footing shall be installed.

616.07.04.02 Mounting Hardware and Steel Equipment Base Plate

The mounting hardware and steel equipment base plate shall be installed as specified in the Contract Documents.

616.07.05 Wooden Pads

616.07.05.01 Installation

Wooden pads for controller cabinets shall be fabricated and placed at locations specified in the Contract Documents.

616.07.05.02 Granular Bases

A granular base shall be installed as a foundation for wooden pads. Granular material shall be placed in conjunction with the installation of ducts under the wooden pads. The granular base shall be compacted according to OPSS 501.

616.07.05.03 Sleeves and Ducts

Sleeves in wooden pads shall be located so that cables may be installed vertically to the cable terminations in the pad mounted equipment. Ducts shall be installed below the pads according to OPSS 603 and shall be suitably aligned for connection to exterior duct or cable systems.

616.07.06 Quality Control

616.07.06.01 Pre-Installation Testing and Inspection

Anchorage assemblies, studs or bolts, and connection components shall be inspected prior to installation to ensure that they are according to the Contract Documents.

616.07.06.02 Proof of Performance Testing and Inspection

The work shall be inspected to ensure that it is according to the Contract Documents. The work shall be inspected to ensure that all components are installed and that all footings and pads, including anchorage assemblies, are properly oriented and in working order.

616.07.07 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except that the work shall include the removal of the installations when they are no longer required.

616.07.08 Site Restoration

Site restoration shall be according to OPSS 492.

616.07.09 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

616.08 QUALITY ASSURANCE

The Owner may perform tests for concrete according to OPSS 1350.

The Owner may perform tests for compaction according to OPSS 501.

The Owner may inspect each pole footing as specified in the Contract Documents.

616.09 MEASUREMENT FOR PAYMENT

616.09.01 Actual Measurement

616.09.01.01 Concrete Footings in Earth

For measurement purposes, a count shall be made of the number of concrete footings installed in earth.

616.09.01.02 Concrete Footings in Rock

For measurement purposes, a count shall be made of the number of concrete footings installed in rock.

616.09.01.03 Concrete Pads

For measurement purposes, a count shall be made of the number of concrete pads installed.

616.09.01.04 Steel Footings

For measurement purposes, a count shall be made of the number of steel footings installed.

616.09.01.05 Wooden Pads

For measurement purposes, a count shall be made of the number of wooden pads installed.

616.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

616.10 BASIS OF PAYMENT

**616.10.01 Concrete Footings in Earth - Item
Concrete Footings in Rock - Item
Concrete Pads - Item
Steel Footings - Item
Wooden Pads - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When a specified steel footing cannot be placed due to local conditions and a concrete footing is installed in its place, such work shall be paid as Extra Work.

**616.10.02 Concrete Footings in Earth, Temporary - Item
Concrete Footings in Rock, Temporary - Item
Concrete Pads, Temporary - Item
Steel Footings, Temporary - Item
Wooden Pads, Temporary - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payment for the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation
20% for removal



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF ROADWAY LUMINAIRES

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617.01 SCOPE

This specification covers the requirements for the installation of luminaires and brackets on poles complete with associated wiring and connections.

617.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 2432	High Pressure Sodium Luminaires for Highway Lighting

CSA Standards

C22.2 No. 9.0-96 (R2016)	General Requirements for Luminaires
C22.2 No. 65-18	Wire Connectors
C22.2 No. 211.2-06 (R2016)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 248.8-11 (R2016)	Low-Voltage Fuses - Part 8: Class J Fuses
C83-96	Communication and Power Line Hardware

American National Standards Institute (ANSI)

C78.380-2016 High-Intensity Discharge Lamps, Method of Designation

Illuminating Engineering Society of North America (IESNA)

LM-63-02	Standard File Format for Electronic Transfer of Photometric Data and Related Information
LM-79-08	Electrical and Photometric Measurements of Solid-State Lighting Products

617.04 DESIGN AND SUBMISSION REQUIREMENTS

617.04.01 Submission Requirements

A photometric test report shall be submitted for each photometric curve used in the luminaires to be installed under the Contract. The testing and test reports for high intensity discharge (HID) luminaires (e.g., high pressure sodium) shall be according to IESNA LM-63. The testing and test reports for LED luminaires shall be according to IESNA LM-79. The testing and test reports shall be completed by an independent laboratory or a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory, which is accredited for testing the type of luminaire to be installed under the Contract (i.e., accredited for IESNA LM-63 for HID luminaires or IESNA LM-79 for LED luminaires). Each test report shall be dated and signed. The test reports shall be submitted to the Contract Administrator prior to the commencement of fabrication.

617.05 MATERIALS

617.05.01 Luminaires

617.05.01.01 Roadway Lighting Type

Roadway lighting luminaires shall be according to OPSS 2432 and the Contract Documents.

617.05.01.02 High Mast Lighting Type

High mast lighting luminaires shall be according to OPSS 2432 and the Contract Documents.

617.05.01.03 Floodlighting Type

Floodlighting luminaires shall be according to CSA C22.2 No. 9.0 and the Contract Documents.

617.05.01.04 LED Roadway Lighting Type

LED roadway lighting luminaires shall be according to the Contract Documents.

617.05.01.05 LED High Mast Lighting Type

High mast lighting luminaires shall be according to the Contract Documents.

617.05.02 Lamps

Lamps shall be high pressure sodium according to ANSI C78.380 with ANSI lamp designations shown in Table 1. Lamp wattages shall be permanently marked using a label affixed to the underside of the luminaires as specified in the Contract Documents.

617.05.03 Low-Voltage Cables

Single conductor low-voltage cables shall be according to OPSS 604.

617.05.04 Wire Connectors

Wire connectors shall be of the compression type and shall be according to CAN/CSA C22.2 No. 65.

617.05.05 Insulating Covers

Insulating covers for connectors shall be of the vinyl snap lock type or heat shrink tubing type and rated at 600 V.

617.05.06 Brackets

Brackets shall be as specified in the Contract Documents.

617.05.07 Conduit and Fittings

Conduit and fittings required for wooden pole mounting shall be of the rigid PVC type according to CSA C22.2 No. 211.2.

617.05.08 Hardware

Hardware for wooden pole mounting shall be according to CSA C83.

617.05.09 Grounding Materials

Ground wire and connectors shall be according to OPSS 609.

617.05.10 Fuse Holders and Fuses

Fuse holders shall be of the in-line type suitable for use with #12 AWG conductors, rated 600 V, and shall be complete with protective boots. Fuses shall be according to CSA C22.2 No. 248.8, 600 V with a current rating as specified in the Contract Documents.

617.07 CONSTRUCTION

617.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

617.07.01.01 Ordering Luminaires

Immediately following the award of the Contract, the Contractor shall order the luminaires as required for this Contract.

The Contractor shall obtain verification of the delivery dates of the luminaires from the supplier and notify the Contract Administrator of the delivery dates within 72 hours after the award of the Contract.

The Contractor shall ensure there is timely and accurate communication with both the Owner and the supplier regarding the delivery, schedules, and requirements for the luminaires.

Delivery and off-loading of the luminaires shall be completed in a timely and efficient manner.

617.07.02 Removals

Removals shall be according to OPSS 610.

617.07.03 Lamp Installation

Lamps shall be installed after poles have been installed and the brackets and luminaires mounted and levelled.

617.07.04 Brackets

617.07.04.01 Roadway Lighting Type

Brackets shall be installed at right angles to the centreline of the roadway being served. Bracket clamping assemblies shall be securely tightened. Brackets shall be mounted on wooden poles using 16 mm diameter galvanized steel square head through bolts, nuts, and 50 x 50 mm washers.

617.07.04.02 Floodlighting Type

Bracket assemblies shall be oriented to give the floodlight aiming specified in the Contract Documents. Bracket clamping assemblies shall be securely tightened.

617.07.05 Luminaires

617.07.05.01 General

Luminaires shall be stored in conditions free of moisture, dirt, and other factors that could damage the ballasts or reflecting surfaces of the optical system.

Luminaires shall be mounted on brackets and shall be installed level along both the longitudinal and transverse axis.

Luminaire clamping assemblies shall be securely tightened upon completion of levelling.

Luminaires shall be orientated and aimed using the horizontal and vertical angles specified in the Contract Documents. When instructed by the Contract Administrator, each luminaire or luminaire component shall be readjusted once under nighttime operating conditions.

Glass refractors shall be installed complete with gaskets. Mounting hardware shall be securely tightened. The luminaire reflector and refractor shall be thoroughly cleaned prior to installing lamps. Lamps shall be installed with the installation date marked on the lamp base.

If required, the refractor and the lamp holder shall be reset or replaced according to manufacturer's instructions to give the proper type of light distribution specified in the Contract Documents.

When specified in the Contract Documents, the luminaires shall be equipped with shields. The shields shall be mounted in such a manner to prevent loosening, turning, or falling when subject to vibration or wind loading in the installed position and to permit relamping without removing or distorting the alignment of the shields.

The shield shall be installed according to the manufacturer's instructions. The orientation of each shield shall be as specified in the Contract Documents. After the shield is attached to the luminaire-retaining

ring, it shall be rotated such that its centre (the deepest point) is aligned with the specified angle. The angle specified is based on geometric rotation with the true north as its reference (0 degrees). Once the shield is aligned to the specified angle, it shall be secured in place by tightening the holding ring.

The luminaire assembly when closed and in the operating position shall not be subject to damage by vibration.

617.07.05.02 High Mast Lighting Type

A maximum of one luminaire shall be installed on each arm of the luminaire ring.

Each luminaire shall be bolted and secured onto its respective luminaire arm.

617.07.06 Wiring and Connections

Riser wires in metal and concrete poles shall be terminated at the luminaire terminal block and installed through the bracket and pole to the pole handhole.

Riser wires on wooden poles shall enter the bracket with a drip loop and shall be installed in conduit when the distance from the bracket to the low voltage bus exceeds 450 mm.

Connections or riser wires to the assigned feeder conductors shall be made with compression connectors insulated with insulating covers.

In-line fuse holders and fuses shall be installed in the pole handhole and placed in an accessible location. For wooden poles, in-line fuse holder and fuses shall be installed at the point of connection.

617.07.07 Grounding

Grounding shall be according to OPSS 609.

For metal or concrete pole mounting, a #12 AWG insulated (green) stranded copper ground wire shall be installed between the luminaire housing ground terminal and the ground stud in the pole handhole.

For wooden pole mounting, a #12 AWG insulated (green) stranded copper ground wire shall be installed between the luminaire housing ground terminal and the system ground.

617.07.08 Replacing Luminaires

Existing luminaires shall be removed and new luminaires installed according to the Contract Documents. Existing riser wires and luminaire ground wire shall be salvaged and connected to the new luminaires.

617.07.09 Relamping

When required, existing lamps shall be removed. The existing luminaires shall be thoroughly cleaned and new lamps installed according to the Contract Documents.

617.07.10 Quality Control

617.07.10.01 Pre-Installation Testing and Inspection

Luminaires, brackets, socket setting, refractor type, and ballast type shall be inspected to ensure they meet the requirements of the Contract Documents.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the pre-installation testing and inspection.

The next operation after the completion of the pre-installation testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

617.07.10.02 Proof of Performance Testing and Inspection

Luminaires shall be tested and inspected to ensure that they are levelled correctly and according to the Contract Documents. All luminaires shall have a minimum burning-in period of 100 nighttime hours prior to acceptance of the work by the Contract Administrator. All luminaire shielding shall be installed prior to the start of the burn-in period.

All tests required on the wiring system shall be according to OPSS 604.

A Request to Proceed shall be submitted to the Contract Administrator after completion of the proof of performance testing and inspection.

The next operation after the completion of the proof of performance testing and inspection shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

617.07.11 Temporary Electrical Work

The work for temporary electrical installations shall be the same as for permanent installations of the same type of work, except the work shall include the removal of the installations when they are no longer required.

617.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

617.09 MEASUREMENT FOR PAYMENT

617.09.01 Actual Measurement

617.09.01.01 Roadway Lighting Luminaires and Bracket Assemblies LED Roadway Lighting Luminaires and Bracket Assemblies

For measurement purposes, a count shall be made of the number of roadway lighting luminaires and bracket assemblies installed.

617.09.01.02 High Mast Lighting Luminaires LED High Mast Lighting Luminaires

For measurement purposes, a count shall be made of the number of high mast lighting luminaires installed.

617.09.01.03 Floodlighting Luminaires and Bracket Assemblies

For measurement purposes, a count shall be made of the number of floodlighting luminaires and bracket assemblies installed.

617.09.01.04 Replace Roadway Lighting Luminaires Replace LED Roadway Lighting Luminaires

For measurement purposes, a count shall be made of the number of roadway lighting luminaires replaced.

**617.09.01.05 Replace High Mast Lighting Luminaires
Replace LED High Mast Lighting Luminaires**

For measurement purposes, a count shall be made of the number of high mast lighting luminaires replaced.

617.09.01.06 Replace Floodlighting Luminaires

For measurement purposes, a count shall be made of the number of floodlighting luminaires replaced.

617.09.01.07 Relamp Roadway Lighting Luminaires

For measurement purposes, a count shall be made of the number of new lamps installed in existing roadway lighting luminaires.

617.09.01.08 Relamp High Mast Lighting Luminaires

For measurement purposes, a count shall be made of the number of new lamps installed in existing high mast lighting luminaires.

617.09.01.09 Relamp Floodlighting Luminaires

For measurement purposes, a count shall be made of the number of new lamps installed in existing floodlighting luminaires.

617.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

617.10 BASIS OF PAYMENT

**617.10.01 Roadway Lighting Luminaires and Bracket Assemblies - Item
LED Roadway Lighting Luminaires and Bracket Assemblies - Item
High Mast Lighting Luminaires – Item
LED High Mast Lighting Luminaires - Item
Floodlighting Luminaires and Bracket Assemblies - Item
Replace Roadway Lighting Luminaires - Item
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Replace LED High Mast Lighting Luminaires - Item
Replace Floodlighting Luminaires - Item
Relamp Roadway Lighting Luminaires - Item
Relamp High Mast Lighting Luminaires - Item
Relamp Floodlighting Luminaires - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

**617.10.02 Roadway Lighting Luminaires and Bracket Assemblies (Temporary) - Item
LED Roadway Lighting Luminaires and Bracket Assemblies (Temporary) - Item
Floodlighting Luminaires and Bracket Assemblies (Temporary) - Item
High Mast Lighting Luminaires (Temporary) - Item
LED High Mast Lighting Luminaires (Temporary) - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments for the above tender items shall be based on the following percentages of the Contract price:

80% for supply and installation

20% for removal

TABLE 1
Lamps for Roadway Lighting

Lamp Type	Lamp Wattage	Lamp Nominal Operating Voltage	Lamp Finish	ANSI Lamp Designation
High Pressure Sodium (HPS)	100	55	Clear	S54-100
	150	55	Clear	S55-150
	200	100	Clear	S66-200
	200	100	Coated	S66/D-22
	250	100	Clear	S50-250
	310	100	Clear	S67-310
	400	100	Clear	S51-400
	600	105	Clear	S106-600
	750	120	Clear	S111-750
	1000	250	Clear	S52-1000



CONSTRUCTION SPECIFICATION FOR TRAFFIC SIGNAL EQUIPMENT

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620.06	EQUIPMENT - Not Used
620.07	CONSTRUCTION
620.08	QUALITY ASSURANCE
620.09	MEASUREMENT FOR PAYMENT
620.10	BASIS OF PAYMENT
APPENDICES	Not Used

620.01 SCOPE

This specification covers the requirements for the installation of traffic signal equipment, including traffic signal heads, mast arms, brackets, signal hangers, optically directed lens assemblies, LED modules, aerial mounting equipment and equipment modifications.

620.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

620.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

620.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials

Ontario Provincial Standard Specifications, Material

OPSS 2409	Traffic Signal Cable
OPSS 2460	Traffic Signal Arms, Brackets, Hangers, Fittings and Hardware
OPSS 2461	Signal Heads

CSA Standards

C22.2 No. 45.2-08 (R2013)	Electrical Rigid Metal Conduit - Aluminum, red brass, and stainless steel (Tri-national standard, with NMX-J-576-ANCE and UL 6A)
C22.2 No. 65-13	Wire connectors (Tri-national standard, with UL 486A-486B and NMX-J-543- ANCE)
C22.2 No. 85-14	Rigid PVC Boxes and Fittings
C22.2 No. 197-M1983 (R2013)	PVC Insulating Tape
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit

620.03

DEFINITIONS

For the purpose of this specification the following definitions apply:

Auxiliary Signal Head means a traffic signal head that is supplementary to the primary and secondary heads and which may be necessary due to local conditions.

Backboard means a panel surrounding a signal head.

Conflict Monitor means a device used to prevent conflicting signal phases.

Controller unit means a traffic signal controller

Highway Signal Head means a traffic signal head with 300 mm diameter red, amber and green lenses.

Light Emitting Diode (LED) means a semiconductor device that emits incoherent monochromatic light when electrically biased in the forward direction. This effect is a form of electroluminescence. The colour depends on the semiconducting material used, and can be near-ultraviolet, visible or infrared. These LEDs are used to provide red, amber, green or green arrow, etc. indications in traffic signal heads.

Load Switch means a device used to switch 120-volt power to the traffic control signal heads. Load switches are normally semi-conductor devices, which are switched by low voltage signal from the controller unit.

Pedestrian Signal Head means a traffic signal head comprising of a "walk" and "don't walk" symbol.

Primary Signal Head means a traffic signal head mounted on the far right side of an intersection approach.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Secondary Signal Head means a traffic signal head mounted on the far left side or in the median of an intersection approach.

Signal Head means an assembly containing the signal face.

Special Signal Head means a traffic signal head comprised of a combination of sections with red, amber and green or green arrow indications.

Standard Signal Head means a traffic signal head with 200 mm diameter red, amber and green lenses.

620.05

MATERIALS

620.05.01

Traffic Signal and Pedestrian Heads

Each traffic signal head shall be provided with LED modules unless otherwise specified in the Contract Documents.

Each traffic signal head shall be a highway signal head unless otherwise specified in the Contract Documents.

Traffic signal heads and pedestrian heads shall be according to OPSS 2461.

620.05.02 Mast Arms, Brackets, Signal Hangers

Mast arms, brackets and signal hangers shall be according to OPSS 2460. Signal hangers shall be adjustable mid-section hanger or dual-end hanger as specified in the Contract Documents.

620.05.03 Traffic Signal Cables

Traffic signal cables shall be according to OPSS 2409.

620.05.04 Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197, rated for -10 °C to 90 °C use, 600 V.

620.05.05 LED Modules

LED modules shall be according to OPSS 2461.

620.05.06 Conduits and Fittings

Rigid PVC conduits and fittings shall be according to CSA C22.2 No. 211.2. Rigid aluminum conduits and fittings shall be according to CSA C22.2 No. 45.2.

620.05.07 Wire Connectors

Wire connectors shall be of the insulated wing nut vibration proof spring type and shall be according to CSA C22.2 No 65.

620.05.08 Junction Boxes and Fittings

PVC junction boxes and fittings shall be according to CAN/CSA C22.2 No. 85.

620.05.09 Strapping

Stainless steel strapping and buckles shall have a minimum ultimate strength of 4.5 KN.

620.05.10 Traffic Signal Mounting Equipment

Fittings, accessories and hardware shall meet the requirements specified in the Contract Documents.

620.05.11 Grommets

Grommets shall be rubber or neoprene sized to suit the aperture metal thickness and cable diameter.

620.05.12 Grounding Materials

Grounding materials shall be according to OPSS 609.

620.07 CONSTRUCTION

620.07.01 Mast Arms

The attachment point of the mast arm shall be set on the pole to obtain the required clearance from finished grade to the bottom of the signal head. When two or more mast arms are mounted on the same pole, the

primary head shall be set to obtain the required clearance height specified in the Contract Documents. Other mast arms, with secondary or auxiliary heads, shall be adjusted on the pole so that a minimum separation of one pole diameter is obtained between fittings or bolts touching the pole.

For wood pole mounting, holes shall be drilled to accommodate through bolts. Nuts shall be tightened to obtain a minimum wood compression of 3 mm under the washers.

Mast arm attachment to steel poles using "U" bolts or pole plates shall be tightened to a point where the pole just begins to deform.

Mast arms shall be installed perpendicular to the through lanes of traffic being served.

620.07.02 Traffic Signal Hangers

Traffic signal hangers shall be slip-fitted on the tenon of the mast arm and secured in position with the signal heads adjusted to vertical.

Installation of the signal hanger shall be according to the manufacturer's instructions.

620.07.03 Double Arm Brackets

Double arm brackets shall be assembled on signal heads prior to pole mounting. The arm shall be installed in parallel alignment and all locknuts securely tightened.

Pole plates shall be mounted on the side of the pole so the bottom of the signal head meets the required clearance height from finished grade. Pole plates shall be secured with stainless steel strapping which shall not overlap or secure any other equipment on the pole.

620.07.04 Signal Heads

Signal heads shall be installed facing the direction of approaching traffic according to the legal drawing, Form PHM-125, approved for the intersection.

Signal heads shall be securely covered with an opaque covering and shall remain in place until all tests have been completed and the signal heads are put into operation. Pedestrian heads shall be turned to face the pole prior to operation.

Signal heads shall be adjusted for maximum visibility and focusing prior to final tightening or sealing of hardware. Unused hubs in signal heads shall be plugged with sealing caps, without a gasket.

620.07.05 Wiring Apertures

In metal poles, wiring apertures shall be drilled as required. Apertures shall be located clear of the vertical seam and overlapping sections of sectional steel poles. Apertures shall be de-burred and painted with grey zinc rich paint. Rubber grommets shall be installed after paint is dry.

620.07.06 Pole Mounted Conduit Systems

Pole mounted conduit systems including rigid PVC junction boxes and all necessary fittings and hardware shall be installed where traffic signal equipment is to be installed on concrete or wood poles. Conduit shall be installed in straight lengths to follow the taper of the pole using stainless steel strapping or galvanized lag screws at 1.5 m maximum spacing. Offset bends shall be used where required to avoid pole attachments and conduits shall be kept free of kinks or scorch marks.

620.07.07**Wiring**

Traffic signal cable shall be installed between the signal head and either the pole handhole or the pole mounted PVC junction box. Wiring shall be run through the mast arms, signal hangers and the upper arm of double arm brackets. A minimum length of 600 mm of riser cable shall be left in pole handholes.

Drip loops shall be left on all external cable. Cable shall be protected with rigid PVC conduit where slack lengths of more than 450 mm are externally exposed. Aerial cable from the PVC junction box to the signal head shall be installed according to OPSS 604.

Riser cables shall be connected to LED modules via terminal blocks, or with insulated wing nut vibration proof spring connectors. Termination of spare conductors and handhole or junction box connections shall be made with insulated spring connectors. All insulated spring connectors shall be held in place with three half laps of electrical vinyl tape. Upon completion of connections, all conductors shall be neatly bundled together and secured with four wraps of electrical vinyl tape.

Metal signal heads shall be grounded according to OPSS 609 by use of the designated spare conductor in the riser cable, connected securely to the ground terminal in the signal head and either the pole ground stud or the system ground wire in PVC junction boxes.

620.07.08**Optically Directed Signal Heads**

Optically directed signal heads shall be installed according to the manufacturer's instructions. Signal heads shall be adjusted to focus along the designated roadways or traffic lanes.

620.07.09**Aerial Mounted Equipment**

All equipment and fittings, hardware, PVC junction boxes, and accessories necessary for the mounting of equipment on aerial messenger cable systems shall be installed as specified in the Contract Documents. All compression nuts, locknuts and fitting hardware shall be securely tightened to prevent shifting of equipment by natural elements (i.e. wind, rain, ice or snow, etc.)

620.07.10**Equipment Modifications**

Removal of existing equipment shall be according to OPSS 610. Installation of new, refurbished or modified equipment shall be according to the requirements for installation of the particular items of equipment as described herein.

620.07.11**Quality Control****Pre-installation Testing and Inspection (PIT):**

Signal heads, mast arm, double arm brackets and connection components shall be inspected prior to installation to ensure that they are according to the Contract Documents.

Proof of Performance Testing and Inspection (POP):

The work shall be inspected and tested to ensure that it meets the requirements of the Contract Documents and without limiting the foregoing, to ensure the following:

- a) All components are installed, tested and proven as specified in the Contract Documents
- b) All cables are energized and in working order prior to activating the traffic signals for public display.

The inspection, testing, and test results shall be witnessed by the Quality Verification Engineer.

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Quality Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the Contract Documents:

- a) Work
- b) Material and installations
- c) Inspection, testing, and test results

620.08 QUALITY ASSURANCE

The Contract Administrator may provide direction for the aiming of signal heads, optically directed lens assemblies and LED modules. At any time, the Contract Administrator may test-drive the controlled traffic lanes and notify the Contractor of any adjustments required.

620.09 MEASUREMENT FOR PAYMENT

620.09.01 Actual Measurement

620.09.01.01 Single Member Arms and Signal Hangers Single Member Arms and Signal Hangers (Temporary) Overbrace Arms and Signal Hangers Overbrace Arms and Signal Hangers (Temporary) Double Arm Brackets Double Arm Brackets (Temporary) Highway Type Signal Heads Highway Type Signal Heads (Temporary) Special Type Signal Heads Special Type Signal Heads (Temporary) Standard Type Signal Heads Standard Type Signal Heads (Temporary) Pedestrian Type Signal Heads Pedestrian Type Signal Heads (Temporary) Single Signal Head Section Single Signal Head Section (Temporary) Optically Directed Signal Heads Optically Directed Signal Heads (Temporary)

For measurement purposes, a count shall be made of the number of arms, hangers, brackets, and signal heads installed.

620.09.01.02 Traffic Signal Equipment Modifications

For measurement purposes, a count shall be made of the number of intersection locations where traffic signal equipment modification is carried out.

620.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

620.10 BASIS OF PAYMENT

- 620.10.01**
- Single Member Arms and Signal Hangers – Item**
 - Single Member Arms and Signal Hangers (Temporary) – Item**
 - Overbrace Arms and Signal Hangers – Item**
 - Overbrace Arms and Signal Hangers (Temporary) – Item**
 - Double Arm Brackets – Item**
 - Double Arm Brackets (Temporary) – Item**
 - Highway Type Signal Heads – Item**
 - Highway Type Signal Heads (Temporary) – Item**
 - Special Type Signal Heads – Item**
 - Special Type Signal Heads (Temporary) – Item**
 - Standard Type Signal Heads – Item**
 - Standard Type Signal Heads (Temporary) – Item**
 - Pedestrian Type Signal Heads – Item**
 - Pedestrian Type Signal Heads (Temporary) – Item**
 - Single Signal Head Section – Item**
 - Single Signal Head Section (Temporary) – Item**
 - Optically Directed Signal Heads – Item**
 - Optically Directed Signal Heads (Temporary) – Item**
 - Traffic Signal Equipment Modifications - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR ELECTRICAL TRAFFIC CONTROL DEVICES

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621.01	SCOPE
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621.06	EQUIPMENT – Not Used
621.07	CONSTRUCTION
621.08	QUALITY ASSURANCE – Not Used
621.09	MEASUREMENT FOR PAYMENT
621.10	BASIS OF PAYMENT

621.01 SCOPE

This specification covers the requirements for the installation of traffic control devices including flasher beacons, flasher mechanisms, downlights, sign light assemblies and internally illuminated signs.

621.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment and Materials
OPSS 620	Traffic Signal Equipment

Ontario Provincial Standard Specifications, Material

OPSS 2461 Signal Heads

CSA Standards

C22.2 No. 45.1-07 (R2012)	Electrical Rigid Metal Conduit - Steel (Tri-National standard, with UL 6 and NMX-J-534-ANCE-2007)
C22.2 No. 45.2-08 (R2013)	Electrical Rigid Metal Conduit - Aluminum, red brass, and stainless steel (Tri-national standard, with NMX-J-576-ANCE and UL 6A)
C22.2 No. 207-15	Portable and Stationary Electric Signs and Displays
C22.2 No. 85-14	Rigid PVC Boxes and Fittings
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit

621.05 MATERIALS

621.05.01 Flasher Beacons

Flasher beacons shall be according to OPSS 2461.

Each flasher beacon that provides intersection control and each red flasher beacon shall be 300 mm diameter unless otherwise indicated in the Contract Documents.

621.05.02 Lamps and LED Modules

Lamps and LED modules shall be according to OPSS 2461.

621.05.03 Internally Illuminated Signs

Internally illuminated signs shall be according to the general requirements of CSA C22.2 No. 207 and as specified in the Contract Documents.

621.05.04 Cable

Cables shall be according to OPSS 604.

621.05.05 Connectors

Connectors shall be according to OPSS 604 and OPSS 609.

621.05.06 Conduit and Fittings

Rigid PVC conduit and fittings shall be according to CSA C22.2 No. 211.2.

Rigid galvanized steel conduit and fittings shall be according to CSA C22.2 No. 45.1.

Rigid aluminum conduit and fittings shall be according to CSA C22.2 No. 45.2.

621.05.07 Junction Boxes and Fittings

Junction boxes and fittings shall be according to CSA C22.2 No. 85.

621.05.08 Grounding Materials

Grounding materials shall be according to OPSS 609.

621.07 CONSTRUCTION

621.07.01 Flasher Beacons and Downlights

Flasher beacons and downlights for post top mounting shall be aligned facing the direction of approaching traffic and secured with set screws tightened to bite into the pole top tenon by approximately 1 mm.

Flasher beacons for pole front or side mounting shall be aligned facing the direction of approaching traffic and mounted on double arm brackets or mast arms and signal hangers according to OPSS 620.

Flasher beacons, single or in multiple clusters, for aerial mounting shall be arranged on the overhead support cable to provide the required visibility and clearances for each direction of approaching traffic. Mounting hardware shall be securely tightened.

621.07.02 Flasher Mechanisms

Flasher mechanisms shall be mounted on poles or in enclosures with the accompanying conduit, conduit fittings and wiring systems.

621.07.03 Sign Light Assemblies

Sign light assemblies shall be constructed of rigid aluminum conduit and fittings, lamp holders and lamps and shall be installed facing the direction of approaching traffic. Lengths of conduit shall be secured against fittings with lock nuts.

621.07.04 Internally Illuminated Signs

Internally illuminated signs shall be installed on double arm brackets, mast arms and signal hangers or aerial support cables according to OPSS 620.

621.07.05 Wiring

Wiring between the traffic control device and the pole handhole or pole mounted junction box shall be installed and connected according to OPSS 620.

621.07.06 Grounding

Traffic control devices shall be grounded according to OPSS 609.

621.07.07 Removals

Removal of traffic control devices necessary for the installation of work described herein shall be according to OPSS 610.

621.07.08 Quality Control

Pre-installation Testing and Inspection (PIT)

Traffic control devices and connection components shall be inspected prior to installation to ensure that they meet the requirements of the Contract Documents.

Proof of Performance Testing and Inspection (POP)

The work shall be inspected and tested to ensure that it meets the requirements of the Contract Documents; and, without limiting the foregoing, the work shall be inspected to ensure the following:

- a) All components are installed, tested and proven as specified in the Contract Documents
- b) All cables are energized and in working order prior to activating the flasher beacons for public display.

The testing and inspection results shall be documented in a report and submitted to the Contract Administrator within 3 Days of completion of the testing and inspection.

621.09 MEASUREMENT FOR PAYMENT

621.09.01 Actual Measurement

621.09.01.01 Flasher Beacons Flasher Beacons and Downlights Sign Light Assemblies for Keep Right Signs Internally Illuminated Signs Flasher Mechanisms

For measurement purposes, a count shall be made of the number of flasher beacons and downlight combinations, flasher beacons, flasher mechanisms, sign light assemblies and internally illuminated signs installed.

621.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

621.10 BASIS OF PAYMENT

621.10.01 Flasher Beacons - Item Flasher Beacons and Downlights - Item Sign Light Assemblies for Keep Right Signs - Item Internally Illuminated Signs - Item Flasher Mechanisms – Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

When the Contract contains a separate item for the Removal of Electrical Equipment, payment shall be at the Contract price and according to OPSS 610.



CONSTRUCTION SPECIFICATION FOR THE INSTALLATION OF TRAFFIC SIGNAL CONTROLLERS

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622.05	MATERIALS
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622.07	CONSTRUCTION
622.08	QUALITY ASSURANCE
622.09	MEASUREMENT FOR PAYMENT
622.10	BASIS OF PAYMENT

APPENDICES	Not Used

622.01	SCOPE

This specification covers the requirements for the installation of traffic signal controllers and associated components.

622.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

622.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

622.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 610	Removal of Electrical Equipment
OPSS 623	Traffic Actuation Equipment

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 2475	Uninterruptible Power Supply Systems for LED Traffic Signals

Ontario Ministry of Transportation Publications:

Ontario Traffic Signal Control Equipment Specifications (OTSCES)

CSA Standards

C22.2 No. 65-13	Wire Connectors (Tri-national standard, with UL 486A-486B and NMX-J-543-ANCE)
C22.2 No. 75-14	Thermoplastic Insulated Wires and Cables (Tri-national standard, with UL 83 and NMX-J-010-ANCE-2010)
C22.2 No. 197-M1983 (R2013)	PVC Insulating Tape
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit

International Municipal Signal Association (IMSA)

MTO 170/332 Training Manual

Others

Caltrans Transportation Electrical Equipment Specifications (TEES)

622.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

AC+ means 120 V AC, 60 Hz power bus.

AC- means 120 V AC, 60 Hz neutral bus, grounded at power source.

Conflict Monitor means a device for detecting and interrupting conflicts in the traffic signal output circuits.

Controller means a complete traffic signal control equipment package including cabinet, controller unit and all associated power control, actuation or interconnection devices.

Controller Cabinet means an outdoor enclosure used for the housing of the controller unit and all associated power, control, activation or interconnection devices.

Controller Unit means that portion of the controller assembly devoted to the selection and timing of traffic movements.

Detection means the operation of a detector sensor unit in registering the presence or passage of a vehicle or pedestrian.

Hold means a command to the controller unit which causes it to retain the existing traffic signal phase.

Interconnection means the system of cables and devices which operate traffic signal controllers at consecutive intersections in a fixed or preprogrammed timing sequence.

Interval means the part or parts of the signal cycle during which signal indications do not change.

Interval Sequence means the order of appearance of signal indications during successive intervals.

Interval Sequence Chart means a chart designating the order in which the signal phases occur and the associated signal display for each interval.

Light Emitting Diode (LED) means as defined in OPSS 620.

Microprocessor means a small, self-contained limited capability computer with the central processing unit on a single chip.

Motherboard means a printed circuit connector interface board with no active or passive components.

Phase Skip means a controller function used to provide omission of a phase in the absence of actuations on that phase.

Pre-emption means the transfer of the normal control of signals to a special control mode which may be required by railroad trains at crossings, emergency vehicles, mass transit vehicles, or other special needs.

Vehicle Extension means the time in seconds added to the green interval to permit additional green time upon actuation by a vehicle approaching the intersection.

622.05 MATERIALS

622.05.01 Conduits and Fittings

Rigid PVC conduits and fittings shall be according to CSA C 22.2 No. 211.2.

622.05.02 Low Voltage Cables

Low voltage cables single conductor, shall be stranded copper type TWH according to CSA C 22.2 No. 75.

622.05.03 Wire Connectors

Wire connectors shall be of the fork tongue compression type for terminal connections of the insulated wing nut vibration proof spring type for wire to wire connections and shall be according to CSA C 22.2. No. 65.

622.05.04 Electrical Insulating Tape

Electrical insulating tape shall be rated for 600 V at -10°C to 90°C working temperature and conform to CSA C22.2 No. 197.

622.05.05 Grounding Materials

Ground wire and connectors shall be according to OPSS 609.

622.05.06 Traffic Signal Controllers

A used traffic signal controller may be used for a temporary installation provided that it is in good condition and it complies with the requirements of the contract.

622.05.07 Concrete

Concrete shall be 30 MPa class according to OPSS 1350.

622.05.08 Solder

Solder shall be 60% tin and 40% lead mix resin core type.

622.05.09 Uninterruptible Power Supply (UPS) System

The UPS system shall be according to the OPSS 2475.

Used UPS systems may be used for temporary installations provided that they are in good condition and meet the requirements of the Contract Documents.

The information contained in this specification covers the UPS system to be used with a Model 332 controller cabinet. If the Contractor uses a different type of traffic signal controller cabinet, such as a NEMA cabinet, then the Contractor shall make all necessary modifications to suit the type of cabinet used.

Uninterruptible power supply systems for LED traffic signals shall include an Arc Flash and Shock Hazard warning label according to Figure 1. The warning sign shall be prominently displayed on the outside of each exterior door. The Contractor shall enter the location information in Figure 1 as indicated by the local MTO electrical coordinator.

The DC arc flash analysis and results in Figure 1 are applicable only to ministry traffic signal UPS systems with the following characteristics:

- a) Application – DC system for back-up power for traffic signals
- b) Nominal DC system voltage of 60 VDC or less.
- c) DC system short circuit current of 5000 A or less.
- d) Condition of electrical plant shall be in good condition and well maintained.

622.05.10 Forced Flash Relay

The forced flash relay shall be 10 Amp, 60 Hz, Double Pole Double Throw (DP DT) relay.

622.05.11 Heater/Fan Breaker

The heater/fan breaker shall be 15 Amp breaker mounted on the service panel.

622.07 CONSTRUCTION

622.07.01 Controller Supplied by the Owner

When the controller is supplied by the Owner, the controller shall be picked up and transported from the location specified in the Contract Documents. The Contractor shall ensure that all components are safely connected, secured or packaged prior to transporting the controller.

The Owner guarantees to the Contractor that the controller and all associated equipment is free of any defects.

622.07.02 Controller Supplied by the Contractor

When the Contractor supplies the controller, the Contractor shall carry out all pre-shipping shop tests specified in the Pre-installation Testing and Inspection clause.

Acceptable storage and testing facilities with temperature and humidity regulated environment shall be provided.

Each traffic signal controller cabinet shall be a model 332 traffic signal controller cabinet capable of 2 to 8 phase operation. Each traffic signal controller cabinet shall be complete with mounting pedestal base, uninterruptible power supply (UPS), 170 type traffic signal controller, conflict monitor, and all other equipment required to perform its intended function, either in standalone operation or as part of the ministry's traffic signal control system, according to the timing sheets, PHM-125 drawing, and the Contract Documents. Without limiting the foregoing, each traffic signal controller cabinet shall include the components listed in Table 1.

All traffic signal control equipment shall be according to the Ontario Traffic Signal Control Equipment Specifications (OTSCES) or the Caltrans Transportation Electrical Equipment Specifications (TEES).

Each traffic signal controller cabinet shall be supplied fully assembled and tested. The testing shall be carried out according to the MTO Operation Guidelines and Procedures in the MTO 170/332 Training Manual. The MTO 170/332 Training Manual may be purchased from the Ontario Section of the International Municipal Signal Association.

All temporary traffic signal controllers shall be equipped with an UPS system.

622.07.03 Timing of Work

The controller shall be installed and the controller cabinet shall be energized within 48 hours of shipment from the place of storage.

622.07.04 Signal Controller Cabinet and UPS Cabinet

622.07.04.01 Pole Mounted Controller Cabinet

Cabinets shall be installed complete with all mounting brackets, hardware stainless steel strapping and pole mounted conduits and fittings.

Pole mounted controller cabinets shall be located such that:

- a) A person operating the controls will be facing the intersection.
- b) The edges of the cabinet do not protrude over a sidewalk or beyond the pole in the direction of the pavement.
- c) Pole handholes and pedestrian push-buttons remain unobstructed.

622.07.04.02 Pad Mounted Controller Cabinet

The cabinet shall be installed complete with all hardware and accessories in an orientation that allows a person operating the controls to face the intersection.

The neoprene gasket shall be attached squarely and symmetrically on the bottom channel of the cabinet prior to installation, with holes for mounting bolts drilled where necessary.

Anchor bolts shall be secured in place in the locations specified in the manufacturer's instructions or where bolt holes have been provided.

Clear silicone shall be used as a sealant between the top of an extension and the bottom of the controller cabinet.

622.07.04.03 Pedestal Mounted Controller Cabinet

Pedestals for controller cabinet mounting shall be installed in an orientation that allows a person operating the controls to face the intersection.

In earth, where the excavation extends beyond the neat limits, concrete may be placed to the undisturbed ground or the concrete encasement may be formed.

The excavation shall be backfilled with native material and compacted according to OPSS 501.

Where bedrock is encountered, rock excavation shall be done such that a minimum of 600 mm length of steel pedestal can be installed in sound rock. The bottom of the pedestal shall be cut off to obtain the proper controller mounting height above finished grade. Rock excavation shall be according to OPSS 603.

The cabinet shall be installed complete with all hardware and accessories.

622.07.04.04 Power Connection

Low voltage feeder cables shall be connected to the controller cabinet. The neutral shall be connected to the AC-terminal bus.

622.07.04.05 Equipment Ground

Stranded copper ground cable shall be installed between the controller cabinet ground bus and the service ground bus. Connections shall be according to OPSS 609 and the manufacturer's drawings or instructions.

For microprocessor type controllers, the AC-terminal bus shall not be grounded to the cabinet or connected to logic ground.

622.07.04.06 Pad Mounted UPS Cabinet

The pad mounted UPS cabinet shall be installed on a pedestal manufactured of the same material as the traffic signal controller cabinet and supplied with the same lock and key. The pedestal shall be anchored to the pad and secured in place at the location specified according to the Contract Documents.

The UPS control unit and the UPS automatic switch shall be installed in the traffic signal controller cabinet according to the Contract Documents. A forced flash relay shall be installed in the traffic signal controller cabinet to allow flash operation when initiated by the UPS control unit. All wiring shall be according to the Contract Documents.

622.07.04.07 Pole Mounted UPS Cabinet

The pole mounted UPS cabinet including batteries and heating pads shall be installed complete with all mounting brackets, hardware, stainless steel strapping and pole mounting conduits and fittings.

The edges of the cabinet shall not protrude over a sidewalk or roadway pavement. The cabinet shall not obstruct access to the pole handhole and pedestrian pushbuttons.

The UPS control unit and the UPS automatic switch shall be installed in the signal controller cabinet according to the Contract Documents. A forced flash relay shall be installed in the traffic signal controller cabinet to allow flash operation when initiated by the UPS control unit. All wiring shall be according to the Contract Documents.

622.07.04.08 UPS Automatic Switch, Forced Flash Relay and Heater/Fan breaker

The UPS automatic switch, forced flash relay, heater/fan breaker and terminal block shall be installed in the signal controller cabinet according to the Contract Documents.

622.07.05 Installation of Controller Equipment

622.07.05.01 Shelf-mounted Equipment

Shelf-mounted controller equipment shall be neatly and suitably arranged on the shelves such that all preformed wiring harnesses are of adequate length to allow connections and may be trained to out-of-the-way locations. Similar items of equipment shall be grouped together. All equipment shall be installed with the front facing outward such that the main operational controls and switches are readily accessible.

622.07.05.02 Rack-mounted and Jack-mounted Equipment

Controller equipment shall be installed only in the racks or jacks intended for use with the particular item of equipment. Equipment shall be installed within the guide provided and shall be set snug so as to lock into any motherboard, channel or connection specified.

622.07.05.03 Cabinet Wall-mounted Equipment

Equipment shall be installed level and clear of nearby components. The equipment shall be bolted in place with 5 mm diameter stainless steel machine bolts, nuts and lock washers.

622.07.05.04 Identification of Equipment

Equipment used for different traffic phases or operations shall be identified by traffic phase with labels of plastic embossed tape.

622.07.05.05 Wiring and Connections

All connections to terminal boards or screw type equipment terminals shall be made with insulated fork-tongue compression connectors only when using stranded cable. All wiring to bulkhead connectors on equipment housings shall be made with military specification (MS) bayonet type connectors according to the Contract Documents or in the manufacturer's drawings.

All connector joints for use with extra-low voltage systems shall be soldered, with the joint metals preheated to the flow temperature of the solder.

Traffic signal cables shall be connected to the terminal board address as assigned on the Contract Drawings. The controller output circuit assigned shall match the proper traffic signal cable circuit. The traffic signal cable neutral(s) shall be securely connected to the AC-bus in the cabinet.

Extra-low voltage cables and interconnection cables shall have the outer jacket removed to expose approximately 150 mm of the shielding and/or drain wire. The shielding or drain wire for all cables serving a similar function shall be twisted together and soldered with a green #10 AWG minimum insulated ground lead securely connected to the cabinet ground bus.

Upon completion of wiring and connections, all incoming cables shall be bundled and held in place with nylon cable ties.

Unused conductors shall be terminated with insulated wing nut vibration proof spring connectors, leaving sufficient cable to reach terminal boards. Incoming cables shall be identified as follows:

- a) Extra-low voltage cable shall be identified with PVC sleeve wire markers having the same number as the traffic phase served.

- b) Traffic signal cable shall be identified with PVC sleeve wire markers placed over the outer multi conductor cable, naming the corner of the intersection that the cable is routed towards such as "northeast", "south-west", etc.
- c) Interconnection cable shall be identified similar to traffic signal cable, naming the direction that the cable is routed towards such as "north", "south", etc.

622.07.05.06 Controller Security

The controller cabinet shall be kept locked during all non-working times. Upon completion of the work, the controller keys shall be given to the Contact Administrator.

622.07.06 Quality Control

622.07.06.01 Pre-installation Testing and Inspection

622.07.06.01.01 General

All tests shall be completed prior to transporting the controller to the Working Area.

Traffic signal controllers, UPS systems, and other components shall be inspected prior to installation to ensure that they are according to the Contract Documents.

622.07.06.01.02 Cabinet Assembly and Components

A visual check shall be made to ensure that all components necessary to the complete controller are present and that all pre-assembled equipment is securely mounted and connected.

622.07.06.01.03 Circuit Output

The output terminal board voltage shall be tested for 108 V minimum output from load switches and for proper terminal assignment according to the manufacturer's wiring diagram.

622.07.06.01.04 Interval Sequence

With the proper programming for the intersection in operation but with modified timing values suitable to test conditions, the controller unit shall be cycled through all phases for a minimum of six hours. Controller output shall be tested to ensure that the proper phases and phase intervals appear in the correct sequence by use of a 120 V test board with lamps or by use of a 24 V test board with LED or other appropriate indicators wired to the input side of the load switches. Test results shall be confirmed a minimum of six times.

622.07.06.01.05 Actuation

With an appropriate test board, the effect of detection devices and pedestrian push-buttons in entering a call to the controller unit shall be tested. All modes of detector sensor unit program and vehicle extension calls shall be tested. Tests shall confirm that all calls are registered, activated and are associated with the correct traffic phase.

622.07.06.01.06 Conflict Monitor

The conflict monitor shall be tested by removal of the monitor programming card or by methods recommended by the manufacturer. Diode breakouts in the monitor card shall be according to the signal operation required. All flash and reset functions shall be tested.

622.07.06.01.07 Flasher

The output of flasher units and flash transfer relays shall be tested for proper functioning over a two hour period.

622.07.06.01.08 Recall

Recall switch functions for each phase shall be tested to ensure that the controller recalls to the phase selected and remains on 'hold' in the absence of a call on an opposing phase.

622.07.06.01.09 Programming

With actual phase timing for the intersection operational, the controller programming or cam breakouts shall be tested to ensure that the intended operation is accomplished. This test shall include all possible combinations of actuation and recall settings together with any special features such as advance green, phase skip, pre-emption or co-ordination.

622.07.06.01.10 Manual Control

The manual over-ride controls shall be tested for proper operation under all possible switching combinations.

622.07.06.01.11 Environmental Protection

The heater element and circuitry shall be tested for continuity and proper resistance. The ventilation fan shall be checked for proper operation in conjunction with the thermostat control system. If the average temperature during the installation period is below 5°C and falling, the cover plate shall be installed over the louvres and the heater circuit shall be prepared for operation.

622.07.06.02 Proof of Performance Testing and Inspection

622.07.06.02.01 Controller

These tests shall be performed upon installation of the controller. The controller shall be allowed to operate functionally only after all testing has been completed and all components are operational.

The Contract Administrator and ministry electrical staff shall be notified of the time and location of all testing 3 Business Days prior to the start of each test.

The work shall be inspected and tested 3 Business Days prior to the actual switch on of the signals to ensure that it according to the requirements of the Contract Documents and without limiting the foregoing, the Contractor shall ensure the following:

- a) All components are installed, tested and proven as indicated in the Contract Documents.
- b) All systems are energized and in working order
- c) The signal timing is consistent and complete, without activating the traffic signals for public display.

The testing and inspection results shall be documented in a report and submitted to the Contract Administrator within 3 Days of completion of the testing and inspection.

622.07.06.02.02 Signal Cable

All traffic signal cable circuits shall be tested disconnected for continuity and the absence of short circuits as determined by an ohmmeter test.

622.07.06.02.03 120 V Test

The operation of all signal head lamps and the absence of short circuits shall be tested by progressively connecting each active signal cable conductor to the AC+ bus through a temporary 10A fuse bypassing the load switches.

622.07.06.02.04 Interval Sequence

With the proper programming and timing functions in operation, the controller shall be cycled through all phases for a minimum of 1 hour with all signal circuits connected but with signal heads covered.

622.07.06.02.05 Actuation

All calls shall be observed to be registered and activated. Actuation equipment shall be tested according to OPSS 623.

622.07.06.03 Testing of UPS System

The UPS system shall be activated according to the manufacturer's recommendations. The Contractor shall be responsible for all testing and documentation required to establish acceptance of the installation and operation of material supplied.

622.07.06.03.01 Pre-installation Testing and Inspection of UPS System

Prior to the installation of the UPS system, the UPS system shall be tested and inspected to verify that it performs according the manufacturer's specifications and the Contract Documents. In particular, and without limiting the foregoing, the UPS system shall be operated and tested to verify the following:

- a) Transfer time in case of power failure is less than 60 milliseconds.
- b) Voltage regulation at 120 VAC is +/- 3 percent.
- c) Frequency regulation at 60 Hz is +/- 3 Hz.
- d) Thermostat controlled battery heating mats operate according to the manufacturer's specifications.
- e) When powered by the batteries alone, the UPS system provides full signal operation at full load for a minimum of 4 hours, and then switches over to flashing operation and provides flashing operation for a further 6 hours.

Prior to installation, certification from the manufacturer stating that the product is according to the Contract Documents shall be submitted to the Contract Administrator. This certification shall include an explicit certification that, when powered by the batteries alone, the UPS system provides full signal operation at full load for a minimum of 4 hours, and then switches over to flashing operation and provides flashing operation for a further 6 hours.

622.07.06.03.02 Proof of Performance Testing and Inspection

The UPS system and all components shall be tested and inspected to verify that it performs according to the manufacturer's specifications and the Contract Documents.

The proof of performance testing and inspection shall include all testing and inspection identified under the Pre-installation Testing and Inspection clause and the testing of grounding equipment according to OPSS 609.

In particular, and without limiting the foregoing, the Contractor shall ensure that all components are installed, tested and proven as specified in the Contract Documents. In addition, the Contractor shall perform visual inspection on the installed UPS system and perform all tests on grounding of equipment according to OPSS 609.

The testing and inspection results shall be documented in a report and submitted to the Contract Administrator within 3 Days of completion of the testing and inspection.

622.07.06.03.03 Testing for New UPS System "Switch On"

A new UPS system installed at a location not previously equipped with a UPS system or to replace an existing UPS system shall be initially switched on for operation according to the following requirements:

- a) The Contract Administrator shall be given a minimum of 3 Business Days notice of when the UPS system is to be installed or switched over and 24 hours notice prior to the start of the work.
- b) All repairs or replacement of defective components shall be completed prior to activation.
- c) Switch on for operation of UPS shall not be permitted on Fridays, Saturdays, Sundays, Mondays, and statutory holidays.
- d) Switch on for operation of UPS shall be under police supervision.

622.07.07 Traffic Signal Controller Modifications

Traffic signal controller modifications shall include the following:

- a) Relocation, rearrangement repair or replacement of traffic signal controller components.
- b) Modification to actuation equipment.
- c) Modification to interconnection equipment.
- d) Removal and salvage or disposal of components according to OPSS 610.

622.07.08 Traffic Signal Control Programming and Timing

Traffic signal interval timing as provided on the Generic Signal Timing Sheet specified in the Contract Documents shall be installed into the traffic signal controller only after verifying that it is complete and consistent and all controller and conflict monitor programming is installed and all timing controls, switches and programming controls are set.

The temporary traffic signals shall have full manual mode operation functionality to allow an operator to interrupt the other modes (e.g. fixed time or actuated) and return to the previous mode when finished.

When directed by the Contract Administrator, the traffic signal operation shall be manually overridden to operate in fixed/actuated or manual as required to reduce or eliminate queuing traffic. The date, start and end time of each manual override occurrence shall be recorded in a log book as specified elsewhere in the Contract Documents.

All routine and emergency maintenance work required for 24-hour operation of the temporary traffic signals shall be performed as specified in the Contract Documents.

622.08 QUALITY ASSURANCE

The testing of the traffic signal controller and UPS system performed by the Contractor shall be witnessed by the Contract Administrator and the Ministry electrical coordinator or inspector. The Contract Administrator shall also be in attendance during the "turn-on" of the traffic signal.

622.09 MEASUREMENT FOR PAYMENT

622.09.01 Actual Measurement

622.09.01.01 Traffic Signal Controllers

For measurement purposes, a count shall be made of the number of traffic signal controllers installed.

622.09.01.02 Traffic Signal Controllers Modifications

For measurement purposes, a count shall be made of the number of traffic signal controllers modified.

622.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

622.10 BASIS OF PAYMENT

622.10.01 Traffic Signal Controllers - Item

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Materials to do the work.

622.10.02 Traffic Signal Controller Modifications – Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Materials required to modify traffic signal controllers, and such work shall include the removal, salvage, installation, relocation, rearrangement, repair or replacement of components.

622.10.03 Rock Excavation

Payment for rock excavation shall be according to OPSS 603.

Table 1
Traffic Controller Components

Item Quantity	Description
1	170 type traffic signal controller
1	Conflict Monitor
1	412C Prom Module with McCain's MTO 233ON1.D local intersection control program
0	412C Prom Module with McCain's MTO 245FM02.09.16 field master control program local intersection control program
1	412C Prom Module with the latest MTO approved McCain PROM Chip
8	Loop Detector, Model 222
8	Load Switch, Model 200
8	DC Isolator, Model 242
1	AC Isolator, Model 252
1	Uninterruptible Power Supply (UPS) system
1	Bell Mobility Sierra GX400 Modem with I/O module Note: To be supplied by the Owner.
1	170 Communication board M33329 Rev B or later (Serial to Ethernet).
1	Cat 5E Ethernet Cable – 2 metres
1	BMAX 824/1850 Antenna
1	GPSPSM-MSMA/MSMA (stud mount) Antenna base.

Figure 1
Arc Flash and Shock Hazard Warning Label

	
Arc Flash and Shock Hazard Location: _____	
Arc Flash	Shock
Working distance: 460 mm (19 in.) Incident energy: 4.4 cal/cm² Arc Flash Boundary: 870 mm (35 in.)	Nominal system voltage: 60 VDC Limited approach: 1000 mm (40 in.) Restricted approach: 300 mm (12 in.)
Minimum PPE Requirements: PPE according to CSA Z462 Arc Flash PPE Category 2 and all other PPE required for protection from battery hazards	
Analysis Date: October 2015	



CONSTRUCTION SPECIFICATION FOR TRAFFIC ACTUATION EQUIPMENT

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623.01 SCOPE

This specification covers the requirements for the installation of vehicular and pedestrian traffic actuation equipment.

623.02 REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Underground Ducts
OPSS 604	Installation of Cables
OPSS 609	Grounding

Ontario Ministry of Transportation Publications

Ontario Traffic Manual

CSA Standards

B137.1-13	Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services
C22.2 No. 38-14	Thermoset-Insulated Wires and Cables (Tri-National Standard, with UL 44 and ANCE NMX-J-451-2014)
C22.2 No. 197- M1983 (R2013)	PVC Insulating Tape
C22.2 No. 85-14	Rigid PVC Boxes and Fittings
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 227.1-06 (R2016)	Electrical Nonmetallic Tubing (Bi-National standard, with UL 1653)

International Municipal Signal Association Specification

IMSA No. 51-5, Loop Wire

Canadian and Provincial Statutes

Accessibility for Ontarians with Disabilities Act (AODA), 2005, - O. Reg. 413/12: Integrated Accessibility Standards

623.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Non-Intrusive Detection means the operation of an aerial sensor unit in detecting and registering the presence of a vehicle

Non-Intrusive Detection System means an assembly of interdependent components composed of one or more microwave, radar, video, or other aerial detectors; software, firmware and hardware for processing of the detector signal; and, power and communication links providing traffic actuation inputs to a traffic signal controller or similar device.

623.04 DESIGN AND SUBMISSION REQUIREMENTS

623.04.01 Submission Requirements

623.04.01.01 Documentation

Three (3) copies of service manuals for the following equipment shall be submitted to the Contract Administrator:

- a) Non-intrusive detection system equipment
- b) Accessible pedestrian signals.

The service manuals for the equipment shall be according to the manufacturer's specifications and the Contract Documents.

623.05 MATERIALS

623.05.01 Cables

Cables for loop detectors shall be #14 AWG type RWU 90, x-link - 40°C rated 1000 V stranded copper conductor according to CSA C22.2 No. 38.

Cables for loop detectors in tubing shall be #14 AWG THHN rated 600 V stranded copper conductor with polyethylene tube, according to IMSA No. 51-5.

623.05.02 Probe Detectors

Probe detectors shall be as specified in the Contract Documents.

623.05.03 Ducts and Fittings

Flexible polyethylene ducts and fittings shall be according to CSA B137.1, Series 75.

Rigid PVC conduits and fittings shall be according to CSA C22.2 No. 211.2.

Electrical non-metallic tubing and fittings shall be according to CSA C22.2 No. 227.1.

623.05.04 Electrical Insulating Tape

Electrical insulating tape shall be according to CSA C22.2 No. 197, rated for - 18°C to 105°C use, 600 V.

623.05.05 Pedestrian Pushbuttons and Signs

Pedestrian pushbuttons shall be as specified in the Contract Documents.

Pedestrian pushbutton signs shall be according to the Ontario Traffic Manual.

623.05.06 Solder

Solder shall be 60/40 tin/lead mix, resin core type.

623.05.07 Sealant Compound

Sealant compound shall be of cold type or hot poured type.

623.05.08 Extra Low Voltage Splice Insulation Kit

Extra low voltage splice insulation kit shall be as specified in the Contract Documents.

623.05.09 Aerial Mounting Equipment

Fittings, accessories and hardware shall be as specified in the Contract Documents.

623.05.10 Junction Boxes and Fittings

Junction boxes and fittings shall be according to CSA C22.2 No. 85.

623.05.11 Prefabricated Detector Loops

Prefabricated detector loops shall be either prefabricated PVC detector loops or prefabricated heavy-duty rubber detector loops as specified in the Contract Documents.

623.05.11.01 Prefabricated PVC Detector Loops

Prefabricated PVC detector loops shall be constructed with rigid PVC conduit, filled with a flexible urethane. The corner of the loops shall be rounded to a radius of 100 mm with the same continued conduit without any visible malformation. A "T" type access conduit fitting shall complete the loops geometric form and allow for the junction lead-in conduit. The number of turns of the wires shall be as specified in the Contract Documents.

The wires in the prefabricated detector loop conduit shall come out of the "T" type fitting and be of adequate length to reach the traffic count station or the handholes without splices. After wiring, the end of the prefabricated PVC detector loop conduit shall be injected with malleable urethane. The number of turns per loop shall be as specified in the Contract Documents.

623.05.11.02 Prefabricated Heavy-Duty Detector Loops

Prefabricated heavy-duty rubber detector loops shall be constructed with 9 mm I.D. (17 mm O.D) reinforced rubber hose with a 1.72 MPa internal pressure rating. The hose for the loops shall be of one continuous piece. Hose "T" type connections constructed of high temperature rubber shall complete the loops geometric form and allow for the junction lead-in conduit. The ends of the "T" type access conduit fitting shall be of proper sizes to attach directly to the hose. The number of turns in the detector loop shall be as specified in the Contract Documents.

The wires used shall be No.16 THWN stranded copper. The wires shall come out of the "T" type fitting and be of adequate length to reach the traffic count station without any splice. The wires shall be twisted a minimum of ten turns per metre. After the insertion of the detector loop and lead-in wires, the hose shall be filled and sealed with a flexible sealant.

623.05.12 Traffic Count Station Type 1

623.05.12.01 Post

The post for the traffic count station type 1 shall be wooden; pressure treated and of the dimensions specified in the Contract Documents.

623.05.12.02 Terminal Electric Box

The terminal electric box (TEB) shall consist of a PVC electrical panel, conduit opening, and double-row barrier terminal block(s) with current capacity equal to the ampacity of #14 AWG stranded copper wire. The size and number of the terminal blocks and the size of the conduit opening shall suit the number of the detector loop cable leads.

The TEB for the traffic count station type 1 shall be constructed using a durable non-corrosive material, grey in colour, and shall be of the size specified in the Contract Documents.

The TEB shall have a cover of similar material or a piano hinge and hasp of similar non-corrosive material. The cover shall be attached to the TEB with four non-corrosive screws.

623.05.12.03 Assembly

The traffic count station Type 1 shall be completely assembled and installed as specified in the Contract Documents.

623.05.13 Traffic Count Station Type 2

623.05.13.01 Base

The base of the traffic count station type 2 shall be a pre-fabricated surface pin-lock base (SPLB). The base shall be constructed of a durable, non-corrosive material, which is black in colour. The dimension of the base diameter shall be smaller than the diameter of the electrical handhole cover over which the base shall be installed. The base shall be constructed in a way so that it can be attached to the electrical handhole, using non-corrosive replaceable fasteners.

623.05.13.02 Post

The post of the traffic count station type 2 shall be pre-fabricated, tubular in shape and made from a flexible, durable, non-discolouring white polypropylene. The post shall be strong enough to hold a terminal electric box. The post shall have two 75 mm wide strips of reflective high intensity amber sheeting, approximately 75 mm apart, located on its upper end. The post shall be of 914 mm in length and shall have a diameter, allowing the accommodation of the necessary number of detector loop cables.

The upper end of the post shall have an additionally installed 60 mm diameter PVC rigid reducer bushing, necessary for the installation of the terminal electric box on the post.

The lower end of the post shall be constructed in such a way that it can easily be mounted on the base (SPLB).

623.05.13.03 Terminal Electric Box

The TEB of the traffic count station type 2 shall be a PVC Rigid Conduit Access Fitting, Type LB ("L" shaped with back entry), constructed using a durable, UV and impact resistant, non-corrosive and non-metallic material, which is grey in colour.

The TEB shall have a cover of the same material and colour, and shall be fastened to the back of the box using two non-corrosive screws.

An ABS fitting cleanout adaptor with a plug having a minimum diameter of 25 mm shall be attached to the front of the TEB.

The bottom of the TEB shall be constructed in such a way, so that it can be mounted on the reducer bushing, already assembled together with the post.

623.05.13.04 Assembly

The traffic count station Type 2 shall be completely assembled with the parts listed above and installed as specified in the Contract Documents.

623.05.14 Accessible Pedestrian Signals

Accessible pedestrian signals (APS) shall meet the requirements of the Accessibility for Ontarians with Disabilities Act (AODA), Ontario Regulation 413/12 as specified in the Contract Documents.

Accessible pedestrian signals shall consist of all material required for the operation of the APS, including but not limited to, all APS displays, pushbuttons, hardware, software, firmware, housings, wiring, and all setup hardware and software required to set up and configure the APS.

Accessible pedestrian signals shall have a locator tone that is distinct from a walk indicator tone. The accessible pedestrian signals shall include both audible and vibro-tactile walk indicators.

The APS shall include both manual and automatic activation features.

The pushbutton locating tone shall be repeated every 1 second and each tone shall be less than 0.15 seconds in duration. The locator tone must be audible up to but not beyond 3.7 m from the pushbutton. The APS shall automatically adjust the locating tone to maintain the tone at 2 to 5 dB over the ambient noise level.

The industry standard “cuckoo” sound shall be used for the north-south direction of travel, and the “Canadian APS melody” sound shall be used for the east-west direction of travel. Where two APS assemblies are installed at the same corner, they must be a minimum of 3000 mm apart. If the separation of 3000 mm cannot be achieved due to site constraints, each APS assembly at that particular corner must play a verbal announcement stating which crossing is active. Each verbal announcement shall be as specified in the Contract Documents.

623.05.15 Non-Intrusive Detection System

The non-intrusive detection system equipment shall be according to the requirements as specified in the Contract Documents.

All hardware and software, including but not limited to all connecting cables, mounting brackets, detector port hubs, interface panels, cabinet wiring harnesses, processor units, set-up hardware, testing hardware, and firmware, shall be according to the non-intrusive detection system manufacturer's specifications and the Contract Documents.

623.06 EQUIPMENT

623.06.01 Slot-cutting Equipment

Slot-cutting equipment shall include a minimum 18 hp engine and a minimum 250 mm diameter diamond tooth blade adjustable between 20 mm and 100 mm depth of cut.

623.07 CONSTRUCTION

623.07.01 Loop Detectors

623.07.01.01 Layout

Loops detectors shall be laid out on the pavement accurate to the dimensions specified in the Contract Documents. Slot cutting lines shall be marked with non-permanent materials. Saw cutting of slots shall not begin until the loop layout has been inspected by the Contract Administrator.

Locations where the layout of a loop crosses a major pavement crack, butt, expansion joint or transition area shall be reported to the Contract Administrator. In such instances, the treatment for crossing the pavement irregularity shall be as specified in the Contract Documents; or, at the discretion of the Contract Administrator, the loop shall be re-marked into 2 separate loops, each beginning approximately 300 mm away from the irregularity.

623.07.01.02 Saw Cutting

Saw cutting of loop slots in pavement shall be in straight lines with slot depths and widths as specified in the Contract Documents. Corner cutting for slots shall be extended only far enough past each corner point to obtain the full depth of the slot. Slot crossing of pavement irregularities shall be constructed using additional widths and depths of slots as specified in the Contract Documents.

Where specified in the Contract Documents, saw cut marks shall be made on the curbs to indicate location of the loop.

623.07.01.03 Slot Preparation

Upon completion of saw cutting, the slot shall be cleaned with a pressurized water stream and dried by means of compressed air forced through a nozzle at a minimum pressure of 300 kPa. The air shall be heated to a maximum of 160 °C where required to remove excess moisture.

The corners of all slots shall be rounded using hand tools. All slots and corners shall be examined for protrusions of sharp stone aggregates or debris which may damage cable. Any such protrusions or debris shall be removed. Final slot preparation shall be done immediately prior to the installation of cable.

623.07.01.04 Flexible Duct Installation

A hole shall be drilled through the pavement to accommodate a flexible duct at the location specified in the Contract Documents.

All work for flexible duct installation, including earth excavation, backfill, removal and restoration, shall be according to OPSS 603.

623.07.01.05 Loop Cable

The loop shall be installed with the size, winding direction, configurations, number of turns and type of cables as specified in the Contract Documents.

The loop cable end which progresses clockwise shall be marked at the splice point with two bands of electrical insulating tape.

Cable in slots shall be firmly and carefully tamped in place using a blunt instrument on each successive turn of cable. To prevent floating, cables shall be held in place using 25 mm lengths of foam backer rod at 600 mm centres.

Where cables are installed in slots crossing pavement irregularities, all cables shall be installed through split neoprene tubing.

Loop cables between the loop and the splice point, including those in the slot, shall be twisted together to form a consistent lay of 10 turns per metre. The entire loop and lead cable system shall be formed of a continuous and unspliced length of cable.

Each loop cable and extra low voltage cable shall be identified with a vinyl sleeve wire marker in the splice point as shown on the Contract Drawings.

623.07.01.06 Sealant

All sealing compounds shall be installed in slots as protection for detector loop cables according to the manufacturer's instructions and recommendations for the type of installation (e.g. installation in top course versus installation in binder course).

The sealing compound shall be allowed to set prior to allowing vehicles to cross over the loop. Cement dust may be added to tacky sealant where necessary. Spilled detector loop sealant or other excess loop sealant on the road surface that is not within the detector loop slot shall be removed from the road surface.

a) Cold Type

Cold pumped sealant shall be installed using a pressure pump or cartridge gun.

b) Cold Type Single Component Polyurethane

Cold pumped single component polyurethane sealant shall be installed using a pressure pump or cartridge gun. Single component polyurethane sealant shall not be used when detector loops are to be installed in the binder course pavement prior to placement of the top course of pavement over the loops.

"Summer Grade" cold pumped single component polyurethane sealant shall not be used at ambient temperatures less than 20 °C.

"Winter Grade" cold pumped single component polyurethane sealant shall not be used at ambient temperatures less than 0 °C.

c) Hot-Poured Type

Hot poured sealant shall not be used when detector loops are to be installed in the binder course pavement prior to placement of the top course of pavement over the loops.

Hot poured sealant shall not be used when the ambient temperature is greater than 0 °C or less than minus 18 °C.

623.07.01.07 Splicing

Splices of cables shall be made only at the designated splice point. Cables shall be stripped of approximately 12 mm of insulation, twisted together with a minimum of four turns and soldered to produce a bonded connection with a maximum resistance of 0.1 Ohm.

Splices shall be insulated with four half-laps of electrical insulating tape and encased in a resin splice with the splices positioned to obtain a minimum coverage of 6 mm of resin around each splice. The black conductor of the extra low voltage cable shall be connected to the clockwise winding lead cable as specified in the Loop Cable clause.

The metallic shield of cables shall be cut off cleanly and left unconnected in the resin splice.

623.07.02 Probe Detectors

Slot preparation, flexible duct installation and splicing for probe detectors shall be as specified in the Loop Detectors subsection.

623.07.02.01 Aerial Installation

Probe detectors, cables, equipment and fittings, hardware, PVC junction boxes, and accessories necessary for the mounting of equipment on aerial messenger cable system shall be installed as specified in the Contract Documents. All compression nuts, locknuts and fitting hardware shall be securely tightened to prevent shifting of equipment by wind.

623.07.02.02 Underpavement Installation

Probe detectors shall be installed in holes vertically, according to the manufacturer's instructions.

Cable in slots shall be firmly and carefully tamped in place using a blunt instrument on each successive turn of cable. To prevent floating, cables shall be held in place using 25 mm lengths of foam backer rod at 600 mm centres.

Where cables are installed in slots crossing pavement irregularities, they shall be installed through split neoprene tubing.

623.07.02.03 Saw Cutting and Drilling

Saw cutting of slots in pavement shall be in straight lines with slot depths and widths as specified in the Contract Documents. Slot crossing of pavement irregularities shall be constructed using additional widths and depths of slots as specified in the Contract Documents.

Holes for probe detectors shall be 25 mm diameter at a depth of 460 mm below grade and in line with the saw cut slot.

623.07.02.04 Bedding and Sealant

Clean and dry silica sand shall be used as bedding for probe detectors. Sealant shall then be applied to the upper portion of the hole. Cold pumped sealant compound shall be installed using a pressure pump or cartridge gun according to the manufacturer's instructions.

The sealant compound shall be allowed to set according to the manufacturer's instruction prior to allowing vehicles to cross the probe detectors. Cement dust may be added to tacky sealant where necessary.

623.07.03 Pedestrian Pushbuttons

623.07.03.01 Installation

Pedestrian pushbuttons and signs shall be mounted on the side of the pole such that the pedestrian signal pushbutton sign arrow indicates the proper direction for which roadway crossing is required.

Pedestrian pushbuttons shall be installed with stainless steel self-tapping screws or stainless steel straps. A wiring aperture shall be drilled in metal poles and fitted with a rubber gromet or a rigid conduit shall be installed on poles, for wiring access.

Pushbuttons for metal poles shall be installed with an integral sign frame or separately mounted with stainless steel straps or screws where specified in the Contract Documents.

623.07.04 Prefabricated Loops

623.07.04.01 Installation

Prefabricated loops shall be installed as specified in the Contract Documents and as described below.

Prefabricated detector loops shall be accurately laid out to the dimensions specified in the Contract Documents when covered by paving materials.

Prefabricated PVC detector loops shall be installed for burial in granular base, for saw cut installation in subsurface pavement course, open-graded drainage layer, or for embedding in concrete.

Heavy-duty rubber detector loops shall be installed for saw cut installation in subsurface pavement course, open-graded drainage layer, or for embedding in concrete.

When installed in concrete with rebar, prefabricated detector loops shall be mounted a minimum 50 mm above the rebar grid and as specified in the Contract Documents.

Any extra length of wiring of the prefabricated detector loop shall be coiled in the electrical handhole.

623.07.04.02 Flexible Duct Installation

Flexible duct installation, including earth excavation, backfill, removal and restoration, shall be according to OPSS 603.

623.07.05 Traffic Count Station Installation

The work for traffic count station shall include the installation of traffic count station, regardless of type.

The traffic count station and all associated equipment shall be installed as specified in the Contract Documents.

623.07.06 Accessible Pedestrian Signals

The installation of APS shall meet the requirements of the AODA Ontario Regulation 413/12 and shall be installed according to the manufacturer's recommendations and the Contract Documents.

Accessible pedestrian signal pushbuttons shall be installed within 1,500 mm of the edge of the curb, and shall be mounted at a maximum of 1,100 mm above ground level as specified in the Contract Documents.

Accessible pedestrian signals shall have tactile arrows that align with the direction of crossing.

623.07.07 Non-Intrusive Detection System

Detectors shall be installed at locations and mounting heights specified in the Contract Documents and according to the manufacturer's guidelines. The detectors shall be oriented and configured for operation according to the manufacturer's specifications and the Contract Documents.

Wiring and cabling shall be installed according to OPSS 604 and shall run continuously from source to destination. Splicing of wires and cables shall not be permitted.

All cabling and equipment required to transmit, receive, and process non-intrusive detection signals shall be installed according to the manufacturer's specifications and the Contract Documents.

Anti-seize compound shall be applied to the mounting bracket.

Drip loops and expansion loops shall be formed at each pole or conduit entry and held free of the pole or of other cables or connections.

Cable shall be protected with rigid PVC conduit where slack lengths of more than 450 mm are externally exposed.

Setup equipment shall be ruggedized and shall have 1 serial port, 1 USB port, 1 ethernet port, and a daylight-readable display. The setup equipment shall include a ruggedized notebook or equivalent device. The setup equipment shall operate correctly in ambient temperatures from 5 to 35 °C.

Metal detector housings shall be connected to the pole ground connector, or the system ground wire in surface mounted PVC junction boxes. All grounding work shall be according to OPSS 609.

For installation on metal poles, wiring apertures shall be drilled as required. The apertures shall be located clear of the vertical seam and overlapping sections of sectional steel poles. Apertures shall be deburred and painted with grey zinc rich paint. Rubber grommets shall be installed after the paint has dried.

623.07.08 Quality Control

623.07.08.01 Pre-installation Testing and Inspection

Prior to installation, an inspection of the following shall be conducted to ensure they are according to the Contract Documents:

- a) Detection devices and connection components
- b) Prefabricated detector loops and components
- c) Traffic count stations

The Contractor shall ensure that the temperature is within allowable limits prior to saw cutting and ensure that any dampness or precipitation can be successfully blown out of saw cut slots prior to beginning installation.

Prior to the overlaying of asphalt, detector loop wiring shall be tested for continuity, for leakage to ground and for inductance. Resistance to ground shall be 10 megohm or greater. Inductance shall be within 25% of the value indicated in the Contract Documents using a 100 kHz signal at 5V. Any prefabricated detector loop not passing these tests shall be replaced.

Prior to installation of probe detectors, the coil resistance shall be tested and shall be within 25% of the manufacturer's rated resistance. For multiple installations of probe detectors, the set shall be tested for total resistance value. Any detector not passing the foregoing tests shall not be used.

623.07.08.01.01 Accessible Pedestrian Signals

Actuation devices and connection components shall have been inspected prior to installation to ensure that they meet the requirements of Ontario Regulation 413/12 of the AODA and the Contract Documents.

623.07.08.01.02 Non-Intrusive Detection System Equipment

Non-intrusive detection system equipment shall be tested and inspected prior to installation to verify that it performs according to the manufacturer's specifications and the Contract Documents.

623.07.08.02 Proof of Performance Testing and Inspection

The Work shall be inspected and tested to ensure that all components are according to the requirements of the Contract Documents.

When the installation of traffic signals is included in the contract, all auxiliary components such as sensor units shall be tested to ensure they are in working order without activating the traffic signals for public display.

The testing and inspection results shall be documented in a report and submitted to the Contract Administrator.

623.07.08.02.01 Detector Loops

Loop wiring shall be tested for continuity, leakage to the ground and for inductance as follows:

- a) Prior to sealing slots.
- b) At the controller cabinet upon the completion of splices, installation of extra low voltage cable, sealing of slots and backfilling of trenches.

Testing requirements shall be the same as specified in the Pre-installation Testing and Inspection clause. Any loop not passing these tests shall be replaced.

Loops to be replaced shall be re-cut in cut in the original slot with new wiring and sealant installed and retested.

623.07.08.02.02 Probe Detectors

Probe detectors shall be tested at the splice point for coil resistance and leakage to the ground prior to sealing all slots and holes. Testing requirements shall be the same as specified in the Pre-installation Testing and Inspection clause.

For aerial installations, the coil resistance shall be tested at the controller cabinet upon the completion of splices to extra low voltage cables.

623.07.08.02.03 Pedestrian Pushbuttons

Upon completion of the installation of pedestrian pushbuttons, the APS system shall be tested at the controller cabinet.

623.07.08.02.04 Prefabricated Detector Loops

Loop wiring shall be tested for continuity, leakage to the ground and for inductance as follows:

- a) After covering with paving materials.
- b) At the controller cabinet or the traffic count station upon the completion of splices, installation of extra low voltage cable, sealing of slots and backfilling of trenches.

Resistance to ground shall be 10 megohm or greater. Inductance shall be within 25% of the value indicated in the Contract Documents.

623.07.08.02.05 Traffic Count Station

Upon completion of the installation of the traffic count station and the connection to the loops, the APS system shall be tested for its wiring continuity, leakage to ground and inductance, as specified in the Prefabricated Detector Loops clause.

623.07.08.02.06 Accessible Pedestrian Signals

The installed APS shall be inspected and tested to confirm that they meet the requirements of Ontario Regulation 413/12 of the AODA and the Contract Documents. The APS shall be tested according to the manufacturer's recommendations.

623.07.08.02.07 Non-Intrusive Detection System

Each non-intrusive detection system shall be inspected and tested to verify that it performs according to the manufacturer's specifications and the Contract Documents. In particular, and without limiting the foregoing, the Contractor shall ensure that all components are installed, tested, and proven to work as indicated in the Contract Documents, and that all cables are energized and in working order.

623.07.08.03 Testing and Training for Non-Intrusive Detection System "Switch On"

A new non-intrusive detection system at a location not previously equipped with a non-intrusive detection system, or a new non-intrusive detection system to replace an existing detection system, shall be switched on for operation according to the following requirements:

- a) The Contract Administrator shall be given a minimum of 3 Business Days' notice of when the new detection system will be installed or switched over, and shall reconfirm that the work will be done as scheduled 24 hours prior to doing the work.
- b) The Contractor shall provide training from the manufacturer to ministry staff, up to a maximum of six (6) persons, on the following topics:
 - i. Overview of the non-intrusive detection system
 - ii. Hardware and software operation
 - iii. Field setup procedures (detection zones setup)
 - iv. Configuration procedures and techniques
 - v. Operation and maintenance of the detection system
- c) The training shall include hand-outs and reference material for each participant.
- d) Training shall be completed on or before the detection system is installed and operational.
- e) The setup equipment shall be handed over to the MTO electrical coordinator responsible for the maintenance of the non-intrusive detection system equipment, at the time of training.
- f) All repairs or replacement of defective components shall be complete prior to activation.
- g) Non-intrusive detection system "Switch On" for operation shall not be permitted on Fridays, Saturdays, Sundays, Mondays, or statutory holidays.
- h) Traffic shall be under police supervision during this operation.

The Contract Administrator may witness any test performed and may make random inspections of the work.

The accessible pedestrian signals shall be tested in the presence of the Contract Administrator and the ministry's electrical coordinator.

The Contract Administrator may provide direction for the aiming of non-intrusive detectors or the adjustment of the non-intrusive detection system.

623.08 QUALITY ASSURANCE

623.08.01 General

The Contractor shall give the Contract Administrator 24 hours notice of when final tests are to be performed. The final tests shall be done after all work is completed.

The Contract Administrator shall witness all final tests. All test results shall be submitted to the Contract Administrator.

The accessible pedestrian signals shall be tested in the presence of the Contract Administrator and the ministry's electrical coordinator.

The Contract Administrator and the ministry's electrical coordinator may witness any testing performed and may make random inspections of the work.

The Contract Administrator may provide direction for the aiming of non-intrusive detectors or the adjustment of the non-intrusive detection system.

The Contract Administrator may witness any test and may make random inspections of the work.

623.08.02 Loop Detectors

Prior to sealing slots, loop wiring shall be tested for continuity, for leakage to ground and for inductance. Resistance to ground shall be 10 mega ohm or greater. Inductance shall be within 25% of the value indicated in the contract using a 100 kHz signal at 5V.

Upon completion of splices, installation of extra low voltage cable, sealing of slots and backfilling of trenches, the foregoing tests shall be repeated at the controller cabinet.

Any loop detector required to be replaced shall be re-cut in the original slot with new wiring and sealant installed. All such loops shall be tested to conform to the foregoing requirements.

623.08.03 Probe Detectors

Prior to installation of probe detectors, the coil resistance shall be tested and shall be within 25% of the manufacturer's rated resistance. For multiple installations of probe detectors, the set shall be tested for total resistance value. Any detector not passing the foregoing tests shall not be used.

623.08.03.01 Aerial Installation

Upon completion of splices, installation of extra low voltage cable, the coil resistance shall be tested at the controller cabinet.

623.08.03.02 Underpavement Installation

Prior to sealing of slots and holes for probe detectors, the coil resistance shall be tested at the splice point. The probe detectors shall also be tested for leakage to ground at the splice point.

623.08.04 Pedestrian Pushbuttons

Upon completion of the installation of the pedestrian pushbuttons, the system shall be tested at the controller cabinet.

623.09 MEASUREMENT FOR PAYMENT

623.09.01 Actual Measurement

623.09.01.01
Loop Detectors
Loop Detectors (Temporary)
Probe Detectors
Probe Detectors (Temporary)
Pedestrian Pushbuttons
Pedestrian Pushbuttons (Temporary)
Prefabricated Detector Loops
Traffic Count Station

For measurement purposes, a count shall be made of the number of loops, detectors, pushbuttons and traffic count stations installed.

623.09.01.02
Accessible Pedestrian Signals
Accessible Pedestrian Signals (Temporary)
Non-Intrusive Detection Systems
Non-Intrusive Detection Systems (Temporary)

For measurement purposes, a count shall be made of the number of intersections where accessible pedestrian signals and non-intrusive detection systems are installed. Each intersection shall be counted only once, regardless of the number of times all or part of the accessible pedestrian signals or non-intrusive detection systems are relocated.

623.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

623.10 BASIS OF PAYMENT

623.10.01
Loop Detectors - Item
Loop Detectors (Temporary) – Item
Probe Detectors - Item
Probe Detectors (Temporary) - Item
Pedestrian Pushbuttons – Item
Pedestrian Pushbuttons (Temporary) - Item
Prefabricated Detector Loops - Item
Traffic Count Station - Item
Accessible Pedestrian Signals – Item
Accessible Pedestrian Signals (Temporary) - Item
Non-Intrusive Detection Systems – Item
Non-Intrusive Detection Systems (Temporary) – Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials required to do the work, including, but not limited to, installation, removal, salvage, relocation, reinstallation, rearrangement, and recalibration of all equipment system components.

Payment for loop detectors that were to be constructed as a single loop but constructed as two loops due to pavement irregularities, as directed by the Contract Administrator, shall be made at the Contract price plus 20%.



**CONSTRUCTION SPECIFICATION FOR
INSTALLATION OF SECTIONAL STEEL
HIGH MAST LIGHTING POLES**

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630-A	Commentary

630.01	SCOPE

This specification covers the requirements for the installation of sectional steel high mast lighting poles complete with raising and lowering equipment, including mechanical and electrical components.

630.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

630.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

630.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 2471	Sectional Steel High Mast Lighting Poles
OPSS 2476	Raising and Lowering Equipment for High Mast Lighting Poles

CSA Standards

S6-14	Canadian Highway Bridge Design Code

630.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

630.04 DESIGN AND SUBMISSION REQUIREMENTS

630.04.01 Submission Requirements

630.04.01.01 Assembly of Sectional Steel High Mast Lighting Poles

Installation drawings, calculations, and procedures shall be submitted to the Contract Administrator at least 14 Days prior to the commencement of scheduled start of pole assembly for approval. An Engineer shall affix his or her seal and signature on the installation drawings, calculations, and procedures verifying that they are consistent with the Contract Documents and sound engineering practices.

These installation drawings, calculations, and procedures shall include all details of equipment to be used in jacking the sections together and lifting the assembled pole, including placing and securing it on the anchorage assembly.

630.04.01.02 Training Certificate

A certificate of training from the manufacturer of the high mast lighting raising and lowering equipment for each person who will be doing the installation work shall be submitted to the Contract Administrator. The certificates shall be submitted 14 Days prior to the commencement of the installation work, and the work shall not proceed until the certificates are accepted by the Contract Administrator. Training certificates that are 5 years old or more shall not be accepted.

The training certificate shall state that the manufacturer certifies that the individual has successfully completed training in the following areas:

- a) Assembly of the pole sections.
- b) Assembly of the raising and lowering equipment.
- c) Operation of the raising and lowering equipment.
- d) Installation of high mast poles and lighting equipment.
- e) Levelling of the luminaire ring assembly.
- f) Inspection of high mast poles and lighting equipment.
- g) Maintenance and repair techniques for sectional steel high mast lighting equipment.
- h) Safety procedures.

The training certificate shall be dated and signed by officers of the manufacturer and shall indicate the dates that the training was provided.

630.05 MATERIALS

630.05.01 Sectional Steel High Mast Lighting Poles

Sectional steel high mast lighting poles shall be according to OPSS 2471 and as specified in the Contract Documents.

630.05.02 Raising and Lowering Equipment

Raising and lowering equipment shall be according to OPSS 2476.

630.07 CONSTRUCTION

630.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

630.07.01.01 Ordering Sectional Steel High Mast Lighting Poles and Raising and Lowering Equipment

Immediately following the award of the Contract, the high mast lighting poles and the raising and lowering equipment shall be ordered, as required for this Contract. All necessary measures shall be taken to ensure sectional steel high mast lighting poles and the raising and lowering equipment are 100% compatible and fully functional.

Verification of the delivery dates of the high mast lighting poles and the raising and lowering equipment shall be obtained from the suppliers and submitted to the Contract Administrator within 72 hours after the award of the Contract.

Timely and accurate communication shall be maintained with both the Owner and the suppliers regarding the delivery, schedules, and requirements for the high mast lighting poles and the raising and lowering equipment.

Delivery and off-loading of the sectional steel high mast lighting poles and the raising and lowering equipment shall be completed in a timely and efficient manner.

630.07.02 Sectional Steel High Mast Lighting Poles and Equipment

630.07.02.01 Assembly of Sectional Steel High Mast Lighting Poles

The lifting equipment used in contact with the pole sections shall be non-abrasive in nature.

Sectional steel high mast lighting poles shall be assembled so that all sections for individual poles are matched as fabricated. The completed sectional steel high mast lighting pole shall be according to the overall tolerances specified in the Contract Documents.

630.07.02.02 Raising and Lowering Equipment

The raising and lowering equipment and the mechanical and electrical components shall be installed according to the manufacturer's specifications and recommendations.

The raising and lowering equipment manufacturer shall be present during the equipment installation to ensure proper assembly procedures and commissioning.

630.07.02.03 Pole Installation

At least 14 Days prior to the start of pole installation, the Contract Administrator shall be informed, in writing, of the pending operation.

The anchorage setting templates shall be removed prior to installation of lighting poles.

The pole shall be installed plumb, with the base plate positioned and the door orientated as specified in the Contract Documents. The pole shall have adequate support during installation. The pole shall not be considered self-supporting until all fasteners in the base are tightened by the turn-of-nut method according to CSA S6.

A 12 mm square, welded, 19 AWG galvanized steel metal mesh shall be placed around the outside circumference of the anchor bolt circle, between the pole base plate and the footing after pole installation is completed.

The orientation of the high mast lighting pole shall be as specified in the Contract Documents.

630.07.02.04 High Mast Lighting Equipment

High mast lighting equipment shall be installed as specified in the Contract Documents.

630.07.03 Quality Control

630.07.03.01 Pre-Installation Testing and Inspection

The pre-installation testing and inspection of the high mast lighting pole complete with raising and lowering equipment, including mechanical and electrical components, shall be according to manufacturer's specification and the Contract Documents.

A letter of compliance from the manufacturer of the sectional steel high mast lighting pole equipment, certifying that the sectional steel high mast lighting pole equipment is according to the Contract Documents shall be submitted to the Contract Administrator by the Contractor.

Testing on the torque limiter shall be conducted on the internal drive raising and lowering equipment and on the portable power drill for the external drive raising and lowering equipment unit. The Contractor shall ensure that the torque limiter is set and functions according to the manufacturer's recommendations. The cord connecting the control to each raising and lowering motor or portable power drill shall be a minimum length of 13 m.

630.07.03.02 Proof of Performance Testing and Inspection

The ring assembly, including luminaires, and the raising and lowering equipment shall be fully raised, latched, unlatched, and fully lowered a minimum of five times for each installed sectional steel high mast lighting pole. After each raising and lowering sequence, every piece of the raising and lowering equipment shall be inspected to ensure that all components are functioning properly and are not damaged. The cables inside the pole shall be inspected. Twisted cables shall be untwisted prior to each subsequent raising and lowering sequence.

The following shall be inspected:

- a) Winch gear and housing.
- b) Winch cable.
- c) Supporting cables.
- d) Power cable.
- e) Ring assembly.
- f) Latching system.

If problems or deficiencies occur during the testing, the test shall be stopped and the problem or deficiency corrected. Once the problem or deficiency has been corrected, the testing process of the pole and associated material shall be repeated in full.

Each ring assembly and supporting cable shall be inspected and adjusted to ensure that the ring is level.

630.07.03.02.01 Certificate of Conformance

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Quality Verification Engineer shall affix his or her seal and signature to the completed Certificate of Conformance confirming the following:

- a) All of the high mast equipment at each high mast pole was tested and inspected.
- b) The high mast lighting raising and lowering equipment is in general conformance with the requirements of the Contract Documents.
- c) Each sectional steel high mast lighting pole has been installed plumb with the base plate positioned as specified in the Contract Documents.
- d) Each sectional steel high mast lighting pole and raising and lowering equipment passed the proof of performance testing and inspection.
- e) The torque limiter has been fully tested and verified to be fully functional according to the manufacturer's recommendations and the Contract Documents.
- f) The sectional steel high mast lighting pole jacking and installation procedures have been carried out according to the installation drawings, calculations, and procedures.
- g) At the end of the testing at each sectional steel high mast lighting pole, the ring assembly has been levelled, raised to the top of the pole, and fully and properly docked and latched to the head frame assembly at the top of the pole.

630.07.04 Document Submission

The service manual for the high mast lighting equipment shall document in detail the installation and operation of the high mast lighting equipment and components. It shall include clear and detailed illustrations indicating layouts of controls, displays, schematic and wiring diagrams, and other information required to correctly operate a fully assembled and operational high mast lighting unit, as well as the maintenance and service aspects of individual components.

The service manual for the high mast lighting equipment shall include part numbers and settings and options of installation and operation. The manual shall provide sections that completely describe the theory of operation using block diagrams, wiring and schematic diagrams, diagnostic and repair procedures, assembly instructions and drawings, component layout drawings, and acceptable manufacturers and suppliers of miscellaneous component parts.

Each manual for the high mast lighting equipment shall detail all major assembling, adjusting, and aligning procedures and identify all acceptable tolerances or variances. Manuals shall also include:

- a) Detailed specifications of major components.
- b) Copies of the Working Drawings specified in OPSS 2471 and OPSS 2476 reduced to 8½ x 11" paper format.
- c) Component warranty certificates.
- d) Operating instructions.
- e) All other relevant documents or drawings.

630.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

630.08 QUALITY ASSURANCE

The Owner may make random inspections of individual high mast lighting poles, visually check for proper assembly with related equipment, and witness the raising and lowering of the ring assembly.

630.09 MEASUREMENT FOR PAYMENT

630.09.01 Actual Measurement

**630.09.01.01 25 m Sectional Steel High Mast Lighting Poles and Equipment
30 m Sectional Steel High Mast Lighting Poles and Equipment
35 m Sectional Steel High Mast Lighting Poles and Equipment
40 m Sectional Steel High Mast Lighting Poles and Equipment
45 m Sectional Steel High Mast Lighting Poles and Equipment**

For measurement purposes, a count shall be made of the number of each size of sectional steel high mast lighting poles and equipment installed.

630.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

630.10 BASIS OF PAYMENT

**630.10.01 25 m Sectional Steel High Mast Lighting Poles and Equipment - Item
30 m Sectional Steel High Mast Lighting Poles and Equipment - Item
35 m Sectional Steel High Mast Lighting Poles and Equipment - Item
40 m Sectional Steel High Mast Lighting Poles and Equipment - Item
45 m Sectional Steel High Mast Lighting Poles and Equipment - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments shall be based on the following percentages of the Contract price for milestones accepted by the Contract Administrator:

- a) 35% for delivery of all high mast lighting poles and equipment
- b) 5% for certificate of training
- c) 20% for installation of all high mast lighting poles and equipment
- d) 40% for completed and signed Certificate of Conformance for all High Mast Lighting Poles and Equipment

Appendix 630-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
CONCRETE FOOTINGS AND MAINTENANCE PLATFORMS
FOR HIGH MAST LIGHTING POLES**

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631.09	MEASUREMENT FOR PAYMENT
631.10	BASIS OF PAYMENT
631.01	SCOPE

This specification covers the requirements for the installation of concrete footings and maintenance platforms for high mast lighting poles.

631.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

OPSS 906 Structural Steel for Bridges

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1202 Bearings - Elastomeric Plain and Steel Laminated
OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete
OPSS 1801 Corrugated Steel Pipe (CSP) Products
OPSS 2474 Anchorage Assembly - High Mast Lighting Pole

631.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Earth means as defined in OPSS 206.

631.05 MATERIALS

631.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

631.05.02 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

631.05.03 Structural Steel

Structural steel shall be according to OPSS 906.

631.05.04 Corrugated Steel Pipe

Corrugated steel pipe shall be according to OPSS 1801 and as specified in the Contract Documents.

631.05.05 Neoprene Pad

Neoprene pad shall be according to the plain bearing requirements specified OPSS 1202.

631.05.06 Granular A

Granular A shall be according to OPSS 1010.

631.05.07 Sleeves and Ducts

Sleeves and ducts shall be according to OPSS 603.

631.05.08 Anchorage Assemblies

Anchorage assemblies shall be according to OPSS 2474.

631.07 CONSTRUCTION

631.07.01 General

General requirements for electrical work shall be as specified in the Contract Documents.

Concrete footings and maintenance platforms for high mast lighting poles shall be as specified in the Contract Documents.

631.07.02 Concrete Footings for High Mast Lighting Poles

631.07.02.01 Earth Excavation

Excavation of the pole base shall be to the neat lines and grades specified in the Contract Documents. When additional excavation beyond the neat limits is required, such excavation shall be a minimum of 300 mm beyond the neat dimensions of the footing to accommodate backfill.

The Contractor is responsible for constructing excavations without disturbing the sides or bases of the excavation.

When rock is encountered, the earth excavation shall be widened to the dimensions suitable for rock excavation or rock drilling operations. Rock excavation shall be according to OPSS 603.

The Contractor is advised that variable subsurface conditions may be encountered at the high mast pole locations. When a Foundation Investigation Report containing information on the subsurface conditions is included in the Contract Documents, reference shall be made to the record of borehole nearest the high mast pole footings for an indication of subsurface conditions.

The Contractor shall assume that overburden has zones of non-cohesive soil and occasional cobbles and boulders, and that groundwater levels are near the surface. The Contractor is advised that non-cohesive soil is susceptible to disturbance under conditions of unbalanced hydrostatic head.

631.07.02.02 Caisson Pile

Caisson piles shall be as specified in the Contract Documents and placed according to OPSS 903.

The base of the caisson or shallow foundation shall be cleaned of loosened or softened materials or both and inspected prior to pouring concrete. Complete documentation of the inspection and installation of each caisson shall be maintained and submitted to the Contract Administrator.

631.07.02.03 Steel Reinforcement

Steel reinforcement shall be placed according to OPSS 905.

631.07.02.04 Anchorage Assemblies

Anchorage assemblies of the size, diameter, length, and type specified in the Contract Documents shall be positioned in footings to obtain the proper position and handhole orientation.

The anchorage assemblies, sleeves, and ducts shall be properly placed in the centre of the concrete footings within a 15 mm tolerance.

Anchorage assemblies shall be securely tied to the steel reinforcement and provided with supports to maintain the position of the anchorage assembly during the placing of concrete. The anchorage assembly shall not be welded to the steel reinforcement.

The anchorage setting templates shall remain in place until immediately prior to the installation of the poles.

631.07.02.05 Sleeves and Ducts

Sleeves and ducts for footings shall be located to suit incoming duct or cable systems and shall be securely tied to the steel reinforcement and supported prior to the placing of concrete.

The number of sleeves shall be as specified in the Contract Documents.

Sleeves shall be cut off cleanly above the footing to a minimum of 150 mm above the pole base plate.

Sleeves shall be temporarily plugged or sealed until wiring is installed.

631.07.02.06 Concrete

Concrete shall be placed according to OPSS 904, except as noted herein.

In earth, concrete may be placed directly against the undisturbed earth or may be formed in place such that a minimum of 300 mm all around the footing is available for the placing of granular backfill. The upper portion of the footing shall be formed to a minimum of 150 mm below grade level. Formwork shall be removed to a minimum depth of 150 mm below finished grade prior to placing granular backfill.

In rock, concrete shall be placed directly against the excavated rock surfaces. Portions of footings in earth above the top of the rock surface shall be formed as noted in the previous paragraph.

Prior to the installation of the pole, the concrete shall have reached the minimum strength specified in the Contract Documents.

Concrete for the high mast lighting pole footings shall be cured according to OPSS 904, except as noted herein.

- a) Wet burlap shall be applied to the top surface of the footing immediately after completion of the finishing operation without damaging or marring the surface of the concrete and shall be kept wet during the curing period.
- b) When white pigmented membrane is used as a curing compound on adjacent concrete barrier wall, a minimum of one coat of the curing compound shall be applied to the concrete footing immediately after completion of the curing cycle for the footing. Additional curing compound shall be applied as necessary to ensure colour uniformity with the adjacent concrete barrier wall.
- c) The curing compound shall only be used on the exposed final surfaces of the footing. Curing compound shall not be applied to construction joints.

631.07.02.07 Granular Backfill

Granular A backfill shall be placed around footings in earth and compacted according to OPSS 501.

631.07.02.08 Granular Apron

A granular apron consisting of Granular A shall be placed around each high mast lighting pole footing as specified in the Contract Documents.

631.07.02.09 Grading

Earth grading around the high mast lighting pole footings shall be as specified in the Contract Documents and OPSS 206.

631.07.03 Maintenance Platforms for High Mast Lighting Poles

631.07.03.01 Neoprene Pad

The size of the neoprene pad shall be as specified in the Contract Documents.

631.07.03.02 Fabrication, Delivery, and Installation

Fabrication, delivery, and installation of the platform and railing shall be according to OPSS 906 and the Contract Documents.

631.07.03.03 Grounding

Grounding shall be according to OPSS 609.

631.07.03.04 Mechanical Concrete Anchors

Mechanical concrete anchors shall be installed in accordance with the manufacturer's recommendations.

631.07.04 Inspection before Installation of High Mast Lighting Poles

A Request to Proceed shall be submitted to the Contract Administrator prior to the placement of concrete.

The placement of concrete shall not proceed until the Contract Administrator has completed the inspection for earth excavation, caisson pile, steel reinforcement, anchorage assemblies, and sleeves and ducts, and has issued a Notice to Proceed.

631.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

631.09 MEASUREMENT FOR PAYMENT

631.09.01 Actual Measurement

631.09.01.01 Concrete Footings for High Mast Lighting Poles

For payment purposes, a count shall be made of the number of concrete footings for high mast lighting poles installed.

631.09.01.02 Maintenance Platform for High Mast Lighting Poles

For payment purposes, a count shall be made of the number of maintenance platforms for high mast lighting poles installed.

631.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

631.10**BASIS OF PAYMENT****631.10.01****Concrete Footings for High Mast Lighting Poles - Item
Maintenance Platform for High Mast Lighting Poles - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

631.10.02**Rock Excavation for Electrical Installation**

Payment for rock excavation for electrical installation shall be according to OPSS 603.



**CONSTRUCTION SPECIFICATION FOR
PERMANENT SMALL SIGNS AND SUPPORT SYSTEMS**

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703.10	BASIS OF PAYMENT

703.01 SCOPE

This specification covers the requirements for the installation and removal of permanent small signs and support systems, and the relocation of small signs.

703.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 1B - Sign Design Principles

CSA Standards

O80 Series-15	Wood Preservation
O141-05 (R2014)	Softwood Lumber

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153/A153M-16	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 780/A 780M-09 (2005)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

Others

National Lumber Grade Authority (NLGA)
Canadian Wood Preservation Certification Authority (CWPCA)

703.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Metal Components means components including slide assembly, collar assembly, and pipe post.

Relocation means to move an existing permanent sign to a new chainage or offset or both.

Removal means to remove and dispose of an existing permanent sign or support system or both.

Sign and Sign Board means a traffic control device mounted on a fixed support that conveys a specific message by means of symbols and or words, and is officially installed for the purpose of regulating, warning, informing, and guiding traffic.

Sign Support System means a wooden or steel post of specified dimensions, hardware, and material installed vertically into the ground or on top of concrete median barrier for mounting signs at a specified height above the roadway.

Sign Hardware means metal hardware including, but not limited to, nuts, bolts, washers, spacers, and lock washers for attaching signs to sign support systems.

Small Sign Assembly means one or more signs mounted on a sign support system with specified sign hardware having a total sign or sign board area not greater than 3.6 m² for ground mounted signs and 1.35 m² for signs mounted on concrete median barrier.

703.05 MATERIALS

703.05.01 General

The Contractor shall select a sign support system for each small sign assembly installation as specified in the Contract Documents.

All supplied components shall be according to the manufacturer's specifications and as specified in the Contract Documents. All sign hardware shall be hot dip galvanized according to ASTM A 153. New sign boards shall be supplied as specified in the Contract Documents.

703.05.02 Wooden Posts

703.05.02.01 General

All wooden posts shall be in dressed sizes and pressure treated with wood preservative.

The tolerance on the cross-sectional dimensions of all wooden posts shall be ± 2 mm.

703.05.02.02 Wood Preservative

Wood preservative shall be according to CAN/CSA O80 Series, Use Category UC 4.1.

703.05.02.03 Marking of Wood for Identification of Grade and Species

All wooden posts shall be stamped for species and grading according to CSA O141 by an approved agency authorized by the National Lumber Grade Authority (NLGA). The stamp shall be visible after installation and located at least 1.5 m above the finished grade.

703.05.02.04 Marking of Wood for Identification of Preservative Treatment

All wooden posts shall be stamped for wood preservative treatment from a treatment plant certified under the Canadian Wood Preservation Certification Authority (CWPCA). The wood preservative stamp shall be visible after installation and located at least 1.5 m above the finished grade.

703.05.03 Metal Posts

703.05.03.01 Metal Components and Hardware

All metal components and hardware shall be as specified in the Contract Documents.

All metal components after fabrication shall be filed smooth and surface free of foreign materials before being hot dip galvanized according to ASTM A 123.

All sign hardware except setscrews shall be hot dip galvanized according to ASTM A 153. All setscrews shall be stainless steel.

703.05.04 Signs

Signs shall be according to OPSS 2001.

703.07 CONSTRUCTION

703.07.01 General

All breakaway and non-breakaway sign support systems shall be installed according to the manufacturer's specifications and as specified in the Contract Documents at locations specified in the Contract Documents.

All sign boards shall be installed according to OTM Book 1B and as specified in the Contract Documents.

All signs shall be installed, relocated, or removed at locations specified in the Contract Documents. Signs shall be installed so that they do not obstruct and are not obstructed by existing permanent signs or other objects. The Contract Administrator shall be notified prior to installation of sign supports if it is not possible to install a new or relocated sign as specified in the Contract Documents due to this requirement.

Signs shall be covered temporarily for traffic operational reasons when directed by the Contract Administrator. Signs shall be covered so they are not visible to approaching motorists. The cover shall remain securely in place until the signs are appropriate for display as directed by the Contract Administrator. The covering material shall not damage or make any marks on the signs.

Acceptable material from post hole excavation shall be used as backfill around posts and compacted according to OPSS 501.

Posts shall be plumbed within a tolerance of ± 20 mm. The sign shall be levelled on a multiple post system within a tolerance of ± 10 mm.

Back-to-back signs may be installed on single or multiple posts. The sign support system shall be selected based on the largest sign area on one side of the post.

Cut ends and field drilled holes shall receive two applications of 2% copper naphthenate wood preservative. Field applied wood preservative that comes in contact with any metal components shall be removed immediately.

Damaged and cut areas of hot dip galvanized coatings on any galvanized components shall be repaired according to ASTM A 780.

703.07.02 Sign Supply

Signs shall be supplied by the Owner or by the Contractor as specified in the Contract Documents.

703.07.02.01 Owner Supplied Signs

703.07.02.01.01 Sign Ordering

The Contractor shall submit a list of signs required for this Contract to the Contract Administrator. The list of signs shall contain the quantity and details of the signs and the date for pick up by the Contractor. The list of signs shall be submitted a minimum of 12 weeks prior to the pickup date.

703.07.02.01.02 Sign Pickup

The Contractor shall pickup all the ordered signs on the list of required signs at a location provided in the Contract Documents to be supplied by the Owner within 10 Business Days of receiving notice from the Contract Administrator that the signs are ready for pickup. The Contractor shall ensure that all signs are safely secured and packaged prior to transporting the signs.

703.07.02.01.03 Sign Confirmation and Inspection

The Contractor shall within 5 Business Days confirm in writing with the Contract Administrator that all the ordered signs were received in accordance with the list of required signs. The Owner shall be notified of any incorrect signs identified by the Contractor. The Contractor shall be responsible for the cost of replacing all damaged, missing, and incorrect signs subsequent to the Contractor's order confirmation.

703.07.02.02 Contractor Supplied Signs

The Contractor shall supply all signs as specified in the Contract Documents.

703.07.03 New Signs

New sign boards shall be attached to new sign support systems with sign hardware as specified in the Contract Documents.

703.07.04 Installation on Concrete Median Barrier

All sign support systems on top of concrete median barrier shall be installed as specified in the Contract Documents.

The top of all concrete barriers shall be ground smooth to provide a uniform flat surface over the length of the slide assembly and steel base prior to installation of anchors.

703.07.05 Relocation of Signs

Relocated sign boards shall be attached to new support systems with sign hardware as specified in the Contract Documents. No portion of the existing sign, support system, and sign hardware shall be left at the original sign location and any excess material including support system and sign hardware shall be managed as specified in the Contract Documents or as directed by the Contract Administrator.

703.07.06 Removal of Signs

Upon removal, sign boards shall be defaced with commercially available paint in a manner that makes them unusable to guide traffic.

No portion of the removed sign, support system, and sign hardware shall be left at the original sign location and any excess materials shall be managed as specified in the Contract Documents.

703.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

703.09 MEASUREMENT FOR PAYMENT

703.09.01 Actual Measurement

703.09.01.01 Small Signs, Ground Mounted, New Small Signs, Concrete Median Barrier Mounted with Wooden Post, New Small Signs, Concrete Median Barrier Mounted with Metal Post, New

For measurement purposes, a count shall be made of the number of new small sign assemblies installed.

703.09.01.02 Small Signs, Relocation

For measurement purposes, a count shall be made of the number of small sign assemblies relocated.

703.09.01.03 Small Signs, Removal

For measurement purposes, a count shall be made of the number of small sign assemblies removed.

703.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

703.10

BASIS OF PAYMENT

703.10.01

Small Signs, Ground Mounted, New - Item

Small Signs, Concrete Median Barrier Mounted with Wooden Post, New - Item

Small Signs, Concrete Median Barrier Mounted with Metal Post, New - Item

Small Signs, Relocation - Item

Small Signs, Removal - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR POST MOUNTED DELINEATORS

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704.09	MEASUREMENT FOR PAYMENT
704.10	BASIS OF PAYMENT

704.01 SCOPE

This specification covers the requirements for the installation of post mounted delineators.

704.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

ASTM International

A36 / A36M - 19 Carbon Structural Steel

A123 / A123M - 17 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153 / A153M - 16a Zinc Coating (Hot-Dip) on Iron and Steel Hardware
D4956 - 19 Retroreflective Sheeting for Traffic Control

704.05 MATERIALS

704.05.01 Delineator Posts

Delineator post dimensions shall be as specified in the Contract Documents.

Delineator posts shall be fabricated from steel according to ASTM A36M and hot dip galvanized after fabrication according to ASTM A123M.

704.05.02 Hardware

Hardware shall be as specified in the Contract Documents. All hardware shall be hot dip galvanized according to ASTM A153M.

704.05.03 Delineators

Delineators shall be outfitted with high intensity retroreflective sheeting according to ASTM D4956, Type III or IV; and the colour according to OTM Book 11. Dimensions shall be as specified in the Contract Documents. Sign blanks shall be metal and according to OPSS 2001 with dimensions as specified in the Contract Documents.

704.07 CONSTRUCTION

704.07.01 General

Post mounted delineators shall be installed plumb and set according to alignment and grade according to and at the locations and spacing specified in the Contract Documents.

704.07.02 Delineators

Delineators shall be mounted on the posts as specified in the Contract Documents. Delineators shall be centred vertically and horizontally over the post holes. The type shall be as specified in the Contract Documents.

704.07.03 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

704.09 MEASUREMENT FOR PAYMENT

704.09.01 Actual Measurement

704.09.01.01 Post Mounted Delineators

For measurement purposes, a count shall be made of the number of complete post mounted delineators installed.

704.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

704.10 BASIS OF PAYMENT

704.10.01 Post Mounted Delineators - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR FLEXIBLE DELINEATOR POSTS

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705.09	MEASUREMENT FOR PAYMENT
705.10	BASIS OF PAYMENT

705.01	SCOPE

This specification covers the requirements for the installation of permanent and temporary flexible delineator posts and relocation of temporary flexible delineator posts.

705.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Material

OPSS 1212 Hot Poured Rubberized Asphalt Joint Sealing Compound

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 - Temporary Conditions
Book 11 - Pavement, Hazard and Delineation Markings

Designated Sources for Materials (DSM)

ASTM International

D4956 - 19 Retroreflective Sheeting for Traffic Control

705.03 DEFINITIONS

For the purpose of this specification, the following definition applies:

Flexible Delineator Post means a tubular plastic marker installed vertically for the purpose of channelizing traffic or delineating roadside features in temporary or permanent applications. The tubular post is securely fixed to the ground surface by hinged (flexible) connection to a solid base. When impacted by a vehicle, the post has the ability to bend 90° from vertical and self-restore following impacts.

705.04 DESIGN AND SUBMISSION REQUIREMENTS

705.04.01 Submission Requirements

One copy of the manufacturer's installation instructions shall be submitted to the Contract Administrator.

Installation of the flexible delineator posts shall not commence until the Contract Administrator has received the copy of the instructions.

705.05 MATERIALS

705.05.01 Flexible Delineator Posts

Flexible delineator posts shall be supplied from a source named on the ministry's DSM.

All supplied system components shall be according to the manufacturer's specifications.

The height of the post shall be as specified in the Contract Documents.

The post colour shall match the colour of the reflective sheeting.

To maintain a visually consistent installation, only one product shall be used on the Contract.

705.05.02 Anchor and Support Hardware

Anchor and support hardware used to fix the flexible delineator post to the ground surface shall be supplied by the manufacturer.

705.05.03 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D4956, Type III or IV. For permanent conditions, the colour shall be according to OTM Book 11. For temporary conditions, the colour shall be according to OTM Book 7. Dimensions, spacing, and quantity shall be as specified in the Contract Documents.

705.05.04 Temporary Flexible Delineator Posts

Temporary flexible delineator posts may be reused provided each post meets each of the following criteria:

- a) The ability to bend 90° from vertical and self-restore to a vertical position after impacts.
- b) The base is intact and permits anchorage to the ground surface that is equivalent to a new post.
- c) The post is intact without any cracks or fissures.
- d) The retroreflective sheeting is fully intact with only minor tears or scratches that do not affect the reflectivity of the sheeting.

705.07 CONSTRUCTION

705.07.01 General

Permanent and temporary flexible delineator posts shall be installed and securely fixed to the ground surface according to the manufacturer's instructions at locations specified in the Contract Documents.

705.07.02 Relocation of Temporary Flexible Delineator Posts

Flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchorage hardware and adhesives.

All holes resulting from the relocation of the delineator post assemblies shall be filled with a hot poured rubberized asphalt joint sealing compound according to OPSS 1212 when they are located in areas not to be resurfaced as part of the Work. At the time of filling, the holes shall be dry and free of dust and debris.

705.07.03 Maintenance of Temporary Flexible Delineator Posts

Flexible delineator posts shall be maintained for the duration of the construction period for which they are required.

Flexible delineator posts shall be monitored daily. Missing or broken flexible delineator posts shall be replaced within 48 hours.

Posts that do not have a uniform or satisfactory appearance to the satisfaction of the Contract Administrator shall be replaced or corrected within 48 hours of notification.

705.07.04 Removal of Temporary Flexible Delineator Posts

Flexible delineator posts and associated hardware and adhesives shall be removed at the completion of the construction period for which they were required.

All holes resulting from the removal of the delineator post assemblies shall be filled with a hot poured rubberized asphalt joint sealing compound according to OPSS 1212 when located in areas not to be resurfaced as part of the Work. At the time of filling, the holes shall be dry and free of dust and debris.

705.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

705.09 MEASUREMENT FOR PAYMENT

705.09.01 Actual Measurement

705.09.01.01 Flexible Delineator Post - Permanent

For measurement purposes, a count shall be made of the number of complete flexible delineator posts installed.

705.09.01.02 Flexible Delineator Post - Temporary

For measurement purposes, a count shall be made of the number of complete flexible delineator posts installed and removed, up to the maximum number of flexible delineator posts required to be in place at any one time during the Contract.

705.09.01.03 Flexible Delineator Post - Relocation

For measurement purposes, a count shall be made of the number of complete flexible delineator posts relocated. Flexible delineator posts that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

705.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

705.10 BASIS OF PAYMENT

**705.10.01 Flexible Delineator Post - Permanent - Item
Flexible Delineator Post - Temporary - Item
Flexible Delineator Post - Relocation - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR TEMPORARY TRAFFIC CONTROL DEVICES

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APPENDICES

706-A	Commentary

706.01	SCOPE

This specification covers the requirements for the use of temporary traffic control devices during construction.

706.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

706.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

706.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 703 Permanent Small Signs and Support Systems

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 – Temporary Conditions (Office and Field Editions)

Designated Sources for Materials (DSM)

706.03 DEFINITIONS

Temporary Traffic Control Signs means all traffic control signs and associated devices identified in OTM Book 7, including vehicles and sign trailers required to support signs and equipment to supply sign lighting; but excludes highway number markers.

Small Sign means small sign as defined in OPSS 703.

706.04 DESIGN AND SUBMISSION REQUIREMENTS

A copy of the traffic control plan shall be submitted to the Contract Administrator at the pre-work meeting.

706.05 MATERIALS

706.05.01 Retroreflective Sheeting

Retroreflective sheeting shall be according to OPSS 2001.

706.05.02 Automated Flagger Assistance Devices

Automated flagger assistance devices (AFAD) shall be according to OTM Book 7.

706.05.03 Temporary Traffic Control Signs

Temporary traffic control signs shall be according to OTM Book 7.

706.05.04 Portable Variable Message Signs

Portable variable message signs (PVMS) shall be supplied from a source named on the ministry's DSM.

706.05.04.01 Modem

Modem requirements for PVMS shall be as specified in the Contract Documents.

706.07 CONSTRUCTION

706.07.01 Temporary Traffic Control Signs

706.07.01.01 General

The work of temporary traffic control signs shall include:

- a) Installation and relocation according to OTM Book 7 unless otherwise specified in the Contract Documents.
- b) Temporarily relocating, modifying as required, and reinstalling existing small signs.
- c) Installing and removing contract information signs.
- d) Installing and removing Speed Fines Doubled (TC-90) signs.

Messaging for all temporary traffic control signs shall be according to OTM Book 7 unless otherwise specified in the Contract Documents.

When a Contract is in a designated bilingual area, bilingual temporary traffic control signs shall be installed. If a bilingual temporary traffic control sign is not available, then the French temporary traffic control sign shall be installed. A French Construction Zone Begins sign (Rb-90AF) and a French Construction Zone Ends sign (Rb-90BF) shall be installed next to the corresponding English Rb-90A and Rb-90B signs. All other French temporary traffic control signs shall be installed 150 m downstream from the English sign.

Temporary traffic control signs shall be installed before work affecting traffic begins, remain operational throughout the duration of the operation requiring signs and be removed upon completion of the operation.

Prior to seasonal shutdown, temporary traffic control signs shall be reviewed and signs that are not required during the seasonal shutdown period shall be removed. At the end of the seasonal shutdown period, the removed signs shall be reinstalled as required.

The condition of the temporary traffic control signs shall meet the quality replacement guidelines specified in OTM Book 7 for the duration of the Work. Signs that do not meet the guidelines shall be removed and replaced.

706.07.01.02 Existing Small Signs

Any existing small signs, excluding Tourism-Oriented Directional Signing and Logo Sign Program signs, removed to accommodate construction shall be kept operational by placement on a temporary support. Temporarily relocated existing small signs shall be kept at the same height, offset and approximate location from traffic as before relocation. All existing small signs shall be reinstalled, at or as close as possible to the original location, according to OPSS 703 upon completion of the Work.

Temporary modifications to existing small signs shall be according to OTM Book 7 unless otherwise specified in the Contract Documents.

706.07.01.03 Contract Information Signs

Contract information signs shall be installed according to OTM Book 7 and removed upon completion of the Work. Contract information signs shall be either a TC-81 sign or an Owner supplied contract information sign.

Owner supplied contract information signs shall be picked up at the location specified in the Contract Documents. The Contractor shall arrange for the pickup of the signs. At Contract Completion, Owner supplied contract information signs shall be returned to the Owner at a location specified by the Contract Administrator.

706.07.02 Road Closing/Restriction Notice Sign (TC-64)

Road closing/restriction notice (TC-64) signs shall be installed and relocated at locations specified in the Contract Documents. Timing requirements for TC-64 signs shall be as specified in OTM Book 7.

The Contract Administrator shall be notified when the Contractor's operations results in changes to the TC-64 sign message details (i.e. dates, times, etc.).

706.07.03 Automated Flagger Assistance Devices

AFAD shall be installed, relocated and removed at locations as specified in the Contract Documents.

If the closure extends across an entrance or side road, a traffic control person shall also be present to direct traffic with a stop/slow paddle according to OTM Book 7.

706.07.04 Portable Variable Message Sign

Installation, including the construction of a temporary base, relocation, and messaging on the PVMS shall be as specified in the Contract Documents. The exact location of the PVMS shall be proposed by the Contractor and shall meet the following criteria:

- a) Maximizes visibility for motorists without impacting safety in accordance with the ministry's clear zone requirements.
- b) Installed on a level surface with adequate bearing capacity to support the weight of the PVMS and temporary base materials.

The Contract Administrator shall approve the location of the PVMS prior to it being deployed. The Contractor Administrator shall be notified at least 2 Business days in advance regarding the delivery, relocation, and removal of PVMS within the construction work zone.

Modem installation, testing, and decommissioning for the PVMS shall be as specified in the Contract Documents.

The PVMS control box shall be secured from entry by unauthorized personnel. There shall be security measures or devices in place to prevent message tampering of the sign.

All PVMS and any temporary base shall be removed upon completion of the Work.

706.07.04.01 Maintenance of Portable Variable Message Sign

Maintenance shall be performed for the continuous operation of the PVMS, as required, throughout the duration of the Contract. Daily inspection of the PVMS shall be conducted to ensure that the PVMS meets the following maintenance requirements:

- a) PVMS sign face is aimed with the sign sight tube to the center of the approach roadway approximately 200m upstream of the sign to ensure maximum visibility.
- b) Solar panels are tilted and rotated to face south.
- c) All pixels and LEDs in the sign face remain operational.
- d) Sign is elevated to its maximum height with the locking pin in place; sign face is to be regularly cleaned from dirt, road salt or debris that may obstruct the visibility of the sign.
- e) Batteries are replaced as needed to ensure that battery levels are maintained per the supplier's operational requirements.
- f) Modems and other remote communications equipment remain operational.

Immediate repairs shall be required whenever there is a failure or cessation of the operation of any component or components of the PVMS. The Contract Administrator shall be notified immediately each time repair work is performed on a PVMS.

706.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

706.09 MEASUREMENT FOR PAYMENT

706.09.01 Actual Measurement

706.09.01.01 Automated Flagger Assistance Devices

For measurement purposes, a count shall be made of the number of AFAD installed.

706.09.01.02 Portable Variable Message Sign (Temporary)

For measurement purposes, a count shall be made of the number of PVMS installed.

706.09.01.03 Portable Variable Message Sign, Relocation

For measurement purposes, a count shall be made of the number of PVMS relocated.

PVMS that are temporarily surplus for intermediate stages but will be required later shall be paid as one relocation for the combined moves into and out of the site storage, including any off-site storage required due to space restrictions.

706.09.01.04 Road Closing/Restriction Notice Signs (TC-64)

For measurement purposes, a count shall be made of the number of TC-64 signs installed.

706.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

706.10 BASIS OF PAYMENT

**706.10.01 Automated Flagger Assistance Devices – Item
Portable Variable Message Sign (Temporary) – Item
Portable Variable Message Sign, Relocation - Item**

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

706.10.02 Temporary Traffic Control Signs - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

For progress payment, fifty percent of the Contract price shall be paid upon the supply and installation of the complete initial traffic control plan. The balance will be prorated over the balance of the Contract Time.

Reinstallation of temporary traffic control signs after seasonal shutdown shall be at no additional cost to the Owner.

706.10.03 Road Closing/Restriction Notice Signs (TC-64) - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

Changes to the TC-64 sign message details (i.e. dates, times, etc.) required as a result of the Contractor's operations shall be completed at no additional cost to the Owner.

Progress payments shall be made as follows: 60% of the unit price per sign upon installation;
 20% of the unit price per sign upon relocation;
 20% of the unit price per sign upon removal.

If no relocation is required:

60% of the unit price per sign upon installation;
40% of the unit price per sign upon removal.

On each occasion when the Contractor fails to install the TC-64 signs according to the requirements of this specification, or fails to remove the TC-64 signs within two hours of re-opening of the affected roadway, a payment reduction of \$2,000.00 shall be assessed. A further payment reduction of \$2,000.00 per Day, or part thereof, with no maximum payment reduction, shall be assessed until such time as the TC-64 signs are removed.

706.10.04 Removals and Replacements

The removal and replacement of defective workmanship or materials shall be at no additional cost to the Owner.

Appendix 706-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



Note: The PROV published in April 2022 replaces OPSS 707 COMMON, November 2015 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR MODIFIED OVERHEAD SIGNBOARDS

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707.05	MATERIALS - Not Used
707.06	EQUIPMENT - Not Used
707.07	CONSTRUCTION
707.08	QUALITY ASSURANCE - Not Used
707.09	MEASUREMENT FOR PAYMENT
707.10	BASIS OF PAYMENT

707.01	SCOPE

This specification covers the requirements for the installation of new overlay signboards on existing overhead extruded signboards.

707.07	CONSTRUCTION

707.07.01	General

All existing overlay signboard panels shall be removed by drilling out all pop rivets used to fasten it to the extruded sign.

New overlay signboard panels shall be installed according to the sign details.

Aluminum pop rivets, 1/8" X 7/16", shall be used to install the overlay panel directly on top of the existing extruded sign. The rivets shall be spaced around the perimeter of each overlay panel 25 mm (1") from the edge of the panel at 150 mm (6") centre to centre spacing.

Inside each 1220 mm (4') panel, 6 aluminum pop rivets shall be inserted equally spaced 610 mm (24") from the edge of the panel. Inside each 914 mm (3') panel, 6 aluminum pop rivets shall be inserted equally spaced 450 mm (18") from the edge of the panel. If the panel is over 1830 mm (6') in height, 6 pop rivets shall be installed equally spaced 450 mm (18") from the edge of the panel.

To ensure panels do not peel, ¼ " stainless steel self-tapping screws shall be attached to the corners of all overlay panels, regardless of size.

707.07.02 Sign Ordering

The following shall be submitted to the Contract Administrator a minimum of 12 weeks prior to the installation date:

- a) List of all required overlay signboards,
- b) Sign details for the overlay signboards, and
- c) Date for pick-up.

707.07.03 Sign Pick up

All ordered signboards shall be picked up at the location specified in the "Schedule of Materials to be Supplied by the Owner" within 10 Business Days of receiving notice from the Contract Administrator that the signs are ready for pick up.

707.07.04 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

707.09 MEASUREMENT FOR PAYMENT

707.09.01 Actual Measurement

707.09.01.01 Modified Overhead Signboards

For measurement purposes, a count shall be made of each modified signboard installed.

707.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

707.10 BASIS OF PAYMENT

707.10.01 Modified Overhead Signboards - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR PORTABLE TEMPORARY TRAFFIC SIGNALS

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APPENDICES

708-A	Commentary

708.01	SCOPE

This specification covers the requirements for the installation, operation and maintenance of portable temporary traffic signals.

708.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

708.01.02 Appendices Significance and Use

Appendices are not for use in provincial Contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner.

Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their Contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

708.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

Ontario Traffic Manual (OTM):
Book 7, Temporary Conditions
Book 12, Traffic Signals

708.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Portable Temporary Traffic Signals (PTTS) means two traffic control signal heads mounted onto a movable trailer.

708.05 MATERIALS

708.05.01 Portable Temporary Traffic Signals

Portable temporary traffic signals shall be supplied from a source named on the ministry's DSM.

The traffic control signal heads shall have a minimum vertical mounting height of 5 metres for both the primary and secondary signal heads.

The primary and secondary signal heads shall be separated by a minimum of 3.0 metres measured laterally.

The signal heads shall be reversible on the trailer's boom.

Highway yellow backboards shall be used on each signal head.

All signal lenses shall comply with the Institute of Transportation Engineers interim/final specifications for incandescent or light emitting diode lamps for chromaticity and luminous intensity.

708.05.02 Temporary Illumination

Temporary illumination shall be provided for all PTTS installations being used at night. Temporary illumination shall meet the following requirements:

- a) A minimum of one luminaire shall be mounted over each PTTS trailer.
- b) Each luminaire shall have a minimum light output of 22,000 lumens.
- c) Each luminaire shall be mounted a minimum of 9 metres vertically above the roadway surface.
- d) The temporary illumination shall be powered by generator or line power.
- e) Temporary illumination shall be on from dusk until dawn. If the temporary illumination has a photo controller, then the temporary illumination shall be switched on when ambient light levels are at 16 Lux and lower and switched off when ambient light levels are at 50 Lux and higher.

708.07 CONSTRUCTION

708.07.01 General

PTTS and its temporary illumination shall be installed and relocated at the locations specified in the Contract Documents, or on the signed legal drawing (PHM-125). PTTS shall be installed on a level and stable surface that allows for on-site maintenance and service of the units.

The PTTS shall be positioned to prevent displacement or damage by weather, maintenance activities, vehicle impact or vandalism.

The Contract Administrator shall be given a minimum of 24-hour notice prior to the activation of the PTTS. The PTTS shall be activated in the presence of the Contract Administrator.

708.07.02 Operational Constraints

Operation of PTTS shall be permitted between April 1st and November 30th of each calendar year. The operation of PTTS outside of this period shall not be permitted unless otherwise specified in the Contract Documents. If PTTS are permitted outside of this period, the PTTS shall be configured with environmental controls to permit operation at any temperature.

When not in use, the PTTS shall be removed or the traffic control signal heads covered or turned up and/or away from the roadway.

708.07.03 Operational Capabilities

708.07.03.01 Portable Traffic Control Signals

The installation and operation of portable temporary traffic signals shall be according to the OTM Book 7 and the traffic control signal head display criteria specified in OTM Book 12.

PTTS shall have the following operational capabilities:

- a) Pre-timed signal operations where the green time, the amber clearance, and the all red times can be manually input to the controller.
- b) Fully actuated operation using a variety of detection devices including loops, microwave, video or non-loop in-pavement detection equipment that will:
 - i) Place a call for a green indication when red or amber is being displayed.
 - ii) Extend the green indication from a minimum to a maximum green time by a user selectable amount each time a vehicle is detected during the green display (extension time).
- c) Rest in red or the last phase served. The user must be able to select this mode through software input on a construction site.
- d) The user must be able to manually enter a minimum green time, a maximum green time, and an extension time for actuated operations.
- e) All timing intervals are capable of being set in increments of one second.
- f) Default mode – flashing red shall display in both directions (at both master and local trailers) at the same time.
- g) Manual mode – shall allow an operator to interrupt the other modes and return to the previous mode when finished.
- h) Default mode warning system – the PTTS shall have the email, text messaging or cell/satellite paging warning system activated and monitored, to advise the Owner/operator and/or Contractor when the signals have gone into the “default mode”.
- i) Be able to communicate between the master and local units through either radio or hardwire with conflict monitoring enabled to ensure malfunctions are identified. The units shall be set up so that if communications are lost, both units will revert to “default mode” operation.
- j) All conflicts must be recorded in an error log with the exact date and time of the occurrence. The error log must be retrievable by the Owner.

708.07.03.02 Trailer Unit

Each PTTS trailer unit shall have the following operational capabilities:

- a) Be able to operate as either a master or local.
- b) Be interconnected by either hardwire or radio.

708.07.03.03 Controller

Each controller shall have the following operational capabilities:

- a) Be capable of providing variable all red clearance intervals between 0 – 600 seconds.
- b) Have circuitry that detects low voltage and prevents the occurrence of an unsafe (conflicting) signal indication. In the event of low voltage the signal must default to a flashing all red.
- c) Must be password protected or have other security devices in place to prevent program tampering.
- d) Provide a red flash cycle that is flashed continuously at a rate of 50 – 60 times per minute with a 50% duty cycle.
- e) If a radio interconnection is used then the system must have a mobile license from Industry Canada.

708.07.03.04 Power Supply

The PTTS shall be powered by one or more of the following methods:

- a) Generator
- b) Solar power
- c) Electrical line power

If a generator is being used to power the PTTS and temporary illumination, suitable housing and sound reduction measures shall be installed to enclose the generator and reduce external noise levels to less than 45 dBA measured at a distance of 7 metres from the generator. The housing shall provide sufficient ventilation to prevent overheating and permit exhausting of any hazardous fumes.

The PTTS shall have a battery backup with a battery capacity sufficient to operate the system for a minimum of 14 days without recharging.

The power supply and other electronic controls shall be completely inaccessible to unauthorized personnel and protected by a sturdy, lockable metal enclosure.

708.07.04 Traffic Signal Control Programming and Timing

A technical expert knowledgeable in the operation of the PTTS shall be at the site to provide assistance during the initial set-up of the unit and shall remain on site until the unit is operating to the satisfaction of the Contract Administrator.

The traffic signal timing as specified in the Contract Documents shall be programmed into the traffic signal controller.

The controller shall be set up by performing all programming, setting all timing controls, switch settings and conflict monitoring.

708.07.05 Temporary Traffic Signals Supplied by Owner

Where the Owner supplies the PTTS, the PTTS shall be picked up and transported from the Owner's premises as specified in the Contract Documents. Once the PTTS is placed into operation, the operation, and maintenance of the PTTS shall be completed at no additional cost to the Owner.

PTTS shall be returned to the Owner's premises or to an alternate site specified by the Contract Administrator within 7 Days of being taken out of operation.

708.07.06 Maintenance of Portable Temporary Traffic Signals

Routine, non-routine and emergency maintenance work required for continuous and proper operation of the PTTS shall be performed as specified in the Contract Documents.

A technical expert shall be available on-call 24 hours a day, 7 days a week, to troubleshoot any PTTS problems on site and perform all work required to restore the PTTS to full operation.

When directed by the Contract Administrator, the traffic signal operation shall be manually overridden to reduce or eliminate queuing traffic.

A logbook shall be maintained and kept with the PTTS or at a location agreed upon with the Owner. The logbook shall record any fieldwork performed on the PTTS system, including the replacement of any hardware, changes to the software, or changes to the configuration, phasing, or timing parameters. The time and date of each entry in the logbook shall be signed by the individual making the entry.

708.09 MEASUREMENT FOR PAYMENT

708.09.01 Portable Temporary Traffic Signals

For measurement purposes, a count shall be made of the number of PTTS installed. Each PTTS shall be counted only once, regardless of the number of times it is relocated.

708.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

708.10 BASIS OF PAYMENT

708.10.01 Portable Temporary Traffic Signals - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work, including all relocations of the PTTS.

Site visits by the technical expert required to restore the PTTS to full operation shall be at no additional cost to the Owner.

Appendix 708-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
PERMANENT INTERMEDIATE SIGNS AND SUPPORT SYSTEMS**

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709.06	EQUIPMENT - Not Used
709.07	CONSTRUCTION
709.08	QUALITY ASSURANCE - Not Used
709.09	MEASUREMENT FOR PAYMENT
709.10	BASIS OF PAYMENT

709.01 SCOPE

This specification covers the requirements for the installation and removal of permanent intermediate signs and support systems, and the relocation of intermediate signs.

709.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 2001 Signs

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 1B - Sign Design Principles

ASTM International

A 123/A 123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153/A 153M-16	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 780/A 780M-09 (2015)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

709.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Intermediate Sign Assembly means one or more plywood sign boards with a total area not greater than 7.2 m² mounted on a metal post breakaway sign support system with specified sign hardware.

Relocation means to move an existing permanent sign to a new chainage or offset or both.

Removal means to remove and dispose of an existing permanent sign or support system or both.

Sign Board means a traffic control device mounted on a fixed support that conveys a specific message by means of symbols and or words, and is officially installed for the purpose of regulating, warning, informing, and guiding traffic.

Sign Hardware means hardware including, but not limited to, nuts, bolts, washers, spacers, and lock washers for attaching sign boards to sign support systems.

Sign Support System means a steel post of specified dimensions, hardware, and material embedded vertically into the ground for mounting sign boards at a specified height above the roadway and ground. The system may consist of a single, double, or triple post configuration.

709.05 MATERIALS

709.05.01 General

A sign support system shall be used for each intermediate sign assembly installation as specified in the Contract Documents.

New sign boards shall be supplied as specified in the Contract Documents.

709.05.02 Metal Posts and Components

All supplied metal posts, bolts, washers, keeper plates, and nuts shall be according to the manufacturer's specifications and as specified in the Contract Documents.

All metal posts shall be hot dip galvanized after fabrication according to ASTM A 123.

All sign hardware shall be hot dip galvanized according to ASTM A 153.

709.05.03 Signs

Signs shall be according to OPSS 2001.

709.07 CONSTRUCTION

709.07.01 General

Intermediate sign support systems shall be installed at locations specified in the Contract Documents and according to the manufacturer's instructions by installers trained by the manufacturer's direct representative.

All sign boards shall be installed according to OTM Book 1B and as specified in the Contract Documents.

All sign boards shall be installed, relocated, or removed at locations specified in the Contract Documents. Sign boards shall be installed so that they do not obstruct and are not obstructed by existing permanent sign boards or other objects. The Contract Administrator shall be notified prior to installation of sign supports if it is not possible to install a new or relocated sign board as specified in the Contract Documents due to this requirement.

Sign boards shall be covered temporarily for traffic operational reasons when directed by the Contract Administrator. Sign boards shall be covered so they are not visible to approaching motorists. The cover shall remain securely in place until the sign boards are appropriate for display as directed by the Contract Administrator. The covering material shall not damage or make any marks on the sign boards.

Acceptable material from post hole excavation shall be used as backfill around posts and compacted according to OPSS 501.

Posts shall be plumb within a tolerance of ± 20 mm. The sign board shall be levelled on a two-post system within a tolerance of ± 10 mm.

Damaged and cut areas of hot dip galvanized coatings on any galvanized components shall be repaired according to ASTM A 780.

709.07.02 Sign Board Supply

Sign boards shall be supplied by the Owner or by the Contractor as specified in the Contract Documents.

709.07.02.01 Owner Supplied Sign Boards

709.07.02.02 Sign Board Ordering

The Contractor shall submit a list of sign boards required for this Contract to the Contract Administrator. The list of sign boards shall contain the quantity and details of the sign boards and the date for pick up by the Contractor. The list of sign boards shall be submitted a minimum of 12 weeks prior to the pickup date.

709.07.02.03 Sign Board Pickup

The Contractor shall pickup all the ordered sign boards on the list of required sign boards at a location provided in the Contract Documents to be supplied by the Owner within 10 Business Days of receiving notice from the Contract Administrator that the sign boards are ready for pickup. The Contractor shall ensure that all sign boards are safely secured and packaged prior to transporting the sign boards.

709.07.02.04 Sign Board Confirmation and Inspection

The Contractor shall within 5 Business Days confirm in writing with the Contract Administrator that all the ordered sign boards were received in accordance with the list of required sign boards. The Owner shall be notified of any incorrect sign boards identified by the Contractor. The Contractor shall be responsible

for the cost of replacing all damaged, missing, and incorrect sign boards subsequent to the Contractor's order confirmation.

709.07.02.05 Contractor Supplied Sign Boards

The Contractor shall supply all sign boards as specified in the Contract Documents.

709.07.03 New Sign Boards

New sign boards shall be attached to new sign support systems with sign hardware as specified in the Contract Documents.

709.07.04 Relocation of Sign Boards

Relocated sign boards shall be attached to new support systems with sign hardware as specified in the Contract Documents. No portion of the existing sign board, support system, and sign hardware shall be left at the original sign location and any excess material including support system and sign hardware shall be managed as specified in the Contract Documents or as directed by the Contract Administrator.

709.07.05 Removal of Sign Boards

No portion of the removed sign board, support system, and sign hardware shall be left at the original sign location.

Upon removal, sign boards shall be defaced with commercially available paint in a manner that makes them unusable to guide traffic.

709.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

709.09.0 MEASUREMENT FOR PAYMENT

709.09.01 Actual Measurement

709.09.01.01 Intermediate Signs, Ground Mounted, New

For measurement purposes, a count shall be made of the number of new intermediate sign assemblies installed.

709.09.01.02 Intermediate Signs, Relocation

For measurement purposes, a count shall be made of the number of intermediate sign assemblies relocated.

709.09.01.03 Intermediate Signs, Removal

For measurement purposes, a count shall be made of the number of intermediate sign assemblies removed.

709.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

709.10.0 BASIS OF PAYMENT

**709.10.01 Intermediate Signs, Ground Mounted, New - Item
Intermediate Signs, Relocation - Item
Intermediate Signs, Removal - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required repairs or removals and replacements of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL SYSTEMS

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721.09	MEASUREMENT FOR PAYMENT
721.10	BASIS OF PAYMENT

721.01 SCOPE

This specification covers the requirements for the installation of steel beam guide rail systems.

721.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501 Compacting

Ontario Provincial Standard Specifications, Material

OPSS 1503 Cable Guide Rail
OPSS 1504 Steel Beam Guide Rail
OPSS 1505 Channel Components for Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G164-18 Hot Dip Galvanizing of Irregularly Shaped Articles

ASTM International

A36/A36M-19	Carbon Structural Steel
A780/A780M-20	Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings
D4956-19	Retroreflective Sheeting for Traffic Control

721.04 DESIGN AND SUBMISSION REQUIREMENTS

721.04.01 Submission Requirements

721.04.01.01 Steel Beam Guide Rail System

The selection of the systems to be installed at each steel beam guide rail location, including the applicable Standard Drawings for each location, shall be submitted to the Contract Administrator a minimum of 7 Days prior to the first placement.

In addition, a copy of the installation instructions and manufacturer's specifications for proprietary systems shall be submitted to the Contract Administrator prior to system installation.

721.05 MATERIALS

721.05.01 Fabricated Steel Bases

Fabricated steel bases shall be according to OPSS 1503.

721.05.02 Non-Proprietary Steel Beam Guide Rail

Single rail guide rail panels shall be according to OPSS 1504.

Channel components shall be according to OPSS 1505.

Wooden posts and blocks shall be according to OPSS 1601.

Plastic blocks shall be as specified in the Contract Documents.

Steel sleeves and spacer tubes used in transition treatments to concrete structures shall be fabricated from Schedule 40 galvanized steel pipe.

Steel posts, sleeves, and spacer tubes shall be hot dip galvanized after fabrication according to CSA G164.

Steel posts shall be according to ASTM A36.

Reflectors shall have a minimum reflective surface of 100 x 100 mm; high intensity retroreflective sheeting according to ASTM D4956, Type VII; colour according to OTM Book 11; and flexibility to bend 90 degrees from vertical and self restore.

Steel base plates for shallow culverts shall be according to ASTM A36

721.05.03 Proprietary Steel Beam Guide Rail

Single rail guide rail panels shall be according to OPSS 1504.

Thrie beam rail shall be according to the Contract Documents.

All supplied proprietary components on proprietary systems shall be according to the manufacturer's specifications.

The names of proprietary systems and manufacturers acceptable for steel beam guide rail are listed in Table 1.

Retroreflective sheeting for adherence to galvanized steel posts shall be according to the manufacturer's recommendations.

Sheeting colour shall be according to OTM Book 11.

721.07 CONSTRUCTION

721.07.01 General

Guide rail systems shall be installed plumb and to the alignment and grade specified in the Contract Documents, regardless of the material encountered.

Tops of wooden posts shall be cut as specified in the Contract Documents and treated with two coats of 2% copper naphthenate wood preservative. Field applied wood preservative that comes in contact with any galvanized components shall be removed immediately.

Acceptable material from posthole excavation shall be used as backfill around posts and compacted according to OPSS 501.

When required, fabricated steel bases shall be installed level and square to the centreline of the Roadway.

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on any galvanized component shall be repaired according to ASTM A780.

Flame cutting shall not be permitted.

721.07.02 Acceptable Systems

The system names and where applicable, the manufacturer's name, of acceptable systems for steel beam guide rail, roadside and median tender items are specified in Table 1.

The Contract Documents specify the system requirements at each installation location, according to the convention defined in Table 2.

A system listed in Table 1 that meets the specified system requirements shall be selected and installed according to the Contract Documents and the Contractor's submission.

721.07.03 Steel Beam Guide Rail

721.07.03.01 Installation

Steel beam guide rail shall be installed as specified in the Contract Documents.

Steel posts used on steel beam guide rail installations shall use either plastic blocks or routed wooden blocks. Where wooden breakaway posts are required, they shall be installed with wooden blocks.

Different types of plastic and wooden blocks shall not be permitted together within a steel beam guide rail installation.

When a transition to a rigid obstacle is required, the offset block for the channel may be either wood or a pipe sleeve over the connecting bolt. The pipe sleeve shall be 89 mm outer diameter (OD) galvanized steel pipe cut to the required length.

Backup plates, steel spacer tubes, and pipe sleeves shall be installed as specified in the Contract Documents. All joints shall be lapped in the direction of traffic.

Bolts shall be tightened to 100 Nm. Bolts for wooden post installations shall be field cut as required to maintain a maximum protrusion of 10 mm beyond the nut. The cut end of the bolt shall be ground smooth with all sharp edges and burrs removed.

In the event of any conflict between the requirements of any proprietary systems and the above requirements, the requirements of the proprietary systems shall govern.

Steel beam guide rail mounting heights shall be measured vertically from the top of the steel beam guide rail.

Steel beam guide rail without channel mounting heights shall be within the following ranges:

- a) 685 to 760 mm during construction and seasonal shutdown.
- b) 685 to 735 mm upon completion of the Work.

Steel beam guide rail with channel mounting heights shall be within the following ranges:

- a) 685 to 785 mm during construction and seasonal shutdown.
- b) 735 to 785 mm upon completion of the Work.

Where curb with gutter is required, steel beam guide rail mounting heights shall be measured:

- a) Vertically at face of steel beam guide rail, when the face of steel beam guide rail is more than 300 mm beyond the back side of the concrete curb.
- b) Vertically at the edge of pavement, when the face of steel beam guide rail is 300 mm or less from the back side of the concrete curb.

Type M and Ezy Guard 4 single and double-sided steel beam guide rail mounting heights shall be within the following ranges:

- a) 710 to 810 mm during construction and seasonal shutdown.
- b) 760 to 810 mm upon completion of the Work.

Where curb with gutter is required with Type M steel beam guide rail, mounting heights shall be measured vertically at the inside edge of the concrete gutter.

Where sidewalk is required with Type M steel beam guide rail, mounting heights shall be measured vertically at the face of Type M steel beam guide rail.

Type M20 base plated steel posts shall be field cut and field punched to provide Type M steel beam guide rail mounting heights according to the Contract Documents.

Type M20 base plated steel posts shall be epoxied according to the Contract Documents by an installer certified by the manufacturer's direct representative.

ACP Sentry single and double-sided steel beam guide rail mounting heights shall be within the following ranges:

- a) 725 to 825 mm during construction and seasonal shutdown.
- b) 775 to 825 mm upon completion of the Work.

Ezy Guard High Containment single and double-sided steel beam guide rail mounting heights shall be within the following ranges:

- a) 905 to 1005 mm during construction and seasonal shutdown.
- b) 955 to 1005 mm upon completion of the Work.

721.07.03.02 Reflectors

Reflectors shall be placed:

- a) Starting at the fifth post from the approach end of a steel beam guide rail end treatment.
- b) At a maximum interval of every tenth post on tangent.
- c) On curves, as specified in OTM Book 11, Table 4, but not at an interval less than every tenth post.
- d) Ending on the last post of the steel beam guide rail installation.
- e) On the posts at the four adjacent steel beam guide rail splices at the approach and leaving end of structures.

The reflector shall be fastened to the post using adhesives, bolts and nuts, or screws with reflective surfaces clear above the top of the posts. One-sided reflectors shall be installed on divided highways and two-sided reflectors shall be installed on undivided highways.

721.07.03.03 Steel Beam Structure Connections

Steel beam guide rail shall be connected to new or existing structure walls as specified in the Contract Documents.

721.07.03.04 Adjust Steel Beam Guide Rail

Steel beam guide rail shall be adjusted at locations specified in the Contract Documents.

Steel beam rail elements, channel elements, and offset blocks shall be disassembled from the posts. Post bolts, washers, nuts and existing steel offset blocks shall be removed and disposed of as specified in the Contract Documents.

Steel beam rail elements, channel elements, wooden offset blocks, and plastic offset blocks, shall be salvaged for reinstallation. Washers from the front face of the existing steel beam guide rail shall not be reinstalled.

Salvaged steel beam rail elements, channel elements, and wooden or plastic offset blocks shall be reinstalled within the mounting height ranges as specified in the Installation clause using new post bolts, washers, and nuts.

For steel post adjustment, the post shall be raised a minimum of 50 mm above the specified height and then driven down to the required depth before the salvaged steel beam guide rail components are reinstalled. When existing steel offset blocks have been removed, new wooden or plastic offset blocks shall be installed. A new hole shall be field punched through the existing post as specified in the Contract Documents.

For wooden post adjustment, a new hole shall be field drilled through the existing post as specified in the Contract Documents. The top of the offset block shall not extend beyond the top of the existing post. When channel elements are being reinstalled, an additional hole shall be field drilled through the existing post as specified in the Contract Documents.

New reflectors shall be supplied and installed as specified in the Reflectors clause. When new reflectors are installed on a wooden post system, the reflector shall be installed on the approach transverse face of the wooden offset block with one edge 12 mm from edge of post.

721.07.03.05 Single Rail Steel Beam Guide Rail, Relocation

Relocation of the single rail steel beam guide rail shall include the dismantling, storage, transportation, and re-installation of steel beam guide rail systems as specified in the Contract Documents.

721.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

721.09 MEASUREMENT FOR PAYMENT

721.09.01 Actual Measurement

**721.09.01.01 Adjust Steel Beam Guide Rail, Wooden Posts
Adjust Steel Beam Guide Rail, Steel Posts
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks**

Measurement of adjust steel beam guide rail shall be by length in metres along the centreline of the adjusted system from end to end of each steel beam guide rail installation. The length includes all treatments, transitions, connections, and terminal systems.

**721.09.01.02 Single Rail Steel Beam Guide Rail, Relocation
Single Rail Steel Beam Guide Rail with Channel
Single Rail Steel Beam Guide Rail, TL-2, Adjacent to Sidewalk
Single Rail Steel Beam Guide Rail, TL-3
Single Rail Steel Beam Guide Rail, TL-3, Adjacent to 2H:1V Slope
Single Rail Steel Beam Guide Rail, TL-3, Adjacent to Curb and Gutter
Single Rail Steel Beam Guide Rail, TL-4
Single Rail Steel Beam Guide Rail, Double Sided, TL-3
Single Rail Steel Beam Guide Rail, Double Sided, TL-4, Median
Double Rail Steel Beam Guide Rail, Double Sided, TL-5, Median
Double Rail Steel Beam Guide Rail, Double Sided, TL-5, Roadside**

Measurement of steel beam guide rail, including relocation, shall be by length in metres along the centreline of the system from end to end of each steel beam guide rail installation. The length includes all treatments, transitions, and connections, but does not include terminal systems.

Steel beam guide rail systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, and including any off-site storage required due to on-site restrictions.

721.09.01.03 Single Rail Steel Beam Guide Rail, TL-3, Base Plated for Shallow Culverts

Measurement of base plated steel beam guide rail shall be by length in metres along the length of the culvert under the face of guide rail along the Roadway.

721.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

721.10

BASIS OF PAYMENT

721.10.01

Adjust Steel Beam Guide Rail, Wooden Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts - Item
Adjust Steel Beam Guide Rail, Steel Posts with Steel Offset Blocks - Item
Single Rail Steel Beam Guide Rail, Relocation - Item
Single Rail Steel Beam Guide Rail with Channel - Item
Single Rail Steel Beam Guide Rail, TL-2, Adjacent to Sidewalk - Item
Single Rail Steel Beam Guide Rail, TL-3 - Item
Single Rail Steel Beam Guide Rail, TL-3, Adjacent to 2H:1V Slope - Item
Single Rail Steel Beam Guide Rail, TL-3, Adjacent to Curb and Gutter - Item
Single Rail Steel Beam Guide Rail, TL-3, Base Plated for Shallow Culverts - Item
Single Rail Steel Beam Guide Rail, TL-4 - Item
Single Rail Steel Beam Guide Rail, Double Sided, TL-3 - Item
Single Rail Steel Beam Guide Rail, Double Sided, TL-4, Median - Item
Double Rail Steel Beam Guide Rail, Double Sided, TL-5, Median - Item
Double Rail Steel Beam Guide Rail, Double Sided, TL-5, Roadside - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Acceptable Systems for Steel Beam Guide Rail Tender Items

Item (Note 1)	System	Manufacturer
Single Rail Steel Beam Guide Rail		
TL-2, Adjacent to Sidewalk	Type M30 SBGR, Adjacent to Sidewalk	Non-Proprietary
TL-3	Type M20 SBGR	Non-Proprietary
	Type M30 SBGR	Non-Proprietary
	ACP Sentry	Australian Construction Products
	Ezy Guard 4	Ingal Civil Products
TL-3, Adjacent to 2H:1V Slope	Type M20 SBGR Adjacent to 2H:1V Slope, with 2438 mm Long Posts	Non-Proprietary
	ACP Sentry Adjacent to 2H:1V Slope, with 2100 mm Long Posts	Australian Construction Products
	Ezy Guard 4 Adjacent to 2H:1V Slope	Ingal Civil Products
TL-3, Adjacent to Curb and Gutter	Type M30 SBGR, Adjacent to Concrete Curb	Non-Proprietary
TL-3, Base Plated for Shallow Culverts	Type M30 SBGR, Base plated for Shallow Culverts	Non-Proprietary
TL-4	ACP Sentry Thrie Beam	Australian Construction Products
	Ezy Guard 4 High Containment	Ingal Civil Products
Double Sided, TL-3	Type M20 or M30 SBGR, Double Sided	Non-Proprietary
	ACP Sentry, Median	Australian Construction Products
	Ezy Guard 4, Median	Ingal Civil Products
Double Sided, TL-4, Median	Ezy Guard 4 High Containment, Median	Ingal Civil Products
Double Rail Steel Beam Guide Rail		
Double Sided, TL-5, Median	Guardian 5, Median	Gregory Industries
Double Sided, TL-5, Roadside	Guardian 5, Roadside	Gregory Industries
Notes:		
1. TL-"X" refers to MASH Test Level (i.e., TL-3 means MASH Test Level 3).		

TABLE 2
Contract Drawing Notation

A - General Item Identification	SBGR - Steel Beam Guide Rail
B - Location Attribute	S3 - 3H:1V Slope or Flatter S2 - 2H:1V Slope or Flatter CG - Adjacent to Concrete Curb and Gutter SW - Adjacent to Sidewalk M - Median
C - AASHTO MASH Test Level	2 - MASH Test Level 2 3 - MASH Test Level 3 4 - MASH Test Level 4 5 - MASH Test Level 5
Notes: A. Steel Beam Guide Rail is noted on the Contract Drawings by AAAA-BB-C (i.e. SBGR-SW-2).	



CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

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APPENDICES

723-A	Commentary

723.01 SCOPE

This specification covers the requirements for the installation of permanent and temporary energy attenuators and relocation of temporary energy attenuators.

723.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

723.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

723.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 510	Removal
OPSS 705	Flexible Delineator Posts
OPSS 740	Concrete Barriers
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-13	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 325-14	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A 780/A 780M-09	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-13	Retroreflective Sheeting for Traffic Control

723.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Dual Duty means a new high exposure energy attenuator that is supplied and installed in a temporary configuration during construction, temporarily relocated as required, and then relocated to its permanent location prior to the end of the Work.

High Exposure means an energy attenuator that is installed in a location where the risk of impact is expected to be high such as in gore areas at exit ramps and express - collector transfers.

Reduced Exposure means a temporary energy attenuator that is installed in a location where the risk of impact is expected to be low. These energy attenuators should be specified in a location where they will be required for short duration of less than four months, are frequently relocated, and where they are not required during seasonal shutdown.

723.04 DESIGN AND SUBMISSION REQUIREMENTS

723.04.01 Design Requirements

The energy attenuator manufacturer shall complete the design of any non-standard details (e.g., a connection or transition to a rigid object other than a concrete barrier or temporary concrete barrier) at locations specified in the Contract Documents.

723.04.02 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings shall be submitted to the Contract Administrator.

Installation of the energy attenuator shall not commence until the Contract Administrator has received the copy of the instructions and Working Drawings.

723.04.02.01 Submission Requirements for Non-Standard Details

Three copies of Working Drawings, prepared by the manufacturer, for any non-standard details shall be submitted to the Contract Administrator prior to the commencement of construction. The Working Drawings shall show full details of the materials and installation procedures. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents. The submission of Working Drawings shall be accompanied by 3 copies of a letter that has been signed by the manufacturer, on company letterhead, summarizing the details of the proposed design.

Installation of the energy attenuator shall not commence until the Contract Administrator has received and accepted the copy of the letters and Working Drawings.

723.05 MATERIALS

723.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

723.05.02 Energy Attenuator Systems

The names of systems acceptable for the Energy Attenuator - Permanent items are shown in Table 1.

The names of systems acceptable for the Energy Attenuator - Temporary items are shown in Table 2.

The Contractor shall have the option of supplying and installing any of these approved systems shown for the appropriate tender item.

723.05.03 Concrete

Concrete for pads and anchor blocks shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

723.05.04 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

723.05.05 Anchor Bolts

Anchor bolts shall be supplied and installed according to energy attenuator manufacturer recommendations.

723.05.06 Bolts for Connection of BB-BEAT System to Concrete Barrier

Bolts used to connect the BB-BEAT system to the concrete barrier shall be according to ASTM A 325 and shall be hot dip galvanized according to ASTM A 123.

723.05.07 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

723.05.08 Flexible Delineator Posts

Flexible delineator posts shall be according to OPSS 705. The post colour shall be orange.

723.05.09 Reflective Sheeting

Flexible delineator posts shall be outfitted with high intensity retroreflective sheeting according to ASTM D 4956, Type IV; white colour; and to the dimensions specified in the Contract Documents.

723.05.10 Reuse of Materials

Notwithstanding subsection GC 5.02, Quality of Material, paragraph 01 of the General Conditions of Contract, the reuse of materials is permitted for temporary energy attenuator installations and relocations, provided the components have not been damaged to affect the safety performance of the system.

723.07 CONSTRUCTION

723.07.01 General

Permanent and temporary energy attenuators shall be installed according to manufacturer's instructions at locations specified in the Contract Documents. A reference for energy attenuator Contract Drawing Notation is shown in Table 3.

Energy attenuators shall not be placed on surfaces with a crossfall greater than 6%.

723.07.02 Permanent Installation

723.07.02.01 New Concrete Pads

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad. The concrete pad shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904.

The granular base below new concrete pads shall be a minimum depth of 150 mm of existing or new Granular A and shall be according to OPSS 314.

723.07.02.02 Existing Concrete Surfaces and Pads

When specified in the Contract Documents, existing 200 mm thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.02.03 Connection of BB-BEAT and QuadTrend Systems to Concrete Barrier

When the BB-BEAT or QuadTrend system is connected to new concrete barrier, the adjacent 4.0 m of concrete barrier shall be according to OPSS 740 and the Contract Documents.

When the BB-BEAT or QuadTrend system is connected to existing concrete barrier, the adjacent 4.0 m of existing concrete barrier shall be removed according to OPSS 510 and a new 4.0 m section of concrete barrier shall be installed according to OPSS 740 and the Contract Documents.

723.07.02.04 Rear Cable Anchor Blocks for QuadTrend Systems

Rear cable anchor blocks shall be as specified in the Contract Documents. In both earth and rock fills, rear cable anchor blocks shall be placed on slopes 3H:1V or flatter. The cable supplied with the unit shall be used to determine the proper location of the rear cable anchor block.

In porous or crumbly soils, forms for cast-in-place anchor blocks shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

The top of the concrete block shall be flush with the embankment slope and the rear cable anchor assembly shall not protrude more than 100 mm above ground.

723.07.02.05 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

723.07.02.06 Posts for BB-BEAT Systems

All posts shall be set to the alignment specified in the Contract Documents, regardless of the material encountered. Permissible tolerance for plumb shall be 20 mm maximum over the post length above the ground. The driving of posts shall be accomplished with methods and equipment that leave the posts free of distortion, burring, and any other damage.

All lower end posts shall be installed so that not more than 100 mm is exposed above finished grade.

723.07.03 Temporary Installation

723.07.03.01 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.02 Asphalt Over Concrete

Existing or new 75 mm minimum thick asphalt over 75 mm minimum thick concrete pavement may be used to support the energy attenuator.

723.07.03.03 Asphalt Over Compacted Granular

Existing or new 150 mm minimum thick asphalt over 150 mm minimum thick compacted granular base may be used to support the energy attenuator. The asphalt shall extend a minimum of 500 mm beyond the anchor bolts.

723.07.03.04 Reduced Exposure

When water filled energy attenuator systems are in use, the temperature shall be monitored on a daily basis. When the temperature is predicted to fall below freezing, antifreeze agents according to manufacturer recommendations shall be added to the water. The use of a water filled energy attenuator system when frozen is not permissible.

Water filled energy attenuator systems shall not be left in place during a seasonal shutdown period without approval from the Contract Administrator. When approval from the Contract Administrator is not granted, water filled energy attenuator systems shall be replaced with another approved energy attenuator listed for the reduced exposure tender item for the duration of the seasonal shutdown period.

Disposal of liquid materials shall be managed according to the Contract Documents.

723.07.03.05 Dual Duty

A new high exposure energy attenuator shall be supplied and installed in a temporary configuration during construction at the locations specified in the Contract Documents.

723.07.03.06 Relocation

Temporary energy attenuators, object markers, oversize snowplow markers, object marker posts, and flexible delineator posts shall be relocated as specified in the Contract Documents, including the removal of existing and installation of new anchor bolts and mounting hardware.

Prior to completion of the Contract, dual duty energy attenuators and associated object markers, oversize snowplow markers, and object marker posts including the replacement of anchor bolts and mounting hardware, shall be relocated to their permanent locations as specified in the Contract Documents and in accordance with the General and Permanent Installation subsections.

723.07.03.07 Permanent and Temporary Concrete Barriers

Temporary concrete barriers shall be modified and installed as specified in the Contract Documents and the modified surfaces shall be smooth. Temporary concrete barriers shall be anchored as specified in the Contract Documents.

Permanent existing concrete barriers shall be modified as specified in the Contract Documents and the modified surfaces shall be smooth.

723.07.04 Delineation

723.07.04.01 Object Markers and Oversize Snowplow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snowplow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snowplow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90° from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snowplow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations specified in the Contract Documents.

723.07.04.02 Flexible Delineator Posts

Flexible delineator posts shall be installed according to OPSS 705 at locations specified in the Contract Documents.

723.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

723.09 MEASUREMENT FOR PAYMENT

723.09.01 Actual Measurement

723.09.01.01 Energy Attenuator - Permanent, Narrow Energy Attenuator - Permanent, Wide Energy Attenuator - Permanent, Extra Wide Energy Attenuator - Permanent, Super Wide Energy Attenuator - Permanent, High Exposure Energy Attenuator - Permanent, Single-Sided

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed.

723.09.01.02 Energy Attenuator - Temporary, Narrow Energy Attenuator - Temporary, Wide Energy Attenuator - Temporary, Extra Wide Energy Attenuator - Temporary, Super Wide

Energy Attenuator - Temporary, Reduced Exposure
Energy Attenuator - Temporary, Dual Duty

For measurement purposes, a count shall be made of the number of complete energy attenuator systems installed and removed, up to the maximum number of systems required to be in place at any one time during the Contract.

723.09.01.03 **Energy Attenuator - Relocation, Narrow**
Energy Attenuator - Relocation, Wide
Energy Attenuator - Relocation, Extra Wide
Energy Attenuator - Relocation, Super Wide
Energy Attenuator - Relocation, Reduced Exposure
Energy Attenuator - Relocation, Dual Duty

For measurement purposes, a count shall be made of the number of complete energy attenuator systems relocated. Systems that are temporarily surplus and are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

723.09.02 **Plan Quantity Measurement**

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

723.10 **BASIS OF PAYMENT**

723.10.01 **Energy Attenuator - Permanent, Narrow - Item**
Energy Attenuator - Permanent, Wide - Item
Energy Attenuator - Permanent, Extra Wide - Item
Energy Attenuator - Permanent, Super Wide - Item
Energy Attenuator - Permanent, High Exposure - Item
Energy Attenuator - Permanent, Single-Sided - Item
Energy Attenuator - Temporary, Narrow - Item
Energy Attenuator - Temporary, Wide - Item
Energy Attenuator - Temporary, Extra Wide - Item
Energy Attenuator - Temporary, Super Wide - Item
Energy Attenuator - Temporary, Reduced Exposure - Item
Energy Attenuator - Temporary, Dual Duty - Item
Energy Attenuator - Relocation, Narrow - Item
Energy Attenuator - Relocation, Wide - Item
Energy Attenuator - Relocation, Extra Wide - Item
Energy Attenuator - Relocation, Super Wide - Item
Energy Attenuator - Relocation, Reduced Exposure - Item
Energy Attenuator - Relocation, Dual Duty - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract contains separate items for the work required by this specification, payment shall be at the Contract price and according to the specification for such work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Energy Attenuator, Permanent (EAP)

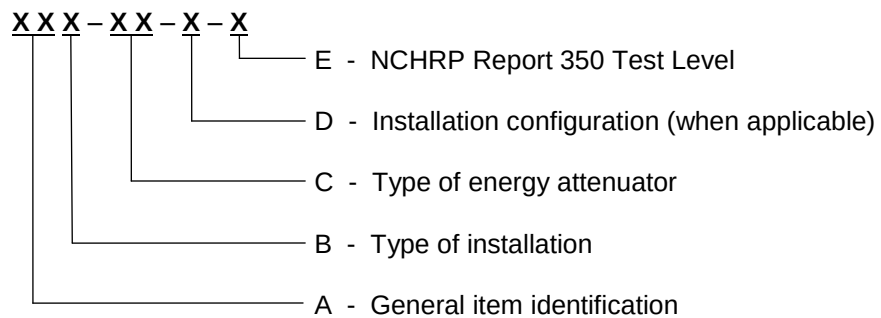
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single- Sided (SS)
TAU-II System	Yes	Yes	Yes	No	No	No	No	No
TAU-II Wide System	Yes	Yes	No	Yes	No	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard System	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System	Yes	Yes	No	Yes	No	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Super Wide System	No	Yes	No	No	No	Yes	No	No
QuadTrend	No	Yes	No	No	No	No	No	Yes
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Smart System	Yes	Yes	Yes	No	No	No	Yes	No

TABLE 2
Energy Attenuator, Temporary (EAT)

Energy Attenuator	NCHRP Report 350 Test Level		Temporary Installation					
	TL-2	TL-3	Reduced Exposure (RE)	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	Dual Duty (DD)
TAU-II System	Yes	Yes	Yes	Yes	No	No	No	No
TAU-II Wide System	Yes	Yes	No	No	Yes	No	No	No
TAU-II Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
Quadguard System	Yes	Yes	Yes	Yes	No	No	No	No
Quadguard Wide System	Yes	Yes	No	No	Yes	No	No	No
Quadguard Extra Wide System	Yes	Yes	No	No	No	Yes	No	No
Quadguard Super Wide System	No	Yes	No	No	No	No	Yes	No
ACZ 350 System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
TRACC System	Yes	Yes	Yes	Yes	No	No	No	No

TABLE 3
Contract Drawing Notation

A	EA - Energy Attenuator
B	P - Permanent T - Temporary R - Relocation
C	NA - Narrow WI - Wide EW - Extra Wide SW - Super Wide HE - High Exposure SS - Single-Sided RE - Reduced Exposure DD - Dual Duty
D	U - Unidirectional B - Bidirectional N - Not applicable
E	2 - NCHRP Report 350 TL-2 3 - NCHRP Report 350 TL-3



Appendix 723-A, November 2015
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
GUIDE RAIL END TREATMENT - STEEL BEAM
ENERGY ATTENUATING TERMINAL SYSTEMS**

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732-A	Commentary

732.01	SCOPE

This specification covers the requirements for the installation of steel beam energy attenuating terminal (SBEAT) systems.

732.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

732.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

732.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-09 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/A 780M-09 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings

732.04 DESIGN AND SUBMISSION REQUIREMENTS

732.04.01 Submission Requirements

One copy of the manufacturer's installation instructions and Working Drawings for each type of SBEAT system to be installed shall be submitted to the Contract Administrator.

Installation of the SBEAT system shall not commence until the Contract Administrator has received the copy of the installation instructions and Working Drawings.

732.05 MATERIALS

732.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

732.05.02 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123/A 123M.

732.07 CONSTRUCTION

732.07.01 General

SBEAT systems shall be installed according to manufacturer's instructions at the locations specified in the Contract Documents.

When an SBEAT system is specified in the Contract Documents, the Contractor has the option of using one of the following systems:

- a) Extruder Terminal system
- b) Sequential Kinking Terminal system
- c) X-Lite Tangent Terminal system
- d) SoftStop Terminal system

When an SBEAT Type M system is specified in the Contract Documents, the Contractor has the option of using one of the following systems:

- a) MGS – ET-Plus 31 Terminal System
- b) MGS – SoftStop Terminal System
- c) MGS – Sequential Kinking Terminal System
- d) MGS – X-Lite Terminal System

SBEAT systems with steel posts shall be installed to steel beam guide rail systems with steel posts.

SBEAT systems with wooden posts shall be installed to steel beam guide rail systems with wooden or steel posts.

SBEAT systems shall be installed according to the manufacturer's instructions at locations as specified in the Contract Documents using only the components supplied for a particular SBEAT system unit.

A minimum 2 m wide area behind the posts, measured from the back of the posts shall be clear of all obstacles for the entire length of the SBEAT system.

732.07.02 Posts and Steel Foundation Tubes

All posts and steel foundation tubes shall be set to the depth and alignment at locations specified in the Contract Documents, regardless of the material encountered.

Wooden post tops shall be cut to the height and to the chamfer as specified in the Contract Documents.

All holes shall be drilled in the wooden posts prior to installation and in the steel posts prior to galvanizing.

The predrilled holes and the cut tops of the wooden posts shall be treated with two coats of an approved wood preservative according to OPSS 1601.

All lower hinge break away posts, steel foundation tubes, and soil plates shall be installed so that no more than 100 mm is exposed above finished grade.

732.07.03 Steel Beam Guide Rails

SBEAT systems shall be connected to new or existing steel beam guide rail as specified in the Contract Documents.

SBEAT system and SBEAT Type M System mounting heights shall be measured vertically from the top of the steel beam guide rail to the ground or gutter line. SBEAT system mounting heights shall be within the ranges in Table 1. SBEAT Type M system mounting heights shall be within the ranges in Table 2.

Where curb with gutter is required, steel beam guide rail mounting height shall be measured:

- a) Vertically at face of steel beam guide rail, when face of steel beam guide rail is more than 300 mm beyond gutter line.
- b) Vertically at gutter line, when face of steel beam guide rail is 300 mm or less beyond the gutter line.

Channel shall not be used within the SBEAT system.

732.07.04 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780/A 780M. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

732.07.05 Object Markers and Oversize Plow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snow plow marker, and galvanized mounting hardware shall be installed at each energy attenuator.

When installed on a paved surface, the object marker and oversize snow plow marker shall be integrally attached to a surface mounted flexible post. The signs and post shall be supplied by the manufacturer as a complete unit. The post shall have the ability to bend 90 degrees from vertical and self-restore after impacts. The minimum outside diameter of the post shall be 60 mm. The post shall be anchored to the pavement according to the manufacturer's recommendations.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snow plow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations as specified in the Contract Documents.

732.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

732.09 MEASUREMENT FOR PAYMENT

732.09.01 Actual Measurement

732.09.01.01 Steel Beam Energy Attenuating Terminal System

For measurement purposes, a count shall be made of each complete steel beam energy attenuating terminal system installed, regardless of the type of steel beam energy attenuating terminal system placed.

732.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the unit shown in the clause under Actual Measurement.

732.10 BASIS OF PAYMENT

732.10.01 Steel Beam Energy Attenuating Terminal System - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
SBEAT System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
Extruder Terminal	685 to 760	685 to 735
Sequential Kinking Terminal	685 to 760	685 to 735
X-Lite Tangent Terminal	685 to 760	685 to 735
SoftStop Terminal	760 to 810	760 to 810

TABLE 2
SBEAT Type M System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
MGS ET-Plus 31 Terminal	760 to 810	760 to 810
MGS SoftStop Terminal	760 to 810	760 to 810
MGS Sequential Kinking Terminal	760 to 810	760 to 810
MGS X-Lite Tangent Terminal	760 to 810	760 to 810

Appendix 732-A, April 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL BEAM TERMINAL SYSTEM

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733.09	MEASUREMENT FOR PAYMENT
733.10	BASIS OF PAYMENT

733.01	SCOPE

This specification covers the requirements for the installation of steel beam terminal (SBT) systems.

733.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 6 - Warning Signs

ASTM International

A 123/A 123M-15	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 780/A 780M-09 (2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

733.04 DESIGN AND SUBMISSION REQUIREMENTS

733.04.01 Submission Requirements

Installation of the SBT system shall not commence until the Contract Administrator has received one copy of the manufacturer's installation instructions.

733.05 MATERIALS

733.05.01 General

All supplied system components shall be according to the manufacturer's specifications.

733.05.02 U Channel Posts

Posts shall be 2.44 m long perforated steel U channel with 11 mm diameter holes spaced on 50 mm centres, minimum weight of 4.46 kg/m, and hot dip galvanized according to ASTM A 123.

733.07 CONSTRUCTION

733.07.01 General

SBT systems shall be installed according to the manufacturer's instructions at locations specified in the Contract Documents using only the components supplied for a particular steel beam terminal system.

The MASH Slotted Rail Terminal (MSRT) M10 Guardrail End Treatment system shall be used for all SBT installations.

A minimum 2 m wide area behind the posts, measured from the back of the posts, shall be clear of all obstacles for the entire length of the SBT.

733.07.02 Posts and Steel Foundation Tubes

All posts and steel foundation tubes shall be set to the depth and alignment at locations specified in the Contract Documents, regardless of the material encountered.

The lower anchor cable release steel post shall be installed so that no more than 100 mm is exposed above finished grade.

733.07.03 Steel Beam Guide Rails

SBT systems shall be connected to new or existing steel beam guide rail as specified in the Contract Documents.

SBT system mounting heights shall be measured vertically from the top of the steel beam guide rail to the ground. SBT system mounting heights shall be within the ranges in Table 1.

733.07.04 Damage to Galvanizing

Precautions shall be taken to protect galvanizing against damage. Minor abrasions shall be repaired according to ASTM A 780. Components with major abrasions shall be replaced.

The method of repair for any damage shall be approved by the Contract Administrator prior to the commencement of such work.

733.07.05 Object Markers and Oversize Plow Markers

A Wa-33 object marker according to OTM Book 6, a Wz-2 oversize snow plow marker, and galvanized mounting hardware shall be installed at each SBT.

When installed on a granular surface, the Wa-33 object marker and Wz-2 oversize snow plow marker shall be securely fastened to a U channel post and the post shall be direct buried to a minimum embedment depth of 900 mm.

Posts shall be installed at locations as specified in the Contract Documents.

733.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

733.09 MEASUREMENT FOR PAYMENT

733.09.01 Actual Measurement

733.09.01.01 Steel Beam Terminal System

For measurement purposes, a count shall be made of each complete steel beam terminal system installed, regardless of the type of steel beam end terminal system placed.

733.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the unit shown in the clause under Actual Measurement.

733.10 BASIS OF PAYMENT

733.10.01 Steel Beam Terminal System - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required removals and replacement or repairs of defective work and materials shall be the Contractor's responsibility at no additional cost to the Owner.

TABLE 1
Steel Beam Terminal System Mounting Heights

System	Height During Construction and Seasonal Shutdown mm	Height for Completion of the Work mm
MASH Slotted Rail Terminal (MSRT) M10	760 to 810	760 to 810



CONSTRUCTION SPECIFICATION FOR PERMANENT CONCRETE BARRIERS

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740.10	BASIS OF PAYMENT

740.01	SCOPE

This specification covers the requirements for the construction of permanent concrete barriers.

740.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 313	Hot Mix Asphalt - End Result
OPSS 314	Untreated Subbase, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1151	Superpave and Stone Mastic Asphalt Mixtures
OPSS 1305	Moisture Vapour Barriers
OPSS 1306	Burlap
OPSS 1308	Joint Filler in Concrete
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1442	Epoxy Coated Reinforcing Steel Bars for Concrete

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 11 - Pavement, Hazard and Delineation Markings

CSA Standards

G40.20-13/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G164-18	Hot Dip Galvanizing of Irregularly Shaped Articles

740.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Asymmetric means the barrier placed where the pavement elevations on each side of the barrier differ.

740.04 DESIGN AND SUBMISSION REQUIREMENTS

740.04.01 Submission Requirements

A request shall be submitted to the Contract Administrator for permission to use a concrete barrier design other than as specified in the Contract Documents. The request shall be submitted at least 4 weeks prior to starting any work affected by the proposed change.

740.05 MATERIALS

740.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa, except that tall wall concrete barrier shall have a nominal minimum 28-Day compressive strength of 35 MPa. Coarse aggregate for the concrete shall have a nominal maximum size of 19.0 mm.

All coarse aggregate used for slip-formed tall wall concrete barrier shall have all faces crushed.

740.05.02 Curing

Membrane curing compound shall be according to OPSS 1315. Burlap shall be according to OPSS 1306 and moisture vapour barrier shall be according to OPSS 1305.

740.05.03 Joint Filler

Joint filler for permanent concrete barrier shall be according to OPSS 1308.

740.05.04 Formwork

Formwork for permanent concrete barrier shall be according to OPSS 919.

740.05.05 Reinforcing Steel

Steel reinforcement shall be according to OPSS 1440.

Dowel bars shall be according to OPSS 1442.

740.05.06 Asphaltic Concrete

Asphaltic concrete shall be according to OPSS 1151.

740.05.07 Granular

Granular foundation material shall be according to OPSS 1010.

740.05.08 Interlocking Components

Hollow structural steel and wide flange steel sections used in permanent precast concrete barrier shall be according to CSA G40.21, grade 350W, and shall be hot dip galvanized after fabrication according to CSA G164.

740.05.09 Marking

The following information shall be permanently marked on the top or sides of the precast sections:

- a) Name or trademark of the manufacturer.
- b) Identification of plant if manufacturer has more than one plant.
- c) The date of manufacture.

740.07 CONSTRUCTION

740.07.01 Concrete Barrier

Concrete barriers shall be installed at locations as specified in the Contract Documents.

Construction of concrete barrier shall be by the following methods:

- a) Conventional wooden or steel formwork.
- b) Slip-form.
- c) Precast concrete barrier units.

Precast concrete barrier containing the I-Lock connection, may be used in permanent installations. The precast concrete barrier shall be secured in place as specified on the Contract Documents.

740.07.01.01 Foundation Preparation

Preparation of the granular foundation shall be according to OPSS 314 and OPSS 301, as appropriate. Immediately ahead of placing the concrete, the subgrade shall be wet down by means of a uniform spray of water sufficient to wet the subgrade thoroughly without leaving standing water.

Placement of asphaltic concrete pavement beneath and adjacent to the precast concrete barrier shall be according to OPSS 313.

740.07.01.02 Tolerances

Dimensions of the completed barrier shall not deviate by more than 10 mm from the dimensions as specified in the Contract Documents.

The horizontal alignment shall not deviate more than 10 mm from the required lines as specified in the Contract Documents.

When a 3 m long straight edge is placed on the top and faces of the concrete barrier surface, the surface of the concrete shall not vary more than 6 mm from the edge of the straight edge.

When the slip-formed concrete barrier does not conform to the tolerances, the concrete barrier may be corrected to the required tolerances using a magnesium float, while the concrete is still plastic, providing the surface and/or the barrier is not damaged during such adjustments.

740.07.01.03 Surface Finish

The surface of the concrete barrier placed with conventional forms shall have a surface finish according to OPSS 904.

Slip-formed barrier surface shall not be brushed. Offsets and fins shall be removed immediately by light trowelling. Surface blemishes 10 mm or less in diameter shall be left untouched. If surface blemishes larger than 10 mm diameter occur, adjustments in the operation shall be made to correct the condition. If the adjustments do not correct the condition within 10 m, the operation shall be halted until the condition is corrected either by adjustments to the operation or to the concrete mix.

The use of water on the completed barrier to correct imperfections shall not be permitted.

740.07.01.04 Curing

Curing shall be according to OPSS 904 with the exception that white pigmented curing compound is permitted with slip-formed concrete.

Curing for formed surfaces shall be according to OPSS 904.

When joints are made after the application of curing compound, the exposed face of the barrier in the vicinity of the joint shall be retreated with curing compound.

When white pigmented membrane is used as curing compound on slip-formed barrier, it shall also be used on adjacent preformed barrier sections for colour uniformity.

740.07.01.05 Concrete Subject to Cold Weather

Concrete shall not be placed by slip-forming when the ambient air temperature is below 0 °C.

When the concrete is placed at temperatures of 5 °C or less, the concrete in the barrier wall shall be maintained at a minimum temperature of 5 °C for 3 Days. The compressive strength cylinders shall be cast and cured with the barrier wall. The 3-Day compressive strength cylinders shall be at least 80% of the minimum specified 28-Day compressive strength of the wall. If these conditions cannot be met, then the concrete shall be protected according to OPSS 904, for footings and slabs on the ground.

740.07.01.06 Expansion Joints

Expansion joints 12 mm minimum in width shall be installed where concrete barrier abuts a structure, adjacent to piers, over existing deck expansion joints, and at the locations as specified in the Contract Documents. The expansion joint shall be filled with Type A expansion joint filler.

If forming the joint is performed before the concrete has hardened, the adjacent portions of the barrier shall be supported firmly to ensure the design shape of the barrier wall is constructed as specified in the Contract Documents.

740.07.01.07 Construction Joints

Construction joints shall be vertical and square with a rough joint face. Joints shall be created by sawcutting the hardened concrete to a depth of 45 mm ± 5 mm around the outside of the barrier and removing the remaining loose and excess concrete.

Curing compound shall be applied to the joint face.

Transition sections between barrier and treatments for high mast lighting poles, overhead sign structures, and bridge piers in median shall be one-piece construction of the same class of concrete as the barrier. No portion of the transition shall be slip-formed.

Dowels shall only be used at transitions.

Continuity between transition sections and barrier wall sections shall be accomplished by using three size 25M by 1.0 m long, epoxy coated smooth reinforcing bars placed horizontally in the wall. The three bars shall be embedded 500 mm into the squared end of the constructed wall and shall be located on the barrier centre line, commencing 150 mm from the top of the barrier and equally spaced vertically at 150 mm intervals. Construction joints at transition sections for tall wall concrete barrier shall consist of five horizontal epoxy coated smooth reinforcing bars installed.

Prior to constructing the addition, the exposed horizontal bars and the squared end of the barrier wall shall be greased to inhibit bonding.

Transitions for high mast lighting poles and overhead sign structures shall be one-piece construction of the same class of concrete as the barrier wall.

740.07.01.08 Treatment at Bridge Piers

Granular A material with asphalt surface shall be used to fill the area between concrete barriers where separation occurs at bridge piers or at other locations where separation of the barriers is required. Compaction of granular shall be according to OPSS 501. The asphalt surface shall be according to OPSS 313.

740.07.01.09 Isolation and Contraction Joints

All joints shall be formed in the plastic concrete immediately following the slip-form equipment. Joints shall be formed using a grooving tool with a minimum 40 mm deep bit and shall be continuous along the front and back vertical face, excluding the top of the barrier. Tooling marks or other surface defects adjacent to the newly formed joint shall be trowelled smooth. A proposal may be submitted to sawcut the contraction joints in lieu of scoring, which may be permitted subject to a demonstration of the proposed technique and prior approval by the Contract Administrator.

Isolation joints shall be placed on each side of the outside perimeter of all sub-surface structural elements such as storm-water and maintenance access structures to accommodate vertical differential movement.

Contraction joints shall be equally spaced along the barrier wall at 4 m intervals. This interval may be locally modified to a length between 3 to 5 m to avoid being within 3 m of any other joint.

The construction joint at the end of the day shall coincide with a contraction or isolation joint.

Cracks outside the joints are unacceptable. The section containing the cracks shall be removed and replaced. The limits of removal shall extend to the nearest joint on each side of the crack.

740.07.02 Reflectors

Reflectors placed on permanent concrete barrier shall be according to the OTM Book 11.

740.07.03 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

740.08 QUALITY ASSURANCE

740.08.01 Acceptance Criteria for Precast Concrete Barrier

Final inspection of the precast units will not be made until they have been installed.

All concrete barrier units shall meet the following criteria:

- a) There shall be no exposed coarse aggregate, such as honeycombing. The top and bottom surface of the precast unit are excluded from this condition.
- b) Cracks shall not extend through the precast unit.

740.09 MEASUREMENT FOR PAYMENT

740.09.01 Actual Measurement

740.09.01.01 Concrete Barrier Tall Wall Barrier Asymmetric Concrete Barrier Asymmetric Tall Wall Barrier

Measurement shall be made in metres along the centreline of the barrier, from end to end of installation, and shall include the length required for lighting pole footings and overhead sign structure footings.

Where two concrete barriers are constructed back to back, Type A-2, TW-2, and M-2; they shall be treated as a single installation and the length will be measured only once for payment purposes.

740.09.01.02 Granular

Measurement shall be according to OPSS 314.

740.09.01.03 Asphaltic Concrete

Measurement shall be according to OPSS 313.

740.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

740.10 BASIS OF PAYMENT

**740.10.01 Concrete Barrier - Item
Tall Wall Barrier - Item
Asymmetric Concrete Barrier - Item
Asymmetric Tall Wall Barrier - Item**

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material required to construct the barriers, including any concrete backfill between Type A-2, TW-2, or M-2 concrete barriers at the location of bridge piers or transitions.

740.10.02 Granular

Granular material used as backfill between concrete barriers shall be paid for at the Contract price for the appropriate granular items.

740.10.03 Asphaltic Concrete

Asphaltic concrete laid as a foundation or used as asphalt surface at bridge piers shall be paid for at the Contract price for the appropriate hot mix item.



CONSTRUCTION SPECIFICATION FOR TEMPORARY CONSTRUCTION BARRIERS (TCB)

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741.01	SCOPE

This specification covers the requirements for the construction of temporary construction barriers.

741.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 723 Energy Attenuators

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete
OPSS 1504 Steel Beam Guide Rail
OPSS 1601 Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Ontario Traffic Manual (OTM):
Book 7 Temporary Conditions
Book 11 Pavement, Hazard and Delineation Markings

Designated Sources for Materials (DSM)

CSA Standards

A23.1-19/A23.2-19	Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete
G40.20-13/G40.21-13	Rolled or Welded Structural Quality Steel/Structural Quality Steel
W59-18	Welded Steel Construction (Metal Arc Welding)

ASTM International

A123/A123M-17	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
D4956-17	Retroreflective Sheeting for Traffic Control

Others

O. Reg. 213/91	Construction Projects under Occupational Health and Safety Act, R.S.O. 1990, c. O.1

741.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Movable Temporary Construction Barrier (MTCB) means a concrete temporary construction barrier that can be quickly shifted laterally using a barrier transfer machine.

Relocation means the movement of a temporary construction barrier or movable temporary construction barrier system from one location to another, which typically occurs when construction operations move from one stage to the next.

Shift means the lateral displacement of a movable temporary construction barrier system, which is typically completed to facilitate the opening or closing of traffic lane(s). The lateral displacement may vary throughout the length of a barrier installation.

Temporary Construction Barrier (TCB) means a concrete or steel barrier device which provides a physical limitation, through which a vehicle would not normally pass, and is intended to contain or redirect an errant vehicle of a particular size range, at a given speed and angle of impact.

741.04 DESIGN AND SUBMISSION REQUIREMENTS

741.04.01 Submission Requirements

741.04.01.01 Temporary Construction Barrier

The Contract Administrator shall be notified in writing of the selection of the types and locations of all temporary construction barrier selected, including all applicable Standard Drawings 7 Days prior to the first placement.

When a proposal is made to change the staging and barrier arrangement that will result in the width of the level area between the back of the barrier and the upper edge of an excavation to be less than 1 metre, a memorandum for each installation not meeting the 1 metre width shall be submitted to the Contract Administrator. Each memorandum shall indicate how the proposal meets Ontario Regulation 213/91, include a slope stability evaluation for each proposed barrier installation adjacent to an excavation, and be signed and sealed by an Engineer.

741.04.01.02 Steel Temporary Construction Barrier

One copy of the manufacturer's installation instructions and Working Drawings shall be submitted to the Contract Administrator prior to the installation of steel TCB.

Installation of steel TCB shall not commence until the Contract Administrator has received the copy of the instructions and Working Drawings.

741.04.02.03 Movable Temporary Construction Barrier

Working Drawings, a copy of the manufacturer's specifications, and installation instructions shall be submitted to the Contract Administrator prior to the installation of MTCB.

Installation of MTCB shall not commence until the Contract Administrator has received the copy of the installation instructions and manufacturer's specifications.

741.05 MATERIALS

741.05.01 Concrete Temporary Construction Barrier

741.05.01.01 General

Concrete for the manufacture of TCB units shall be according to OPSS 1350, except that the restrictions on volume batching shall not apply. The following specific requirements shall apply:

- a) Class of concrete: Exposure class C-1 according to CSA A23.1.
- b) Coarse aggregate: 19.0 mm nominal maximum size.

741.05.01.02 Marking

All concrete TCB units shall be permanently and legibly marked by the manufacturer as follows:

- a) Name or trademark of manufacturer on file with Owner including identification of plant if manufacturer has more than one plant and year of manufacture embossed on top of each concrete TCB at one end.
- b) Owner approved three-digit code of manufacturer and plant identification, and six-digit code for date of manufacture (Year Month Day, example January 15, 2008 is 080115) stencilled in minimum 50 mm high digits with indelible ink or paint on top of each concrete TCB at opposite end of embossed markings.
- c) Duplicate three-digit code of manufacturer and plant identification, and six-digit code for date of manufacture, stencilled in minimum 50 mm high digits with indelible ink or paint on the vertical face of one end elevation of each concrete TCB.
- d) Markings are not permitted on traffic faces of concrete TCB.

741.05.01.03 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440 and as specified in the Contract Documents.

741.05.01.04 Connection Assembly Components

Connection assembly components for non-proprietary concrete TCB systems shall be as specified in the Contract Documents. Connection assembly components for proprietary concrete TCB systems shall be according to manufacturer's specifications and as specified in the Contract Documents.

741.05.01.05 Restraint Systems, Type M Connection Only

All materials required for the restraint systems as specified in the Contract Documents.

741.05.01.06 Thrie Beam Guide Rails, Bolts, and Nuts

Thrie beam guide rails shall be fabricated according to OPSS 1504 and as specified in the Contract Documents. Bolts and nuts shall be according to OPSS 1504.

741.05.01.07 Steel Plates, Bolts, and Nuts

Steel plates shall be fabricated according to CSA G40.20/G40.21 and as specified in the Contract Documents. Steel plates shall have minimum yield strength of 345 Mpa. All steel plates shall be hot dip galvanized after fabrication according to ASTM A123. Bolts and nuts shall be according to OPSS 1504.

741.05.01.08 Wooden Blocks

Wooden blocks shall be according to OPSS 1601.

741.05.02 Delineators

Delineators shall be two-sided, and each side shall have a minimum reflective surface of 100 × 100 mm; high intensity retroreflective sheeting according to ASTM D4956, Type VIII; orange colour; and flexibility to bend 90 degrees from vertical and self-restore.

741.05.03 Steel Temporary Construction Barrier

All supplied components shall conform to the manufacturer's specifications.

Table 1 lists the manufacturers and barrier systems that are acceptable for steel TCBs. The choice to supply and install any of the approved systems in Table 1 is allowed.

741.06 EQUIPMENT

741.06.01 Barrier Transfer Machine for Movable Temporary Construction Barrier

Barrier transfer machines required to shift MTCB shall be supplied from a source named on the ministry's

741.07 CONSTRUCTION

741.07.01 Temporary Construction Barrier

741.07.01.01 General

Where a temporary construction barrier, restraints permitted item is used, the TCB shall meet the minimum category in Table 2.

Where a temporary construction barrier, freestanding item is used, the TCB shall meet the minimum category in Table 3.

Where a temporary construction barrier, end restraints only item is used, the TCB shall meet the minimum category in Table 4.

Where a temporary construction barrier, freestanding, narrow item is used, the TCB shall meet the minimum category in Table 5.

Where a temporary construction barrier, restrained, narrow item is used, the TCB shall meet the minimum category in Table 6.

Temporary construction barriers shall be installed at locations as specified in the Contract Documents and according to the convention defined in Table 7.

Temporary construction barrier of higher deflection categories is also acceptable for use for lower categories within the same restraint type (i.e., freestanding, restraints permitted or end restraints only). For example, deflection category II, III and IV items (if available for the restraint type) are also acceptable for use for Category I items of the same restraint type.

741.07.01.02 Type M Connection

Type M connection used for concrete TCB restraint systems shall have been manufactured after October 2011, as verified by the markings.

Mechanical and adhesive anchoring systems shall be installed according to the manufacturer's specifications to the minimum embedment depth as specified in the Contract Documents.

All welds shall be according to CSA W59.

741.07.02 Movable Temporary Construction Barrier

741.07.02.01 General

The MTCB system shall be installed and relocated at the locations as specified in the Contract Documents, the Working Drawings, and according to the manufacturer's installation instructions and specifications.

The MTCB shall be installed on a paved surface having a maximum crossfall of 6% measured perpendicular to the installation and shall be in place prior to the opening of traffic operations.

Gaps between barriers shall be kept clear of debris at all times.

The MTCB system shall be removed from the Working Area when no longer required.

741.07.02.02 Shifting

The shift of MTCB, including the shift of energy attenuators, shall be at the locations as specified in the Contract Documents. The method and procedure for the shift shall be according to the manufacturer's installation instructions. The MTCB and energy attenuators shall be shifted back to the original location when required. Shifting of the MTCB and energy attenuators at the locations as specified in the Contract Documents shall be completed as many times as is necessary to complete the work requiring the shift.

741.07.03 Maximum Deflection

Table 2, Table 3, or Table 4 shall be used to determine acceptable barrier types for "restraints permitted", "freestanding", and "end restraints only" items respectively. The back face of a barrier system shall not be placed less than the minimum distance from the top of an excavation or fixed object as specified in the Contract Documents, regardless of the deflection category corresponding to the tender item.

741.07.04 Foundation Preparation

Temporary construction barrier shall be installed on a paved surface having a maximum crossfall of 6% measured perpendicular to the installation and shall be in place prior to the opening of traffic operations. 2 Days shall be allowed between the placement of final asphalt surface and placement of temporary construction barrier. Temporary construction barrier shall be in place prior to the opening of traffic operations.

Drainage shall be maintained under the temporary construction barrier.

741.07.05 Installation

Temporary construction barrier shall be installed at locations as specified in the Contract Documents.

Construction of temporary construction barrier shall be by use of precast concrete or prefabricated steel barrier units.

Temporary construction barrier shall be installed with connections properly engaged. Proprietary systems shall be installed according to the manufacturer's installation instructions.

741.07.06 Anchorages

Steel TCB shall be installed and anchored according to the manufacturer's installation instructions for the specified configuration.

741.07.07 Transitions

741.07.07.01 Concrete Temporary Construction Barrier

Transition from one type of concrete TCB to another type of concrete TCB is permitted by using the concrete TCB transition detail as specified in the Contract Documents.

The proportion of each type of approved concrete TCB used for the Work shall be at the Contractor's discretion. However, a minimum continuous length of 100 m of any one type of concrete TCB is required prior to transitioning to another type.

Transitions between unrestrained concrete TCB and permanent concrete barrier shall be as specified in the Contract Documents.

Transitions between reduced deflection concrete TCBs and unrestrained concrete TCBs shall be as specified in the Contract Documents.

741.07.07.02 Type M Connection Only

Transitions between restrained concrete TCB and unrestrained concrete TCB shall be as specified in the Contract Documents.

741.07.07.03 Steel Temporary Construction Barrier

Transitions between two different steel TCB systems or between steel and concrete TCB shall not be permitted.

Transitions between permanent concrete barrier and steel TCB shall not be permitted.

Transitions between steel beam guiderail and steel TCB shall not be permitted.

741.07.08 End Treatment

741.07.08.01 Steel Temporary Construction Barrier

One end or both ends, as specified in the Contract Documents, of the steel TCB installation shall be protected with an energy attenuator according to the manufacturer's specifications according to OPSS 723.

741.07.08.02 Movable Temporary Construction Barrier

One end or both ends, as specified in the Contract Documents, of the MTCB installation shall be protected with an energy attenuator according to the manufacturer's specifications and according to OPSS 723.

741.07.09 Drainage Gaps for Concrete Temporary Construction Barrier

Gaps for drainage for concrete TCB shall be installed as identified in the field to accommodate surface runoff using the three beam transition as specified in the Contract Documents.

741.07.10 Tolerances

The horizontal and vertical alignment at the junction of each barrier section shall be within 15 mm. The minimum radius on which the barrier may be placed shall be according to the manufacturer's requirements for each type of connection.

741.07.11 Construction Markers

Construction markers shall be placed in advance of the temporary construction barrier installation to assist in directing the traffic away from the flared approach end treatment. Taper length for full lane closures and the maximum distance between markers shall be according to OTM Book 7.

741.07.12 Quality Control for Temporary Construction Barrier

741.07.12.01 General

Temporary construction barrier units shall be certified that it meets the acceptance criteria. A completed MTO Form PH-CC-876 shall be submitted to the Contract Administrator within 24 hours of installation or relocation of the units. An inspection of temporary construction barrier units shall be performed pre- and post-installation. Certification shall be done by an authorized representative of the Contractor.

When the installed or relocated temporary construction barrier units do not meet the acceptance criteria, they shall be removed and replaced within 48 hours with units that meet the acceptance criteria.

Units damaged while in service as part of the Work or the alignment discontinuity is beyond that allowable by the acceptance criteria shall be replaced or reinstalled as necessary. The repair shall be performed within a 48-hour period starting at the occurrence or first awareness of the damage.

741.07.12.02 Concrete Temporary Construction Barrier

Repaired precast concrete TCB units may be used provided that the structural integrity of the unit is maintained. An Engineer's seal and signature shall be affixed to documentation certifying that the repair method used shall not impact the structural integrity of the unit.

741.07.12.03 Movable Temporary Construction Barrier

Certification is not required after shifting of MTCB.

741.07.13 Acceptance Criteria for Temporary Construction Barrier

741.07.13.01 Concrete Temporary Construction Barrier

For all applications, any concrete TCB unit that fails one or more of the following acceptance criteria shall be rejected:

- a) Dimensions of each unit shall not deviate from those specified by more than the following tolerance:
 - i. Specified dimensions up to 300 mm $\pm$ 5 mm
 - ii. Specified dimensions greater than 300 mm $\pm$ 10 mm
- b) Steel elements of each connecting device shall be free of visible fracture, distortion, and perforation.
- c) Concrete within 200 mm of a connecting device shall be free of visible cracks that are greater than 0.3 mm in width, measured at the widest point of the crack.

- d) All cracks greater than 0.3 mm in width, other than addressed in c), shall neither extend through the precast unit nor be greater than 300 mm in length.
- e) The unit shall be free of honeycombing.
- f) The end of any unit shall not be located greater than 50 mm from the horizontal alignment of the installation.

In addition to the above criteria, when the precast units are used on facilities with a posted regulatory speed limit of 80 km/h or higher, any unit that fails one or more of the following acceptance criteria shall be rejected:

- a) Damage to edges shall not extend greater than 100 mm onto any adjacent face. When edge damage extends greater than 50 mm onto such a face, damage to the opposite side of that edge shall not extend greater than 50 mm onto the opposite face.
- b) The total length of concrete breakout damage to edges flanking the connecting devices, whether repaired or not, shall not exceed 25% of the respective connecting device length on each side of each connecting device.
- c) The concrete damage in the area of the drainage recess shall not reach higher than one third of the lower sloped surface containing the recess.
- d) Concrete breakouts on the traffic faces or on the top of the precast unit other than addressed in a) to c) above shall not be greater than 150 mm in any direction measured on the surface, nor shall the breakout depth at any point be greater than 25 mm measured perpendicularly to the face.
- e) Accumulated total concrete breakouts addressed in d) on the traffic sides of the unit shall not exceed 10% of the total surface area of the respective side.
- f) Drilled holes into the barrier shall not have diameter greater than 40 mm.
- g) The horizontal and vertical alignment discontinuity between adjacent units shall not be greater than 20 mm, as measured with a 1 m straightedge.

741.07.13.02 Steel Temporary Construction Barrier

Any steel TCB unit that fails one or more of the following acceptance criteria shall be rejected:

- a) Dimensions of each unit shall not deviate from those specified by more than the following tolerances:
 - i. For specified dimensions up to 300 mm, the tolerance shall be ± 5 mm.
 - ii. For specified dimensions greater than 300 mm, the tolerance shall be ± 10 mm.
- b) Connecting devices shall be free of visible fracture, distortion, or perforation.
- c) Surface impact deformations shall not exceed 25% of the barrier faces. Surface deformations shall not be greater than 25 mm in depth as measured perpendicularly to the face.
- d) All steel surfaces shall be free of visible gaps.
- e) All welds shall be in visibly cracks or rips.
- f) All steel surfaces shall be free of rust.

741.07.13.03 Movable Temporary Construction Barrier

Any MTCB unit that fails one or more of the following acceptance criteria shall be rejected:

- a) Dimensions of each unit shall not deviate from those specified by more than the following tolerances:

- i. For specified dimensions up to 300 mm, the tolerance shall be ± 5 mm.
 - ii. For specified dimensions greater than 300 mm, the tolerance shall be ± 10 mm.
- b) Steel elements of each connecting device shall be free of visible fracture, distortion, and perforation.
- c) Top or head of each unit shall not expose mesh or rebar nor have damage greater than 75 mm deep.
- d) Bottom or foot of each unit shall not have:
 - i. Damage greater than 250 mm long measured parallel to roadway.
 - ii. Damage greater than 75 mm wide measured perpendicular to roadway.
 - iii. Damage greater than 150 mm high.
- e) All cracks greater than 0.3 mm in width shall neither extend through the unit nor be greater than 300 mm in length.
- f) The unit shall be free of honeycombing.

741.07.14 Restoration of Asphalt and Concrete Surfaces

Restoration of asphalt and concrete surfaces disturbed during the installation and removal of restrained temporary construction barrier shall be as specified in the Contract Documents.

741.07.15 Delineators

Delineators according to OTM Book 11 shall be installed at 4 m intervals on concrete TCBs and at the barrier unit connections on steel TCBs.

Delineators shall be securely fastened to the top of the temporary construction barrier with reflective surfaces clearly visible.

Delineators shall be maintained at all times.

741.07.16 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

741.08 QUALITY ASSURANCE

The Owner may conduct random quality assurance checks on units that have been supplied and installed or relocated to verify the Contractor's ability to ensure compliance with the acceptance criteria. Units that are identified by the Owner's representative as not meeting the acceptance criteria or those units that have been repaired and do not have documentation certifying the method of repair must be removed and replaced with units that meet the acceptance criteria for temporary construction barrier. This shall be done within a 48-hour period of notice to the Contractor, unless agreed otherwise in writing.

741.10 MEASUREMENT FOR PAYMENT

741.09.01 Actual Measurement

- 741.09.01.01**
 - TCB, Restraints Permitted, Category I, II, III or IV
 - TCB, Freestanding, Category I, II, III or IV
 - TCB, Freestanding, Narrow, Category I
 - TCB, Restrained, Narrow, Category IV
 - TCB, End Restraints Only, Category I
 - Movable TCB

Measurement of barriers shall be by length in metres along the centreline of the barrier, from end to end, including temporary end sections installed and removed, up to the maximum length of barriers required to be placed at any one time during the Contract.

**741.09.01.02 TCB, Relocation
Movable TCB, Relocation**

Measurement of barriers shall be by length in metres along the centreline of the barrier, from end to end, including temporary end sections relocated.

Barriers that are temporarily surplus to a Contract or a stage within a Contract, including for seasonal shutdown requirements, which are required for future stages shall be paid for as one relocation for the combined moves into and out of storage, including any off-site storage required due to on-site restrictions.

741.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

741.10 BASIS OF PAYMENT

**741.10.01 TCB, Restraints Permitted, Category I, II, III, or IV - Item
TCB, Freestanding, Category I, II, III, or IV - Item
TCB, Freestanding, Narrow, Category I - Item
TCB, Restrained, Narrow, Category IV - Item
TCB, End Restraints Only, Category I - Item
TCB, Relocation - Item
Movable TCB - Item
Movable TCB, Relocation - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

741.10.02 Movable TCB, Shift - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment shall be prorated over the time requiring shifting of movable temporary construction barrier.

TABLE 1
Acceptable Steel TCB Systems

Manufacturer	System
Laura Metaal	BarrierGuard 800
Hill and Smith Inc	Zoneguard
Laura Metaal	Safezone
Safe Barriers	Defender Barrier
Saferoads	HV2
Highway Care	HighwayGuard

TABLE 2
Deflection Categories for TCB, Restraints Permitted (Note 1)

Type	System	Hard Surface, Unrestrained	HMA, Restrained	Concrete, Restrained	Bolted to Bridge Deck	Gravel, Restrained
Concrete TCB	Type J (4 m or 6 m), Non-Restrainable	I	-	-	-	-
	Type J (4 m and 6 m), Restrained	I	IV	IV	-	-
	Type M	II	III	III	IV	
	Type QMB	I	-	-	-	-
	Type T (4 m and 6 m)	II	-	-	-	-
	Type X (9.0, 6.0, or 3.0 m), Non-Restrainable	III (Note 2)	-	-	-	-
	Type X (4 m), Restrained	III	IV	IV	-	-
	Type Z, Non-Restrainable	III	-	-	-	-
	Type Z, Restrained	III	IV	IV	-	-
	Type FLUX	I	-	-	-	-
Steel TCB	BarrierGuard 800	I (Note 3)	-	-	-	-
	BarrierGuard 800 LDS	-	III	III	III	-
	BarrierGuard 800 MDS	-	IV	IV	IV	-
	Defender LDS	-	III	III	IV	I
	HV2	I	-	-	-	-
	SafeZone	I (Note 3)	-	-	-	-
	SafeZone LDS	-	III	III	III	-
	ZoneGuard	I (Note 3)	-	-	-	-
	ZoneGuard MDS	-	IV	IV	IV	-
	HighwayGuard	-	I	I	-	I
	HighwayGuard LDS	-	III	III	-	-
	HighwayGuard MDS	-	IV	IV	-	-
Notes: 1. The Roman numerals I, II, III and IV in the table indicate that a barrier is acceptable for use when the TCB item of the corresponding deflection category is specified. 2. Concrete TCB, Type X, is acceptable for deflection category IV when used adjacent to a single reversible lane, controlled by traffic signals resting in red phase and with a posted regulatory speed of less than 70 km/h. 3. Barrier system requires anchoring at end of run according to the Contract Documents.						

TABLE 3
Deflection Categories for TCB, Freestanding (Note 1)

Type	System	Hard Surface, Unrestrained
Concrete TCB	Type J (4 m and 6 m), Non-Restrainable	I
	Type J (4 m and 6 m), Restrainable	I
	Type M	II
	Type QMB	I
	Type T	II
	Type X (9.0, 6.0, or 3.0 m), Non-Restrainable	III (Note 2)
	Type X (4 m), Restrainable	III (Note 2)
	Type Z, Non-Restrainable	III
	Type Z, Restrainable	III
	Type FLUX	I
Steel TCB	HV2	I
Notes: 1. The Roman numerals I, II and III in the table indicate that a barrier is acceptable for use when the TCB, Freestanding item of the corresponding deflection category is specified. 2. Type X TCB is acceptable for deflection category IV when used adjacent to a single reversible lane, controlled by traffic signals resting in red phase and with a posted regulatory speed of less than 70 km/h.		

TABLE 4
Deflection Categories for TCB, End Restraints Only (Note 1)

Type	System	Hard Surface, Unrestrained
Concrete TCB	Type J (4 m and 6 m), Non-Restrainable	I
	Type J (4 m and 6 m), Restrainable	I
	Type M	I
	Type QMB	I
	Type T (4 m and 6 m)	I
	Type X (9.0, 6.0, or 3.0 m), Non-Restrainable	I
	Type X (4 m), Restrainable	I
	Type Z, Non-Restrainable	I
	Type Z, Restrainable	I
	Type FLUX	I
Steel TCB	BarrierGuard 800	I (Note 2)
	HV2	I
	SafeZone	I (Note 2)
	ZoneGuard	I (Note 2)
Notes: 1. The Roman numeral I in the table indicates that a barrier is acceptable for use when the Temporary Construction Barrier, End Restraints Only item of the corresponding deflection category is specified. 2. Barrier system requires anchoring at end of run according to the Contract Documents.		

TABLE 5
Deflection Categories for TCB, Freestanding, Narrow

Type	System	Hard Surface, Unrestrained
Concrete TCB	Type Z, Non-Restrainable	III
	Type Z, Restrainable	III

TABLE 6
Deflection Categories for TCB, Restrained, Narrow

Type	System	Hard Surface, Unrestrained
Concrete TCB	Type Z, Restrainable	IV

TABLE 7
Contract Drawing Notation - Temporary Construction Barrier

A	TCB - Temporary Construction Barrier REL - TCB Relocation
B	FS - Freestanding FN - Freestanding, Narrow RP - Restraints Permitted ER - End Restraints Only MO - Movable
C	1 - Category I 2 - Category II 3 - Category III 4 - Category IV
Note: 1. Temporary Construction Barrier is noted on the Contract Drawings by AAA-BB-C (e.g., REL-FS-2).	



CONSTRUCTION SPECIFICATION FOR CONNECTICUT IMPACT ATTENUATION SYSTEM (CIAS)

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753.01	SCOPE

This specification covers the requirements for the installation of Connecticut Impact Attenuation Systems (CIAS).

753.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 314	Untreated Granular, Subbase, Base, Surface, Shoulder, and Stockpiling
OPSS 904	Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

G40.20-04/G40.21-04 (R2009)	Rolled or Welded Structural Quality Steel/Structural Quality Steel
W47.1-03 (R2008)	Certification of Companies for Fusion Welding of Steel
W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)

ASTM International

A53 / A53M - 07	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A123 / A123M - 09	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153 / A153M - 03	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307 - 07	Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

753.05 MATERIALS

753.05.01 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

753.05.02 Granular Base

Granular base shall be Granular A according to OPSS 1010.

753.05.03 Reinforcing Steel Bars

Reinforcing steel bars for concrete backwall shall be according to OPSS 1440.

753.05.04 Fasteners

Bolts, nuts, washers, and spacers shall be according to ASTM A307 and hot dip galvanized according to ASTM A153.

753.05.05 Steel Cylinders

Cylinders shall be fabricated from steel according to CSA G40.21, Grade 300W, and hot dip galvanized after fabrication to provide a zinc coating not less than 610 g/m² according to ASTM A123.

Cylinders shall be cut square and seamless or electric welded. The finished cylinder shall be within 15 mm of true round. Each cylinder shall be labelled at the top with the designated A to N alphabetical character.

All edges shall be machined and free of burrs and sharp edges.

753.05.06 Steel Rails

Steel rails shall be fabricated as specified in the Contract Documents from flat stock steel according to CSA G40.21, Grade 300W, and hot dip galvanized after fabrication to provide a zinc coating not less than 610 g/m² according to ASTM A123.

753.05.07 Steel Straps, Lid Support Angles, and Lifting Devices

Steel straps, lid support angles, and lifting devices shall be steel according to CSA G40.21, Grade 300W. All straps shall be cut to the width and length and welded to the cylinder as specified in the Contract Documents.

753.05.08 Steel Pipes

Steel pipes shall be 48.3 mm OD, standard weight, Schedule 40 steel pipe according to ASTM A53 and welded to one side of the cylinder as specified in the Contract Documents.

753.05.09 Steel Pipe Retainers

Steel pipe retainers shall be 50 mm by 32 mm OD, standard weight, Schedule 40 steel pipe according to ASTM A53 and welded to the side of the cylinder as specified in the Contract Documents.

753.05.10 Lids

Lids shall be fabricated from low-density polyethylene composed of 25% recycled plastic materials. Lids shall be black in colour and UV stabilized to a minimum rating of UV8D. The lid shall be of sufficient strength to support a centred point load having a mass of 60 kg producing a maximum deflection of 100 mm.

Each lid shall have a steel restraining chain for attachment of the lid to the cylinder.

Associated metal hardware for the lids, such as washers, eye bolts, chains, and screws shall be hot dip galvanized according to ASTM A153 or equivalent electroplated or anodized treated.

753.05.11 Welds

All welding shall be according to CSA W47.1 and CSA W59.

753.07 CONSTRUCTION

753.07.01 General

Connecticut Impact Attenuation Systems shall be installed according to and at locations specified in the Contract Documents.

753.07.02 Concrete Pads and Backwalls

Levelling and site preparation required for the existing granular base shall be performed prior to placing the concrete pad and backwall.

Concrete pads and backwalls shall be constructed as specified in the Contract Documents. Concrete shall be placed, cured, and finished according to OPSS 904. Cross fall of the concrete pad is desirably 6% or less and shall not exceed 10%. All exposed edges of the backwall shall have a 25 mm chamfer. Drilling of anchor holes shall commence a minimum of five days after concrete has been placed.

753.07.03 Granular Base

The granular base below the concrete pad shall be a minimum depth of 150 mm and shall be placed according to OPSS 314. The granular material shall be compacted to 95% of the maximum dry density.

753.07.04 Connection to Barriers

The concrete backwall shall be connected to the barrier as specified in the Contract Documents.

753.07.05 Delineation

Delineation shall be provided as specified in the Contract Documents.

753.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

753.09 MEASUREMENT FOR PAYMENT

753.09.01 Actual Measurement

753.09.01.01 Connecticut Impact Attenuation System (CIAS)

For measurement purposes, a count shall be made of the number of complete Connecticut Impact Attenuation Systems installed.

753.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

753.10 BASIS OF PAYMENT

753.10.01 Connecticut Impact Attenuation System (CIAS) - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE

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771.01 SCOPE

This specification covers the requirements for the installation of highway fence, brace panels, and gates.

771.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 510 Removal

Ontario Provincial Standard Specifications, Material

OPSS 1540 Standard Highway Fence Components

ASTM International

A 780 / A 780M-09 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings

771.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Brace Post means the wooden post installed to anchor the diagonal wooden brace within the brace panel.

Corner Post means the terminal post installed at horizontal deflections in the fenceline greater than 22 degrees.

Cross Fences means intersecting wire fences.

Line Post means the fence post spaced at regular intervals between terminal posts throughout each section of fence.

Line Wire means the horizontal wire of the fence fabric.

Stay Wire means the vertical wire that is woven or wrapped around the line wire to form the rectangular opening of the fence fabric.

Steel Brace Panel means the steel brace, steel line post, angle iron, and grout.

Straining Post means the terminal post installed at changes in vertical deflections in the fence line greater than 22 degrees or at approximately 200 m intervals.

Terminal Post means end, gate, corner, and straining posts.

Twitch-Stick Method means the tensioning of wires by inserting and rotating a twitch stick between the space of the diagonal wires as they cross.

Wooden Brace Panel means the diagonal wooden brace, wooden brace post, brace wire, fasteners, and when installed in rock, steel T-rail posts with 3.5 mm wire and grout.

771.05 MATERIALS**771.05.01 Highway Fence**

Highway fence components shall be according to OPSS 1540.

771.05.02 Fence Fabric

Only one type of fence fabric shall be used within the limits of the Contract.

771.07 CONSTRUCTION**771.07.01 Removal**

Removal of existing fence shall be according to OPSS 510.

771.07.02 Site Preparation

Prior to the commencement of fencing operations, all debris shall be removed and ground undulations shall be corrected along the fenceline to obtain a smooth and uniform gradient.

All trees, stumps, and brush along the fenceline shall be cut off at ground level and all logs and overhanging branches that interfere with the installation of the fence shall be removed.

771.07.02.01 Selective Clearing

When fencing is required through wooded areas that are not designated for clearing and grubbing, only selective clearing shall be permitted in order to gain access to the fenceline and to permit fence installation with lightweight equipment. Clearing shall be kept to a minimum and shall be subject to the approval of the Contract Administrator prior to the commencement of any clearing operation. Travel around obstructions may be required.

The location of access points shall be based on the least amount of clearing required and the frequency of access points shall be subject to reasonable material delivery requirements. The access points shall be approved by the Contract Administrator.

771.07.03 Highway Fence

771.07.03.01 General

Highway fence shall be installed at locations as specified in the Contract Documents.

Survey reference points or permanent property boundary markers shall not be disturbed or moved without the authorization of the Contract Administrator. When it is necessary to set posts adjacent to such points, the posts shall be placed on the roadway side of the property line as close as feasible to the monuments or markers.

771.07.03.02 Post Installation

771.07.03.02.01 General

All posts shall be installed plumb and to the depth as specified in the Contract Documents.

Terminal posts shall be installed at all highway fence ends, both sides of all openings and gates, locations with changes in horizontal or vertical deflections greater than 22 degrees in the fenceline, and at locations identified for straining purposes. Terminal posts shall be installed on each side of watercourse crossings. Line posts shall be installed as specified in the Contract Documents.

771.07.03.02.02 Post Installation in Earth, Shale, or Loose or Friable Rock

Postholes for wooden posts shall be excavated to 150 mm greater than the diameter of the larger end of the post. The large end of the post shall be placed in the bottom of the posthole. Material resulting from posthole excavation shall be used as backfill around the posts and compacted to 90% modified proctor density.

Steel posts shall be driven with care to ensure they will not be bent or burred.

771.07.03.02.03 Post Installation in Rock

Posts installed in solid rock shall be steel posts as specified in the Contract Documents.

Postholes for steel posts shall be drilled in rock to a maximum diameter of 150 mm. Overburden shall be

excavated to a maximum diameter of 300 mm. Posts shall be placed in the postholes and filled as specified in the Contract Documents.

771.07.03.03 Brace Panels

Brace panels shall include the installation of the diagonal wooden braces or diagonal angle iron braces; diagonal brace wires; and fasteners, as appropriate.

Diagonal brace wires may be tensioned using the twitch-stick method.

When cross fence separates property owners, three brace panels shall be installed at the end post of cross fences. When the cross fence does not separate property owners, one brace panel shall be installed on the cross fence at the end post.

Brace panels at straining posts shall be installed at equal intervals of approximately 200 m without any intervals greater than 230 m. Brace panels shall be installed on each side of a corner, straining, opening, or gate locations.

Brace panels shall be installed at terminal posts on each side of watercourse crossings.

When fences are to be partially removed, brace panels shall be installed at the terminal ends of the remaining fence.

771.07.03.04 Fence Fabric

Fence fabric shall be placed on the side of the post nearest the roadway, except on curves with a radius of less than or equal to 1,750 m. In this situation, the fabric shall be placed on the side of the post away from the centre of the curve.

Fence fabric shall be uniformly tensioned so that its line wires are tight and parallel and the stay wires are straight, uniformly spaced, and at right angles to the line wires.

Staples for fence fabric with design numbers 948-12-9.75 and 949-12-9 shall be set diagonally to the grain of the wooden post and driven securely. Top wire shall be double stapled and all other wires single stapled.

Staples for fence fabric with design number 949-12-12.5 shall be set diagonally to the grain of the wooden post and driven securely, but shall allow for movement of the horizontal line wires as a result of thermal expansion and contraction.

Fence fabric shall be fastened to the steel post using wire ties at all nine line wires.

Fencing fabric shall be tensioned and properly terminated with the wire wrapped around the terminal posts at least once and around itself at least four complete turns and stapled to the terminal posts.

Rolls of fence fabric with design numbers 948-12-9.75 and 949-12-9 shall be spliced together by wrapping adjacent line wires, using mechanical splicing units or using crimp sleeves. The same method shall be used throughout the limits of the Contract.

Rolls of fence fabric with design number 949-12-12.5 shall be spliced together using mechanical splicing units or crimp sleeves.

When splicing is achieved by wrapping adjacent line wires, wrap the overhanging line wires around the corresponding line wires on the adjacent roll, at least four complete turns as specified in the Contract Documents.

Mechanical splicing units and crimp sleeves shall be installed according to the manufacturer's instructions and as specified in the Contract Documents.

After splicing, all projecting ends of the line wires shall be removed. Terminal posts shall not be installed for splice purposes only.

771.07.04 Cross Fences

Cross fences shall be secured to the adjacent post prior to cutting the fence at the brace panel.

771.07.05 Gates

Gates shall be installed at locations and be of the type and size as specified in the Contract Documents.

When gates are required without adjacent fencing, terminal posts with brace panels shall be installed on each side of the gate.

Gates shall be installed to open away from the roadway and to close by gravity.

771.07.06 Marking

Identification plates, provided by the material supplier, shall be securely attached to the completed fence installation at the following intervals:

- a) At the start and end of each fence installation.
- b) At a maximum interval of 300 m.

The fence identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 300 mm from the top of the fence fabric. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B 209 series 1100 or 5005-H34.

Each fence identification plate shall be engraved with the following information:

- a) Contract number.
- b) Name or trademark of fence Subcontractor.
- c) Name or trademark of fence supplier (i.e., suppliers of fence fabric and posts).
- d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

771.07.07 Zinc Coating Repairs

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on galvanized components, except fence fabric, shall be repaired according to ASTM A 780.

771.07.08 Site Restoration

After fence installation, the site shall be cleaned and trimmed and the ground restored to a neat condition.

771.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

771.08 QUALITY ASSURANCE

771.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to this specification may result in a partial or complete inspection of the installation by the Owner and removal and replacement of all defective workmanship or materials by the Contractor.

771.08.02 Material Certification

Certificates of compliance for each fence component used in the installation shall be provided to the Contract Administrator. The certificate of compliance shall indicate that the material was manufactured, sampled, tested, and inspected according to the reference specification and has been found to meet the requirements.

Each certificate of compliance shall include the following information typed on company letterhead:

- a) Manufacturer's name or trademark.
- b) General description of the component.
- c) Reference specification for material (e.g., CGSB 138.1, Fence Fabric for Chain-Link Fence).
- d) Signed and dated by the manufacturer's authorized representative.

All certificates of compliance shall be assembled and submitted to the Contract Administrator prior to completion of the Work.

771.08.03 Material Sampling

The Contract Administrator may obtain and test samples to ensure compliance with the specifications. Products represented by the test samples that are not in compliance shall be removed from the Work Area and replaced.

771.09 MEASUREMENT FOR PAYMENT

771.09.01 Actual Measurement

771.09.01.01 Highway Fence

Measurement of highway fence shall be by length in metres along the contour of the ground for the actual length of highway fence installed and shall include gate openings and brace panels.

771.09.01.02 Brace Panels

For measurement purposes, a count shall be made of the number of brace panels installed, regardless of material type.

771.09.01.03 Gates

For measurement purposes, a count shall be made of the gates installed, regardless of the size and type. Double gates shall be counted as one gate.

771.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

771.10 BASIS OF PAYMENT

**771.10.01 Highway Fence - Item
Brace Panels - Item
Gates - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR CHAIN-LINK FENCE

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772.01	SCOPE

This specification covers the requirements for the installation of chain-link fence.

REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904 Concrete Structures

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production

OPSS 1541 Chain-Link Fence Components

CSA Standards

W59 - 2018 Welded Steel Construction (Metal Arc Welding)

ASTM International

A123/A123M-17	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A780/A780M-20	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B209/209M-21a	Aluminum and Aluminum-Alloy Sheet and Plate

772.03 DEFINITIONS

For the purpose of this specification, the following definitions shall apply:

Barbed Wire means the twisted longitudinal wires, termed line wires, to which the barbs are attached.

Barbed Wire Arm means the metal arm used to support the barbed wire.

Bottom Wire means the wire installed at the bottom of the fence which is fastened to the bottom of the fence fabric and extends throughout each section of fence between terminal posts.

Brace Band means a symmetrically formed strip of metal shaped to fit around a post and used with a carriage bolt and nut to attach the rail end or brace rail end to the post. Also, used for attaching barbed wire, tension wire, and other items to a terminal post.

Brace Rail means a tubular, fabricated or roll-formed steel section used for bracing terminal posts.

Corner Post means a terminal post at a point where the line of fence changes in two or more directions.

Diagonal Brace Wire means the wire used for bracing terminal posts.

End Post means the fence post positioned at the ends of a section of fence.

Fence Fabric means the chain-link mesh installed between the fence posts.

Fence Post means an upright tubular, fabricated or roll-formed steel member for supporting fencing material.

Fitting means the mechanical connection of various designs, shapes, and metals to join fence components into an integral structure.

Gatepost means a terminal post on each side of a gate forming a gateway.

Hog Ring means a preformed open wire clip designed to close up into a ring to secure chain-link fabric to horizontal top and bottom wires.

Knuckled means the type of selvage obtained by interlocking adjacent wire ends in pairs and then bending the wire ends back into a closed loop.

Line Post means the fence post spaced at regular intervals between terminal posts throughout each section of fence.

Line Post Cap means a cap with a loop or hole used to position the top rail or top wire atop of the line posts. It also prevents water from entering the tubular post.

Marcelled Tension Wire means a type of wire manufactured with either a uniform helix or a series of waves put into the wire to facilitate tensioning the wire when installed to support the top or bottom of the chain-link fence fabric.

Post Sleeve means a length of tube or pipe that is embedded into a concrete retaining wall, and used to hold fence posts in place.

Rail End means a cup-shaped fitting used with a brace band to connect the top rail or brace to a post.

Selvage means the edge finish on woven chain-link fabric joining pairs of pickets. The selvage may be knuckled or twisted.

Straining Post (or Pull Post) means a terminal post in a line of fence used to brace a long stretch or to effect a change in elevation along a fence line.

Tension Band means an offset strip of metal shaped to fit around the terminal post and used with a carriage bolt and nut to attach the tension bar to the post.

Tension Bar means the bar used with tension bands to secure the fence fabric to a terminal post.

Terminal Post means end, gate, corner, and straining post.

Terminal Post Cap means a cap atop a post (end, gate, corner or straining post) that prevents water from entering the tubular post.

Top Rail means a tubular, fabricated or roll formed steel section continuously joined by means of sleeves or couplings throughout all sections of fence extending between terminal posts.

Top Rail Sleeve means a fitting used to join two pieces of top rail when swedged top rail is not used.

Top Wire means the wire installed at the top of the fence and extends continuously throughout all sections of fence between terminal posts.

Twisted means the type of selvage obtained by interlocking adjacent wire ends in pairs and then twisting the wire at least two turns with the wire ends above the twist.

Wire Ties means the wire used to tie chain-link fence fabric to line posts, bottom wires, and top rails or top wires.

772.04 DESIGN AND SUBMISSION REQUIREMENTS

772.04.01 Submission Requirements

772.04.01.01 Proprietary Systems

When a proprietary fence is installed, one copy of the manufacturer's installation instructions and Working Drawings for each type of proprietary fence system to be installed shall be submitted to the Contract Administrator.

Installation of a proprietary fence shall not commence until the Contract Administrator has received a copy of the installation instructions and Working Drawings.

772.05 MATERIALS

772.05.01 Chain-Link Fence

Chain-link fence components shall be according to OPSS 1541.

772.05.02 Concrete

Concrete shall be according OPSS 1350 and have a nominal minimum 28-Day compressive strength of 20 MPa.

772.07 CONSTRUCTION

772.07.01 Site Preparation

Prior to the commencement of the fencing operations, all debris shall be removed and ground undulations shall be corrected along the fenceline to obtain a smooth and uniform gradient.

All trees, stumps, and brush along the fenceline shall be cut off at ground level and all logs and overhanging branches that interfere with the installation of the fence shall be removed.

772.07.02 Proprietary Systems

Proprietary fences shall be installed according to manufacturer's installation instructions at the locations specified in the Contract Documents.

The following proprietary system may be installed as an alternative to chain link fence:

- a) Cochrane Global ClearVu

772.07.03 Chain-Link Fence

772.07.03.01 General

Chain-link fence shall be installed at locations specified in the Contract Documents.

Survey reference points or permanent property boundary markers shall not be disturbed or moved without the authorization of the Contract Administrator. When it is necessary to set posts adjacent to such points, the posts shall be placed on the roadway side of the property line as close as feasible to the monuments or markers.

772.07.03.02 Post Installation

772.07.03.02.01 General

All posts shall be installed plumb and to the depth specified in the Contract Documents.

Posts shall be cut to the required height above the ground to present a smooth and uniform profile. Line post spacing shall be in equal horizontal distances with a maximum of 3,000 mm between line posts.

Tubular posts shall be fitted with waterproof post caps designed to fit and fasten securely over the posts.

Corner posts shall be installed at horizontal deflections in the fence line of 10 degrees or more.

Straining posts shall be installed at equal intervals not exceeding 150 m. Additional straining posts shall be installed when changes in vertical alignment of the fence exceed 30 degrees.

772.07.03.02.02 Posts on Concrete Barrier

All posts installed on concrete barrier shall be according to the Contract Documents.

Each post shall be fabricated with a welded steel base plate grade 300W, hot dip galvanized according to ASTM A123M, and according to the Contract Documents. All welds shall be to a low hydrogen classification according to CSA W59. Electrodes used for manual welding shall be E7015, E7016, or E7018. All welds shall be continuous.

772.07.03.02.03 Footings

All posts shall be installed according to the Contract Documents. Roll-formed steel line posts may be direct driven when bedrock is not present.

Concrete placing, curing, and protection from the elements shall be according to OPSS 904.

Concrete material sampling and testing shall be according to OPSS 1350.

772.07.03.03 Bracing

A brace rail or brace wire shall be placed diagonally across the panel at all ends and gateposts. Corner and straining posts shall be supported with diagonal braces placed on both sides of the post. The higher end of the diagonal brace shall be connected at the terminal post.

End fittings shall be secured by a 6 mm bolt placed through the fitting and braced at both ends of the brace.

772.07.03.04 Top Rails, Top Wires, and Bottom Wires

Top rails or top wires shall be installed as specified in the Contract Documents.

All line post caps shall carry either the top rail or top wire as specified in the Contract Documents. Top rails or top wires shall be fastened securely to tubular line post tops using waterproof post caps. Roll-formed steel shape posts do not require waterproof post caps.

In sag locations, the post and post cap shall be drilled and fastened with a self-tapping screw to ensure a secure fit.

Top rails shall be fastened to terminal posts with centre bands.

Top and bottom wires shall be stretched tight and securely fastened to terminal posts with turnbuckles and centre bands.

One turnbuckle shall be used between terminal posts.

772.07.03.05 Fence Fabric

Fence fabric shall not be installed until the concrete footings have cured for a minimum of 5 Days.

The fabric shall be stretched tight and securely fastened to terminal posts with steel tension bars and steel or aluminum tension bands. The longitudinal axis of the diamond pattern shall be perpendicular to the slope of the top rail or top wire.

The fabric shall be placed on the side of the post nearest the roadway with the barbed edge at the top, except on curves of 50 m or smaller radius, the fabric shall be placed on the side of the post away from the centre of the curve.

The fabric shall be securely fastened to the line posts, bottom wire, and top rail or top wire with wire ties. The fabric shall not be fastened to any diagonal braces.

Manually fastened round wire ties shall engage one strand of the chain-link fence fabric with one end of the tie by wrapping it with two 360 degree turns and then wrapping the body of the tie around the post or top rail a minimum of 180 degrees. The remaining end of the tie shall be secured to the second strand of the chain-link fence fabric by wrapping it with two 360 degree turns. The fabric and the main body of the tie shall be drawn tightly to the rail or post.

Power fastened wire ties shall engage two strands of the chain-link fence fabric at a diamond joint closest to the post or top rail. The manufacturer's installation instructions shall be followed to complete the operation. The ends shall be twisted three full twists or one and one-half machine turns. The end of the tie shall be positioned on the post or rail so that it is parallel to the chain-link fence fabric.

The ends of wire ties shall not protrude beyond the vertical plane on either side of the chain-link fence fabric. Protruding ends of wire ties shall be removed.

The hog rings on top and bottom wires shall be installed according to the Contract Documents.

772.07.03.06 Barbed Wire

Barbed wire shall be installed when specified in the Contract Documents. The barbed wire shall be pulled taut to remove all slack and shall be firmly installed in the slots of the barbed wire arms. The ends of the barbed wire shall be securely connected at the terminal posts with brace bands. Barbed wire arms shall be installed with the arm pointing away from the roadway.

772.07.04 Gates

772.07.04.01 General

Gates shall be installed at locations and of the type and size specified in the Contract Documents.

772.07.04.02 Gate Installation

Gates shall be constructed with the fabric on the side furthest from the roadway with the barbed edge at the top.

All gates shall have a chain hook to hold gates open and double gates shall have a steel gate centre rest with a drop bolt for the closed position.

The surface grade within the required gate sweep area shall be low enough to permit free movement of the gate.

772.07.05 Marking

Identification plates, provided by the material supplier, shall be securely attached to the completed fence installation at the following intervals:

- a) At the start and end of each fence installation.
- b) At a maximum interval of 300 m.

The fence identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 300 mm from the top of the fence fabric. The maximum dimensions of the plate shall be 200 mm by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B209 series 1100 or 5005-H34.

Each fence identification plate shall be engraved with the following information:

- a) Contract number.
- b) Name or trademark of fence Subcontractor.
- c) Name or trademark of fence supplier (i.e., supplier(s) of fence fabric and posts)
- d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

772.07.06 Zinc Coating Repairs

Cut ends, field drilled holes, and damaged areas of hot dip galvanized coatings on galvanized components shall be repaired according to ASTM A780M.

772.07.07 Site Restoration

After fence installation, the site shall be cleaned, trimmed and the ground restored to a neat and original condition existent prior to the fencing operations.

772.07.08 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

772.08 QUALITY ASSURANCE

772.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to the specification may result in a partial or complete inspection of the installation and removal and replacement of all defective workmanship or materials.

772.08.02 Material Certification

Certificates of compliance for each fence component used in the installation shall be provided to the Contract Administrator. The certificate of compliance shall indicate that the material was manufactured, sampled, tested, and inspected according to the reference specification and has been found to meet the requirements.

Each certificate of compliance shall include the following information on company letterhead:

- a) Manufacturer's name or trademark.
- b) General description of the component.
- c) Reference specification for material (e.g., CAN/CGSB 138.1 Fence Fabric for Chain-Link Fence).
- d) Signed and dated by the manufacturer's authorized representative.

All certificates of compliance shall be assembled and submitted to the Contract Administrator prior to completion of the work.

772.08.03 Material Sampling

The Contract Administrator may obtain and test samples to ensure compliance with the specifications. Products represented by the test samples that are not in compliance shall be removed from the Work Area and replaced.

772.08.04 Concrete

Concrete footing acceptance shall be according to OPSS 1350.

772.09 MEASUREMENT FOR PAYMENT

772.09.01 Actual Measurement

772.09.01.01 Chain-Link Fence

Measurement of chain-link fence shall be by length in metres along the contour of the ground for the actual length of fence installed and shall include gate openings.

772.09.01.02 Gates

For measurement purposes, a count shall be made of the number of gates installed, regardless of the size and type. Double gates shall be counted as one gate.

772.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

772.10 BASIS OF PAYMENT

**772.10.01 Chain-Link Fence - Item
Gates - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



**CONSTRUCTION SPECIFICATION FOR
REQUIREMENTS FOR ANTI-GLARE SCREENS**

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791.10	BASIS OF PAYMENT

791.01 SCOPE

This specification covers the requirements for the installation of anti-glare screens.

791.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

ASTM International

A153/A153M-06	Zinc Coating (Hot Dip) on Iron and Steel Hardware
A325-14	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
A1011/A1011M-18a	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
B209-14	Aluminum and Aluminum-Alloy Sheet and Plate

791.04 DESIGN AND SUBMISSION REQUIREMENTS

791.04.01 Installation Instructions

One copy of the manufacturer's installation instructions shall be submitted to the Contract Administrator prior to installation of any proprietary paddle-type anti-glare screen.

791.05 MATERIALS

791.05.01 Mesh

Steel mesh panels shall be fabricated from expanding quality hot rolled sheets according to ASTM A1011M.

Aluminum mesh panels shall be fabricated from expanding utility grade 3003 H14 sheets or 1100 H14 rolls.

Mesh panels shall consist of regular 19 mm diamond shaped patterns formed by expanding 1.6 mm thick panels to provide panels 600 mm or 1,200 mm in width and a minimum of 2,400 mm plus one diamond width in length. The diamonds shall be according to the following:

- a) Width of diamond, centre to centre of strand shall be 22 mm.
- b) Length of diamond, centre to centre of strand shall be 50 mm.
- c) Width of strand shall be 5 mm.
- d) Cut-off angle shall be a minimum of 21 degrees.

Mesh panels installed on concrete barrier and steel beam guide rail shall be 600 mm in width.

Mesh panels installed on chain-link fence shall be 1,200 mm in width.

The size of the finished mesh panels shall not deviate more than 3 mm from the specified width and more than 12 mm from the specified length.

Mesh panels shall be levelled and wire brushed after the expanding operation.

Mesh panels fabricated from steel sheets shall be hot dip galvanized after fabrication to provide a mass of zinc coating not less than 610 g/m² of total surface.

791.05.02 Hardware

Washers, nuts, and bolts shall be according to ASTM A325. All hardware shall be galvanized according to ASTM A153 and to provide a mass of zinc coating of not less than 305 g/m² of total surface.

Metal discs used to fasten mesh panels to the chain-link fence fabric shall be fabricated from 1.6 mm thick steel and hot dip galvanized after fabrication to provide a mass of zinc coating of not less than 610 g/m² of the total surface.

791.07 CONSTRUCTION

791.07.01 General

Anti-glare screens shall be installed at locations specified in the Contract Documents. Mesh panels shall be oriented as specified in the Contract Documents.

791.07.02 Expanded Metal Anti-Glare Screens on Chain-Link Fence

Mesh panels shall be fastened to the chain-link fence as specified in the Contract Documents.

791.07.03 Marking

Identification plates, provided by the material supplier, shall be securely attached to the completed expanded metal anti-glare screen installation at the following intervals:

- a) At the start and end of each expanded metal anti-glare screen installation.

- b) At a maximum interval of 300 m.

The expanded metal anti-glare screen identification plate shall be located within 300 mm of a terminal post with the top of the plate located approximately 300 mm from the top of the expanded metal anti-glare screen. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B209 series 1100 or 5005H34.

Each expanded metal anti-glare screen identification plate shall be engraved with the following information:

- a) Contract number.
- b) Name or trademark of anti-glare screen Subcontractor.
- c) Name or trademark of anti-glare screen supplier (i.e., suppliers) of expanded metal anti-glare screen and posts.
- d) Date of completed installation (i.e., yyyy-mm).

The height of the letters and numerals shall be within the range of 6 to 32 mm.

791.07.04 Paddle Type Anti Glare Screen

Paddle type anti-glare screens shall be installed at locations specified in the Contract Documents in accordance with the manufacturer's installation instructions. Work shall not begin until the Contract Administrator has received a copy of the installation instructions for the type of barrier being installed on.

Acceptable paddle type anti-glare screens shall be one of the following systems:

- a) Safe-Hit® Glarescreen System
- b) GlareGaard

Paddle type anti-glare screens may be used on temporary construction barriers in accordance with the manufacturer's specifications. Screen bases shall be installed such that all portions of a base are installed on a single barrier unit.

791.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

791.08 QUALITY ASSURANCE

791.08.01 Construction

The Contract Administrator may perform a spot visual inspection to determine conformance with the workmanship, design, and dimensional requirements of this specification.

Failure to conform to the specifications may result in a partial or complete inspection of the installation and removal and replacement of all defective workmanship or materials.

791.10 MEASUREMENT OF PAYMENT

791.09.01 Actual Measurement

**791.09.01.01 Expanded Metal Anti-Glare Screen
Paddle Type Anti-Glare Screen
Paddle Type Anti Glare Screen, Temporary**

Measurement of anti-glare screen shall be by length in metres along the length of chain-link fence, concrete barrier, or temporary construction barrier for the actual length of screen installed.

791.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

791.10 BASIS OF PAYMENT

**791.10.01 Expanded Metal Anti-Glare Screen - Item
Paddle Type Anti-Glare Screen - Item
Paddle Type Anti-Glare Screen, Temporary - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Costs associated with any required repairs or removal and replacement of defective materials shall be the Contractor's responsibility at no additional cost to the Owner.



Note: The PROV published in April 2018 replaces OPSS 801 COMMON, November 2010 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR THE PROTECTION OF TREES

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801.01 SCOPE

This specification describes the measures required to protect trees not designated for removal.

801.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Barrier means a fence placed around a single tree or group of trees to protect them from removal and injury.

Dripline means the location on the ground surface directly beneath the theoretical vertical line from the tips of the outermost branches of the trees.

801.07 CONSTRUCTION

801.07.01 Operational Constraints

Trees not designated for removal shall not be damaged and shall be protected from flooding and sediment deposits from construction operations.

Equipment and vehicles shall not be operated within the dripline of trees not designated for removal unless specified in the Contract Documents. In such cases, operation of equipment shall be kept to the minimum necessary to perform the work required.

Equipment or vehicles shall not be parked, repaired, or fuelled within the dripline of any tree not designated for removal.

Construction materials and earth shall not be stockpiled within the dripline of any tree not designated for removal.

801.07.02 Barrier for Tree Protection

Barriers for tree protection shall be a minimum height of 1.2 m consisting of material approved by the Contract Administrator, supported by steel posts. The number of steel posts shall be enough to keep the material from sagging and the fence erect.

The barriers shall be erected at the dripline of trees or woodlot edges within the Working Area, prior to commencement of construction operations at locations specified in the Contract Documents. Where a clearance zone of 1.5 m cannot be established between the barrier at the dripline and the limit of grading, the barrier may be placed within the dripline, subject to the approval of the Contract Administrator. When the barrier is placed within the dripline,

- a) a minimum distance of 0.75 m shall be maintained between the trunk of the tree and the barrier, and
- b) a distance of 1.5 m shall be maintained between the barrier and the limit of grading.

When the trunks of trees are less than 4.5 m apart, the trees shall be considered a woodlot and the barrier shall be placed so it forms a continuous barricade around the woodlot as specified in the Contract Documents.

A barrier is not required where an existing fence serves the same purpose. At such locations, the barrier shall terminate at the existing fence so that a continuous barricade is provided between the trees and the area of work.

The barriers shall be maintained erect and in good repair throughout the duration of construction operations without breaks and unsupported sections and shall be removed upon completion of the work.

801.07.03 Tree Repair

Trees not designated for removal that are damaged by construction operations shall be repaired as follows, within 5 Days of the damage:

- a) Branches 25 mm or greater in diameter that are broken shall be cut back cleanly on the tree side of the break or to within 10 mm of their base, if a substantial portion of the branch is damaged.
- b) Roots 25 mm or larger in diameter that are exposed shall be cut back cleanly to the soil surface.
- c) Bark that is damaged shall be neatly trimmed back to uninjured bark without causing further injury to the tree.

801.07.04 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

801.09 MEASUREMENT FOR PAYMENT

801.09.01 Actual Measurement

801.09.01.01 Barrier for Tree Protection

Measurement shall be in linear metres measured along the length of the barrier. Overlaps shall not be measured.

801.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

801.10 BASIS FOR PAYMENT

801.10.01 Barrier for Tree Protection - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material required to do the work.

Progress payments shall be based on the following percentage of the Contract price:

60% for supply and erection
25% for maintenance
15% for removal

When there is not a separate item for Barrier for Tree Protection, payment at the Contract price for the applicable tender items of the Contract that necessitate the placing of barriers for tree protection shall include full compensation for all labour, Equipment, and Material to do the work of protecting and repairing trees not designated for removal.



CONSTRUCTION SPECIFICATION FOR VEGETATIVE COVER

TABLE OF CONTENTS

803.01	SCOPE
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803.10	BASIS OF PAYMENT

803.01 SCOPE

This specification covers the requirements for the application of vegetative cover.

803.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 802	Topsoil
OPSS 804	Temporary Erosion Control
OPSS 805	Temporary Sediment Control

Canadian and Provincial Statutes

Seeds Act (R.S., 1985, c. S-8)
Invasive Species Act (S.O. 2015)
Weed Control Act (R.S.O., 1990, c.W.5)

803.03

DEFINITIONS

For the purposes of this specification the definitions in OPSS 182 and the following definitions shall apply:

Invasive Species means as defined in the Invasive Species Act.

Local Seed Bank means the seeds of species native to a project site and the topsoil the seeds are contained in, located within a vegetated area.

Local Vegetation Block means a salvaged layer of topsoil containing grass and herbaceous plant material that has a dense, intact root structure.

Northern Ontario means the area of Ontario north of a line joining Waubesaushene, Severn Bridge, Bancroft and Ottawa.

Noxious Vegetation means a plant that has been listed in the Schedule of Noxious Weeds found in Regulation 1096 made under the Weed Control Act.

Seeded Earth Area means the prepared earth area that has received the applied seed and fertilizer.

Southern Ontario means the area of Ontario between the northern and southern boundaries of Southwestern Ontario and Northern Ontario respectively.

Southwestern Ontario means the area of Ontario south of a line joining Grand Bend and Clarkson.

Vegetative Cover means seed, sod, local seed bank, and local vegetation blocks.

Winter dormant period means as defined in Table 1 and 2 for the specified vegetative cover.

803.04

DESIGN AND SUBMISSION REQUIREMENTS

803.04.01

Submission Requirements

A certificate of seed analysis from a seed testing laboratory approved by the Canadian Food Inspection Agency for all permanent seed mixes to be used in the Work shall be submitted to the Contract Administrator for review a minimum of 24 hours prior to any seeding operations.

The certificate of seed analysis shall identify the seed supplier's lot designation numbers, germination and purity for each seed species of the mix, as well as the seed mix composition expressed as a percentage of each seed species by mass for each seed mix as specified in the Contract Documents.

Written confirmation shall be submitted to the Contract Administrator within 30 Days of the pre-start meeting that the seeds specified in the Contract Documents have been sourced.

803.05

MATERIALS

803.05.01

Local Seed Bank

Local seed bank shall be sourced on-site from designated salvage areas as specified in the Contract Documents and shall not contain invasive species.

803.05.02

Local Vegetation Blocks

Local vegetation blocks shall be sourced on-site from designated salvage areas as specified in the Contract Documents and shall not contain invasive species.

803.05.03 Seed

803.05.03.01 Certificate of Seed Analysis

Permanent seed mixes shall have a valid certificate of seed analysis.

803.05.03.02 Seed Packaging, Labeling, and Storage

All permanent seed mixes and annual nurse crop seeds shall be in the original factory sealed package with the original label securely attached.

Labeling shall be in accordance with the requirements of the Seeds Act and Regulations. Each package shall be labeled to show:

- a) The name and address of the seed supplier.
- b) The name of the seed mix and the various individual seed species that comprise the seed mix and the percentage by mass of each.
- c) The grade of the seed or seed mix.
- d) The supplier's lot designation number corresponding to the certificate of seed analysis.
- e) Mass in kilograms of the seed mix.
- f) The inoculant type, strain, and expiry date.

All seed and inoculant shall be stored in cool, dry locations until use. Inoculant is only required for permanent seed mixes containing crown vetch or Birdsfoot trefoil.

803.05.03.03 Permanent Seed Mixes

Permanent seed mixes shall be according to Table 3.

803.05.03.04 Annual Nurse Cover Crop Seed

Annual nurse crop seed sowing time shall be according to Table 4.

803.05.04 Seed Fertilizer

Fertilizer shall be supplied in original factory sealed bags bearing the manufacturer's original label indicating mass and analysis. All fertilizer shall be in granular form being dry, free flowing, free from lumps, and according to Table 5.

803.06 EQUIPMENT

803.06.01 Drill Seeder

The drill seeder shall be a pasture or rangeland type. It shall accommodate the seed sizes and weight of seed to be applied using as many compartments as required. Seeds of compatible size and weight may be mixed and placed in the same compartment. The seeder shall be capable of planting seeds 6 to 13 mm in depth.

803.06.02 Hydraulic Seeder

The hydraulic seeder shall be capable of mixing the materials into a homogeneous slurry and maintaining the slurry in a homogeneous state until it is applied. The discharge pumps and gun nozzles shall be capable of applying the materials uniformly over the specified area. A hose extension for the hydraulic seeder shall be on site and available for use for areas outside of the range of the gun nozzle. Equipment shall provide constant agitation to prevent seed and slurry from clogging equipment.

The seeding equipment shall be calibrated to provide the coverage shown in Table 5.

803.06.03 Mechanical Seeder

A manually operated mechanical or broadcast seeder may be used for smaller or inaccessible locations as specified in the Contract Documents, or as approved by the Contract Administrator.

803.07 CONSTRUCTION

803.07.01 General

When placement of vegetative cover is required on a waterbody bank, material from the waterbody bank shall not enter the waterbody during preparation or grading of the waterbody bank.

803.07.01.01 Control of Spread of Invasive Species and Noxious Vegetation

Work shall occur in a manner to prevent the spread of invasive species and noxious vegetation to, from and within the Working Area.

Soil from areas impacted by invasive species shall not be stockpiled for reuse.

Debris including earth clods and invasive and noxious vegetation material attached to the outside surfaces of equipment is prohibited from entering the Working Area. Equipment coming on site shall be inspected as close to the site entrance as possible for debris. If present, debris shall be completely removed prior to the equipment proceeding to the Working Area and shall be collected and managed by disposal to a licensed waste disposal site as non-hazardous solid industrial waste prior to the equipment proceeding to the Working Area.

Equipment shall also be inspected for debris prior to leaving the Working Area. Any debris shall be removed and managed as specified above, and in a manner that prevents equipment from coming into further contact with standing, sprayed or cut invasive or noxious vegetation.

803.07.02 Seeding

803.07.02.01 General

Seed shall not enter any waterbodies.

The seeding operation shall not commence until the Contract Administrator has accepted that the surface preparation is according to OPSS 802 and the layout of seed mix locations are as specified in the Contract Documents.

Seeding on final grade shall occur prior to the application of temporary erosion control according to OPSS 804, unless the Contract Administrator approves the simultaneous application of seeding and temporary erosion control.

Seed applications or re-applications shall not be carried out under adverse weather conditions such as high wind or heavy rain or when field conditions are not conducive to seed germination such as frozen soil or soil covered with snow, ice, or standing water.

Where advanced seeding around high-risk areas is specified in the Contract Documents, seed and temporary erosion control shall be applied within 48 hours of final grade.

Seeding shall overlap the adjoining established ground cover by 300 mm.

803.07.02.02 Surface Preparation for Seeding

The surface to be seeded shall be prepared according to OPSS 802 and not more than five Days prior to the seeding operation.

At the time of seeding, all surface areas designated for seeding shall exhibit no evidence of erosion and shall be uniformly cultivated to a minimum depth of 50 mm.

Two weeks prior to seeding a prepared surface with the Native Grass and Forb mixes, a non-selective herbicide shall be applied.

803.07.02.03 Layout for Seeding

Seeding areas shall be staked out as specified in the Contract Documents.

803.07.02.04 Application Rates for Seed, Fertilizer, and Water

Application rates for permanent seed mixes, annual nurse crop seed, and fertilizer shall be as shown in Table 5.

803.07.02.04.01 Hydraulic Seeding

There shall be a uniform dispersal of the mixed material over the entire area designated for seeding. The spray shall not dislodge soil or cause erosion.

803.07.02.04.02 Drill Seeding

Seeds shall be applied uniformly over the specified area at a depth of 6 mm to 8 mm and shall be applied along the contours of the ground.

803.07.02.04.03 Mechanical Seeding

Seeds shall be sown in two directions with 50% of the seed applied with each direction. The application of these two directions shall be perpendicular to each other.

After application of seeds is complete, they shall be covered by raking and/or chain harrowing. If soil is uneven soil may be rolled with roller not exceeding 50 kg where conditions warrant.

Once the seed is covered the area shall be watered to a minimum depth of 50 mm. The application of water shall not cause movement of seeds or erosion.

803.07.02.05 Cleanup

When seed is applied to the foliage of trees, shrubs, or other susceptible plant material, the seed shall be immediately removed from the trees, shrubs, or plant material, and the trees, shrubs, and plant material washed with clean water.

When seed is applied to areas or objects other than those designated, the seed shall be removed from the areas and objects.

803.07.03 Sodding

803.07.03.01 Fertilizer Application for Sodding

Fertilizer shall be applied uniformly to the surface area designated for sodding, a maximum of 48 hours prior to sod placement, at the rate specified on its bag by the manufacturer.

803.07.03.02 Sod Placement

The locations specified for placement of sod shall be prepared and graded prior to placement according to OPSS 206.

Sod shall not be separated from its mineral soil base and not damaged during transportation, handling, and placement.

Sod shall be securely placed lengthwise across the face of slopes and parallel to the centreline of ditches in the locations as specified in the Contract Documents. Voids shall not be left between the soil portion of the sod and the underlying ground surface. Sod shall be countersunk to existing grade level at all edges.

End joints of adjacent sod pieces shall be staggered. The edges of adjacent sod pieces shall be placed tightly against one another without overlapping. Joints shall be tamped to a uniform surface. Sod shall be placed up to the subgrade elevation on the roadway front slope.

Where required, sod shall be staked to the grade to avoid movement.

803.07.03.03 Maintenance of Completed Sodding

Sod shall be maintained for 30 Days following placement. During this period, the placed sod shall be kept actively growing and green in colour. This requirement shall be suspended during the specified winter dormant period.

803.07.04 Local Seed Bank Salvage

Local seed bank shall be salvaged prior to the specified winter dormant period.

Designated salvage areas for local seed bank shall be excavated to a depth of 150 mm to 300 mm or as specified in the Contract Documents.

803.07.04.01 Local Seed Bank Stockpiles

Salvaged local seed bank may be stockpiled for storage in locations specified in the Contract Documents or as approved by the Contract Administrator for up to six months if it cannot be installed on designated receiving sites immediately.

Local seed bank stockpiles shall not be placed in areas with invasive or noxious vegetation and shall not exceed 1500 mm in height. Machinery shall not be allowed on stockpiles. Compaction of stockpiles shall be avoided.

Local seed bank stockpiles shall be kept moist to prevent seeds from drying out during storage.

To prevent soil erosion and contamination by weeds during storage local seed bank stockpiles shall be covered with tarps or apply temporary erosion control according to OPSS 804.

Light duty sediment barrier according to OPSS 805 shall be installed around the entire base of local seed bank stockpiles.

803.07.04.02 Local Seed Bank Installation

Salvaged local seed bank shall be installed on designated receiving sites as specified in the Contract Documents immediately, when practicable.

If any designated receiving area is subsequently re-graded after installation of local seed bank, additional local seed bank shall be salvaged and installed according to this specification.

Should local seed bank no longer be available, vegetative cover and temporary erosion control shall be applied to the area according to this specification and OPSS 804 respectively.

803.07.05 Local Vegetation Blocks

803.07.05.01 Local Vegetation Block Harvest and Installation

The locations specified for placement of local vegetation blocks shall be prepared and graded prior to placement as specified in the Contract Documents and according to OPSS 206.

Local vegetation blocks shall remain intact and undamaged during harvesting and installation.

Local vegetation blocks shall be mechanically harvested from and installed at the locations as specified in the Contract Documents on the same Day, or otherwise within 24 hours, and prior to the winter dormant period. Local vegetation blocks shall be sized as specified in the Contract Documents.

After harvesting, seed and temporary erosion control shall be applied to the source location of the vegetation blocks according to this specification and OPSS 804 respectively.

803.07.06 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

803.07.07 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

803.08 QUALITY ASSURANCE

803.08.01 Seeding

803.08.01.01 Acceptance Criteria for Seeding

An inspection shall take place a minimum of 60 Days after the application of any seed. If application is completed too late in the year to achieve the performance measures after 60 Days, then the inspection will take place a minimum of 60 Days after the end of the specified winter dormant period.

Southwestern and Southern Ontario:

The following criteria shall be met for acceptance during the inspection:

- a) The annual nurse crop shall be evident at mature height in an evenly dispersed, uniform ground cover.
- b) Germination of the specified permanent seed species shall be visually evident in an evenly dispersed uniform ground cover.
- c) A total of 65% of the total area shall be covered with permanent seeded species.
- d) Bare areas shall not exceed 10% of the total seeded area.

Northern Ontario:

The following criteria shall be met for acceptance during the inspection:

- a) The annual nurse crop shall be evident in an evenly dispersed, uniform ground cover.

- b) Germination of the specified permanent seed species shall be visually evident in an evenly dispersed uniform ground cover.
- c) A total of 50% of the total area shall be covered with permanent seeded species.
- d) Bare areas shall not exceed 10% of the total seeded area.

Inspections shall not be made when site conditions prohibit a visual field inspection.

803.08.01.02 Failure to Meet Acceptance

If the completed work does not meet the acceptance criteria, written notification of the failed areas will be provided by the Contract Administrator. The specified permanent seed mixes and annual nurse crop seed shall be re-applied according to this specification within 14 Days of receipt of the notification, or within 14 Days of the end of the specified winter dormant period.

Upon reapplication of the specified permanent seed mixes and annual nurse crop seed the areas that did not previously meet acceptance will be inspected until the requirements in the Acceptance Criteria for Seeding clause have been achieved.

Locations that are specified in the Contract Documents to receive vegetative cover, that fail to meet the acceptance criteria specified in the Quality Assurance section by the winter dormant period, or where vegetative cover has not been applied prior to the winter dormant period, shall be protected from erosion according to OPSS 804 until vegetative cover can be applied or reapplied.

803.08.02 Sodding

803.08.02.01 Acceptance of Sod

After the 30 Days maintenance period has ended, the Contract Administrator shall inspect all placed sod based on the requirements specified in the Maintenance of Completed Sodding clause. If placement of sod is completed less than 30 Days prior to the start of the winter dormant period, then the inspection will take place 30 Days after the end of the winter dormant period.

The sod shall be in the same location as originally placed and shall not have moved, eroded, slipped, or sloughed. Sod shall show evidence of rooting into the underlying soil. The sod shall be of sufficient density that no surface soil is visible and there shall be no competitive growth, emerging from the sod or from between the sod joints.

803.08.02.02 Failure to Meet Acceptance

When the work does not meet the requirements specified herein, written notification will be provided by the Contract Administrator, and sod shall be reapplied according to this specification within 14 Days of receipt of the notification.

The site shall be maintained, and temporary erosion control will be provided OPSS 804 until the sod has been replaced.

Upon replacement of sod in the locations that did not previously meet acceptance will be inspected until the requirements in the Acceptance of Sod clause have been achieved.

803.09 MEASUREMENT FOR PAYMENT

803.09.01 Actual Measurement

803.09.01.01 Seed

Measurement shall be by area in square metres following the contours of the ground.

803.09.01.02 Sod

Measurement shall be by area in square metres following the contours of the ground.

803.09.01.03 Local Seed Bank

Measurement shall be by area in square metres following the contours of the ground.

803.09.01.04 Local Vegetation Blocks

Measurement shall be by area in square metres following the contours of the ground.

803.09.02 Plan Quantity Payment

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

803.10 BASIS OF PAYMENT

**803.10.01 Seed - Item
Sod - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments shall be based on the following percentages of the Contract price for milestones accepted by the Contract Administrator:

- a) 50% for installation
- b) 50% upon acceptance.

**803.10.02 Local Seed Bank - Item
Local Vegetation Blocks - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Winter Dormant Period - Seed and Local Seed Bank Salvage

SOUTHWESTERN ONTARIO	SOUTHERN ONTARIO	NORTHERN ONTARIO
November 15 to April 15 inclusive	November 1 to April 30 inclusive	October 1 to June 1 inclusive

TABLE 2
Winter Dormant Period - Sod and Local Vegetation Blocks

SOUTHWESTERN ONTARIO	SOUTHERN ONTARIO	NORTHERN ONTARIO
November 15 to April 15 inclusive	November 1 to April 30 inclusive	Oct 15 to May 15 inclusive

TABLE 3
Permanent Seed Mixes and Seed Certificate Analysis Values

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Standard Roadside Mix	Canada #1 Lawn Grass Seed Mixture	70	85	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					52	45 to 60
Kentucky Bluegrass: <i>Poa pratensis</i>					10	5 to 15
Perennial Ryegrass: <i>Lolium perenne</i>					35	30 to 40
White Clover: <i>Trifolium repens</i>					3	2 to 7
Modified Native Standard Roadside Mix	Canada #1 Lawn Grass Seed Mixture	70	85	0.5		
Creeping Red Fescue: <i>Festuca Rubra</i>					60	45 to 60
Canada Bluegrass: <i>Poa compressa</i>					10	5 to 15
Colonial Bentgrass: <i>Agrostis capillaris</i>					10	5 to 15
Intermediate Ryegrass: <i>Lolium hybridum</i>					20	15 to 25
Crown Vetch Mix	Common #1 Ground Cover	70	N/A	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					66	62 to 70
Crown Vetch: <i>Coronilla varia</i> inoculated seed					34	30 to 38
Birdsfoot Trefoil Mix	Common #1 Forage Mixture	75	N/A	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					66	62 to 70
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					34	30 to 38
<i>Continues on Next Page</i>						

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Salt Tolerant Mix	Canada #1 Ground Cover	70	85	0.5		
Tall Fescue: <i>Festuca arundinacea</i>					25	20 to 30
Fults Alkali Grass: <i>Puccinellia distans</i>					20	15 to 25
Creeping Red Fescue: <i>Festuca rubra</i>					25	15 to 30
Perennial Ryegrass: <i>Lolium perenne</i>					20	15 to 25
Hard Fescue: <i>Festuca trachyphylla</i>					10	5 to 15
Lowland Mix	Canada #1 Ground Cover	70	N/A	0.5		
Creeping Red Fescue: <i>Festuca rubra</i>					35	30 to 40
Brome Grass: <i>Bromus nerres</i>					25	20 to 30
Kentucky Bluegrass: <i>Poa pratensis</i>					10	5 to 15
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					5	3 to 7
White Clover: <i>Trifolium repens</i>					5	3 to 7
Perennial Ryegrass: <i>Lolium perenne</i>					20	15 to 25
Continues on Next Page						

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Acidic Soil Mix	Canada #1 Ground Cover	70	N/A	0.5		
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					30	25 to 40
Red Top: <i>Agrostis gigantea</i>					10	5 to 15
Tall Fescue: <i>Festuca arundinacea</i>					15	10 to 20
Creeping Red Fescue: <i>Festuca rubra</i>					30	25 to 35
Hard Fescue: <i>Festuca trachyphylla</i>					5	3 to 7
Alsike Clover: <i>Trifolium hybridum</i>					5	3 to 7
Red Clover: <i>Trifolium pratense</i>					5	3 to 7
Northern Ontario Mix	Canada #1 Ground Cover	70	N/A	0.5		
Red Top: <i>Agrostis gigantean</i>					3	1 to 5
Canada Bluegrass: <i>Poa compressa</i>					7	5 to 15
Creeping Red Fescue: <i>Festuca rubra</i>					40	35 to 45
Birdsfoot Trefoil: <i>Lotus corniculatus</i> inoculated seed					5	2 to 8
Alsike Clover: <i>Trifolium hybridum</i>					3	1 to 5
White Clover: <i>Trifolium repens</i>					2	1 to 5
Perennial Rye Grass: <i>Lolium perenne</i>					30	25 to 35
Meadow Fescue: <i>Festuca pratensis</i>					10	5 to 15
Continues on Next Page						

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Old Field Mix	Canada # 1 Ground Cover	70	N/A	0.5		
Flat-topped Aster: <i>Aster umbellatus</i>					37	35 to 40
New England Aster: <i>Aster novaeangliae</i>					17	10 to 20
Purple-stemmed Aster: <i>Aster punicens</i>					16	10 to 20
Canada Goldenrod: <i>Solidago Canadensis</i>					12	10 to 15
Panicked Aster: <i>Aster simplex/lanceolatus</i>					8	6 to 10
Heath Aster: <i>Aster simplex/lanceolatus</i>					5	3 to 7
Grass-leaved Goldenrod: <i>Solidago memorialis</i>					5	3 to 7
Northern Ontario Mix	Canada # 1 Ground Cover	70	N/A	0.5		
Red Top: <i>Agrostis gigantean</i>					3	1 to 5
Canada Bluegrass: <i>Poa compressa</i>					7	5 to 15
Creeping Red Fescue: <i>Festuca rubra</i>					40	35 to 45
Birdsfoot Trefoil: <i>Lotus corniculatus</i> 'Leo' inoculated seed					5	2 to 8
Alsike Clover: <i>Trifolium hybridum</i>					3	1 to 5
White Clover: <i>Trifolium repens</i>					2	1 to 5
Perennial Rye Grass: <i>Lolium perenne</i>					30	25 to 35
Meadow Fescue: <i>Festuca pratensis</i>					10	5 to 15
Continues on Next Page						

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Southern Ontario Native Grass and Forb Mix – Well Drained	Canada # 1 Ground Cover	70	N/A	0.5		
Grass species - shall be 85% of seed mix						
Big Blue Stem: <i>Andropogon gerardii</i>					22	20 to 25
Canada Wild Rye: <i>Elymus canadensis</i>					11	10 to 15
Switchgrass: <i>Panicum virgatum</i>					16	15 to 20
Little Bluestem: <i>Schizachyrium scoparium</i>					16	15 to 20
Indian Grass: <i>Sorghastrum nutans</i>					20	15 to 25
Forb species - shall be 15% of seed mix and contain a minimum of 8 of the following species						
Common Milkweed: <i>Asclepias syriaca</i>					1	1 to 3
Sweet Ox-eye: <i>Heliopsis helianthoides</i>					2	1 to 3
Hairy Beardtongue: <i>Penstemon hirsutus</i>					1	1 to 3
Black eyed Susan: <i>Rudbeckia hirta</i>					2	1 to 3
Hoary Vervain: <i>Verbena stricta</i>					1	1 to 3
Wild Bergamot: <i>Monarda fistulosa</i> var. <i>fistulosa</i>					1	1 to 3
Path Rush: <i>Juncus tenuis</i>					1	1 to 3
Evening Primrose: <i>Oenothera biennis</i>					2	1 to 3
Smooth Aster: <i>Symphyotrichum laeve</i>					1	1 to 3
Round-headed Bush-clover: <i>Lespedeza capitata</i>					1	1 to 3
Foxglove Beardtongue: <i>Penstemon digitalis</i>					1	1 to 3
Showy Tick-trefoil: <i>Desmodium canadense</i>					1	1 to 3
Continues on Next Page						

Permanent Seed Mix	Grade Name	Minimum Seed Germination %	Minimum Seed Purity %	Maximum Weed Seed %	Seed Mix %	Seed Species Composition %
Southern Ontario Native Grass and Forb Mix - Poorly Drained	Canada # 1 Ground Cover	70	N/A	0.5		
Grass species - shall be 85% of seed mix						
Big Blue Stem: <i>Andropogon gerardii</i>					22	20 to 25
Virginia Wild Rye: <i>Elymus virginicus</i>					11	10 to 15
Switchgrass: <i>Panicum virgatum</i>					16	15 to 20
Fox Sedge: <i>Carex vulpinoidea</i>					16	15 to 20
Indian Grass: <i>Sorghastrum nutans</i>					20	15 to 25
Forb species - shall be 15% of seed mix and contain a minimum of 8 of the following species						
Swamp Milkweed: <i>Asclepias incarnata</i>					1	1 to 3
Sweet Ox-eye: <i>Heliopsis helianthoides</i>					1	1 to 3
Virginia Mountain Mint: <i>Pycnanthemum virginianum</i>					1	1 to 3
Black eyed Susan: <i>Rudbeckia hirta</i>					2	1 to 3
Blue Vervain: <i>Verbena hastata</i>					1	1 to 3
Wild Bergamot: <i>Monarda fistulosa</i> var. <i>fistulosa</i>					1	1 to 3
Path Rush: <i>Juncus tenuis</i>					1	1 to 3
Evening Primrose: <i>Oenothera biennis</i>					2	1 to 3
New England Aster: <i>Symphyotrichum novae-angliae</i>					1	1 to 3
Foxglove Beardtongue: <i>Penstemon digitalis</i>						
Missouri Ironweed: <i>Vernonia missurica</i>					1	1 to 3
Spotted Joe Pye Weed: <i>Eupatorium maculatum</i> var. <i>maculatum</i>					2	1 to 3

TABLE 4
Annual Nurse Crop Seed Sowing Times

Nurse Crop	Sowing Time Southwest and Southern Ontario	Sowing Time Northern Ontario
Annual Oats (<i>Avena sativa</i>)	April - May or late August - October	Late May - June or late August - early October
Canada Wild Rye (<i>Elymus canadensis</i>)	Late August - October	Late August - early October
Virginia Wild Rye (<i>Elymus virginicus</i>)	Late August - October	Late August - early October
White Millet (<i>Panicum milliaceum</i>)	June - mid September	June - mid September
Fall Rye Grain (<i>Secale cereale</i>)	March - April or August - October	April - August to early October

TABLE 5
Application Rates for Seed and Fertilizer

Permanent Seed Mixes	Permanent Seed Mix Rate kg/10,000 m²	Fertilizer Rate minimum 200 kg/ha			Nurse Crop Rate kg/10,000 m²
		8-32-16	0-46-0	0-0-60	
Standard Roadside Mix	170	365			60
Crown Vetch Mix	140	365	260		60
Modified Native Standard Roadside Mix	170	365			60
Birdsfoot Trefoil Mix	140	365	260		60
Salt Tolerant Mix	170	350			60
Lowland Mix	170	350			60
Acidic Soil Mix	170	350	220	220	60
Northern Ontario Mix	170	365			60
Oldfield Mix	70	350			60
Southern Ontario Native Grass and Forb Mix - poorly drained areas	25 - 30				25 - 30
Southern Ontario Native Grass and Forb Mix - well drained areas	25 - 30				25 - 30



CONSTRUCTION SPECIFICATION FOR TEMPORARY EROSION CONTROL

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804.01	SCOPE

This specification covers the requirements for temporary erosion control measures to protect disturbed earth surfaces during construction, minimize sedimentation and support the establishment of vegetation.

804.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 511	Rip-Rap, Rock Protection, and Granular Sheeting
OPSS 803	Vegetative Cover
OPSS 805	Temporary Sediment Control

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous

OPSS 1801 Corrugated Steel Pipe Products
OPSS 1840 Non-Pressure Polyethylene Plastic Pipe Products

804.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Diversion Ditch means a temporary runoff control channel to intercept and convey overland flow away from areas of disturbed or erodible soil and to minimize erosion of slopes from sheet flow.

Earth means as defined in OPSS 206.

Erosion means the physical removal or detachment of sediment from an earth surface, followed by the transport of detached sediment to another location by the action of a mobile agent including rain, flowing water, wind, equipment and vehicles.

Fibre Roll means an assembled or commercially available flexible, tubular structure that provides erosion and/or sediment control and may provide run-off filtration and includes wattles, filter socks and filter berms.

Permanent Cover means the final cover treatment as specified in the Contract Documents to provide permanent erosion control on earth surfaces and may include, but not be limited to: rock protection, rip-rap, granular sheeting, established vegetative cover meeting the requirements of the Quality Assurance section of OPSS 803, gabions and retained soil systems.

Significant Rainfall means a rainfall event exceeding 15 mm within a 24-hour period.

Sediment means soil particles detached from an earth surface by erosion.

Slope Drain means a temporary surface water runoff control measure that directs water into a pipe or lined channel to prevent water flowing over disturbed earth surfaces on slopes and causing erosion.

Slope Texturing means contouring and roughening disturbed earth surfaces to increase water infiltration and retention, reduce runoff velocity, reduce sediment transport, and reduce soil erosion.

Temporary Seeding means the application of seed to stockpiles of erodible construction materials, excess or surplus materials, or disturbed earth surfaces to provide temporary erosion control until the materials are needed for construction, removed from the site, or until permanent cover is applied.

804.05 MATERIALS

804.05.01 Mulch and Matrix

804.05.01.01 Mulch

Mulch shall be either a mixture of straw mulch and organic straw mulch tackifier or hydraulic mulch.

804.05.01.02 Straw Mulch

Straw shall be supplied in bales, dry, and free of weeds and other foreign materials.

Organic straw mulch tackifiers may include wood and fibre paper mulch or guar and starch based tackifiers. Asphalt based tackifiers shall not be used.

804.05.01.03 Hydraulic Mulch

Hydraulic mulch shall consist of shredded wood or paper fibres or both, and water or a stabilizing emulsion or both.

Stabilizing emulsions shall consist of an organic tackifier or an inorganic polymer.

Hydraulic mulch shall be capable of dispersing rapidly in water to form a homogeneous slurry.

Hydraulic mulch shall be dry, free of weeds and other foreign materials, and shall be supplied in factory sealed packages bearing the manufacturer's label indicating the product name, its mass and content.

804.05.01.04 Hydraulic Matrix

Matrix shall be bonded fibre matrix (BFM) or fibre reinforced matrix (FRM).

804.05.01.04.01 Bonded Fibre Matrix (BFM) and Fibre Reinforced Matrix (FRM)

The BFM and FRM shall be capable of being hydraulically applied and after application be capable of adhering to the soil. In a dry state, BFM and FRM shall be comprised of greater than or equal to 70% by weight of long stranded wood fibres held together by organic or mineral bonding agents or both. The bonding agent shall not dissolve or disperse upon re-wetting.

The curing period for BFM shall be less than 24 hours. The FRM shall not have a curing period.

804.05.02 Erosion Control Blanket (ECB)

The ECB shall be of a consistent thickness with a 100% biodegradable, even fibre distribution. The ECB shall be covered on top with a non-plastic biodegradable mesh or sewn together with biodegradable thread.

The ECB shall be supplied in a dry rolled mat protected with an outer waterproof wrap bearing the manufacturer's original label indicating product name and application instructions.

804.05.02.01 Erosion Control Blanket (ECB) Staples

The ECB staples shall be according to manufacturer's specifications. The ECB staples shall have the strength and length to satisfy control measure installation, performance and maintenance requirements.

804.05.03 Fibre Rolls

Fibre rolls shall be of a consistent internal thickness with even fibre distribution throughout the roll.

Fibre rolls shall be covered on the outside with an open-weave, biodegradable mesh or netting that securely contains the fibres within the rolls.

Fibre rolls shall be filled with 100% organic, biodegradable material such as shredded straw, wood fibres or compost and may contain seed according to OPSS 803.

804.05.04 Rock

Rock for rock flow check dams shall be according to the requirements for rip-rap and gabion stone according to OPSS 1004.

804.05.05 Pipe for Slope Drains

Slope drains shall be constructed with non-perforated, corrugated steel pipe according to OPSS 1801 or polyethylene plastic pipe according to OPSS 1840. Pipe diameter shall be as specified in the Contract Documents.

804.05.05.01 End Sections for Slope Drains

End sections for the inlet and outlet of slope drains shall be according to OPSS 1801.

804.05.06 Plastic Sheeting

Plastic sheeting shall be a minimum thickness of 6 mm of polyethylene.

804.06 EQUIPMENT

804.06.01 Hydraulic Mulcher

The hydraulic mulcher shall be capable of mixing the materials into homogeneous slurry and of maintaining the slurry in a homogeneous state until it is applied.

The discharge pumps and gun nozzles shall be capable of applying the materials uniformly over the specified area. A hose extension for the hydraulic mulcher shall be on site and available for use for areas outside of the range of the gun nozzle.

804.06.02 Straw Mulch Blower

Where straw mulch is applied mechanically by blower, the straw mulch blower shall be capable of separating straw from the bales without chopping it into short lengths and applying the straw mulch in a uniform, cohesive mat.

When tackifiers are used, the straw mulch blower shall be capable of applying straw mulch and tackifiers simultaneously.

The straw mulch blower shall be equipped with a minimum of two nozzles located inside the end of the blower pipe to coat the straw with the tackifier. Crimping may also be used to secure the straw mulch.

804.07 CONSTRUCTION

804.07.01 General

Riparian vegetation areas to be preserved as specified in the Contract Documents shall be clearly marked in the field.

Temporary erosion control shall be applied and inspected within 24 hours prior to forecasted significant rainfall events.

Temporary erosion control materials and products shall not come in contact with the foliage of any trees, shrubs, or other vegetation, except as specified in OPSS 803 and shall not come in contact with waterbodies.

All stockpiles of erodible construction materials and excess or surplus materials within 30 m of a waterbody shall be protected from erosion within 48 hours of being built until they are required for construction or removed from the site.

Hydraulic mulch shall not inhibit growth or germination of the seed mix when applied to protect disturbed earth surfaces during the establishment of vegetative cover.

804.07.02 Temporary Cover

The measures, materials, products, and/or methods of temporary cover shall be selected and applied to be most suitable for the site conditions, operations and duration of the construction project. Temporary cover shall be applied to protect disturbed earth surfaces during construction to prevent erosion from occurring until permanent cover can be established.

Temporary cover measures, materials, products, and/or methods applied to, include but are not limited to:

- a) Materials or products including straw mulch, hydraulic mulch, fibre matrix, hydraulic matrix, wood chips, compost, plastic sheeting, temporary seeding, temporary sodding, rolled erosion control products, flow check dams and grade breaks.
- b) Methods such as but not limited to diversion of water from disturbed earth surfaces, slope texturing, staging of original vegetation or other permanent cover removal (e.g. deferring clearing and/or grubbing) and/or replacement (e.g. advancing permanent cover placement) and retaining vegetative buffers around waterbodies.

The Contract Administrator shall be notified in writing of the selected temporary cover measures, materials, products, and/or methods prior to either the removal of original permanent cover, or to a change in the selected method of temporary cover.

Temporary cover measures, materials, products, and/or methods selected shall be according to this specification and the instructions of the material or product manufacturer or supplier as applicable.

804.07.02.01 Application

The locations and application limits for temporary cover shall be clearly staked out as specified in the Contract Documents. Temporary cover shall be applied at these locations and any additional locations shall be at the discretion of the Contract Administrator.

Temporary cover is not required in areas where the permanent cover is applied immediately after existing cover removal provided there is no presence of erosion or sedimentation as confirmed by the Contract Administrator.

804.07.02.02 Timing

Temporary cover shall be applied prior to any forecasted precipitation and less than 48 hours after the removal of any portion of the existing vegetative cover or other earth cover.

Where the retention of existing vegetative cover, or other permanent cover, is the chosen temporary cover option, this existing cover will be retained until immediately prior to construction. This operation will be timed so that there will be less than 48 hours between the removal of existing cover and the placement of permanent cover.

Where grubbing is specified temporary cover shall be applied prior to any forecasted precipitation and less than 48 hours after any grubbing.

Temporary cover shall remain in place until the placement of the permanent cover, except for when work on disturbed earth surfaces is required or as specified in the Contract Documents.

804.07.03 Straw Mulch

Straw mulch shall be either applied manually by hand or mechanically by blower and secured using a tackifier or by crimping.

Straw mulch shall be applied to form a uniform, cohesive mat over 100% of the specified disturbed earth surface. The straw mulch shall be applied to a depth of greater than 25 mm and less than 50 mm as measured at the time of application.

804.07.04 Hydraulic Mulch

The hydraulic mulcher shall be calibrated to provide the coverage as specified for each of the hydraulically applied mulches.

Hydraulic mulch shall be applied at the rate of 2,000 kg of dry product per 10,000 m². Hydraulic mulch shall be thoroughly mixed with water into a homogeneous slurry.

The hydraulic mulch slurry shall be applied to the specified disturbed earth surface by nozzle sprayer or extension hose. The mixed material shall be evenly dispersed over the entire disturbed earth surface to form a uniform, cohesive mat. The spray shall not dislodge soil or cause erosion.

804.07.05 Bonded Fibre Matrix (BFM) or Fibre Reinforced Matrix (FRM)

Hydrated BFM and FRM shall be applied to the specified disturbed earth surfaces to form a viscous material that dries to a high strength, porous, and erosion-resistant uniform, cohesive mat.

The BFM and FRM shall not be applied when rainfall is expected within 24 hours, during rainfall, or within 12 hours after rainfall.

804.07.06 Erosion Control Blanket (ECB)

The ECB shall be placed into position over the entire specified disturbed earth surface. The ECB shall be overlapped a minimum of 300 mm along parallel runs and on adjoining end runs.

The ECB shall be installed in direct contact with the ground surface to form a uniform, cohesive mat over the specified disturbed earth surface. The ECB shall be stapled to ensure direct contact with the soil over the entire area.

Overlapping and direct contact with the ground surface shall be maintained.

On slopes, the uppermost edge of the ECB shall be extended 1 m beyond the crest of the slope and anchored in a 150 mm wide by 150 mm deep trench excavation. The trench shall be backfilled with the excavated native material and compacted. When extension beyond the crest of the slope is not possible, the ECB shall be anchored at the top of the slope preventing any movement.

804.07.07 Fibre Roll Grade Breaks

Fibre roll grade breaks shall be constructed as specified in the Contract Documents.

Fibre rolls shall be installed horizontally starting from the toe of the slope and working up to the top of the slope. Any rills and gullies on the slope face shall be filled in as the fibre rolls are installed.

Fibre rolls shall be installed along the contour of the ground into trenches that have been excavated into the soil perpendicular to the slope face and width across the slope.

Fibre rolls shall be installed so that their base is in continuous contact with the underlying soil along their entire length without gaps and angled upslope at each end run in a "J" pattern. The ends of adjacent fibre roll segments shall be tightly butted up against each other and shall not be overlapped vertically or horizontally.

A metal bar shall be used to make pilot holes perpendicular to the slope face through the centre of the fibre rolls as specified in the Contract Documents. Pilot holes shall also be made at the ends of each fibre roll segment angled towards the next abutting fibre roll to hold adjacent rolls together.

Wooden stakes shall be driven into the pilot holes perpendicular to the slope face to secure the fibre rolls to the slope along their entire length. Additional stakes shall be driven into the fibre rolls along the downslope side at every grade change or if soils are very loose and uncompacted or the slope is steep.

Soil excavated from the trenches shall be placed along the upslope side of the fibre rolls and well compacted into the front of the trench to minimize possible undermining by runoff.

The soil on the upslope and downslope sides of the fibre rolls shall be seeded according to OPSS 803.

804.07.08 Flow Check Dams - General

Flow check dams are fibre roll flow check dams, sandbag flow check dams, or rock flow check dams.

When the flow check dam item is specified, any of the flow check dams or any combination of them may be used.

Flow check dams shall be constructed such that the spillway level of the downstream flow check dam is the same as the base of the upstream flow check dam when they are specified in series.

Flow check dams shall be constructed without gaps and without undermining to prevent sediment passage through, under, or around the flow check dam.

Flow check dams shall include protection placed against the downstream side at the lowest point of the flow check dam so that any overflow of the flow check dam is prevented from causing soil scour and erosion.

804.07.08.01 Fibre Roll Flow Check Dams

Fibre roll flow check dams shall be constructed as specified in the Contract Documents.

804.07.08.02 Sandbag Flow Check Dams

Sandbag flow check dams shall be constructed as specified in the Contract Documents.

804.07.08.03 Rock Flow Check Dams

Rock flow check dams shall be constructed as specified in the Contract Documents.

804.07.09 Slope Drains

Slope drains shall be constructed as specified in the Contract Documents.

When slope drains are specified in the Contract Documents, the slope drain and associated berm barrier shall be constructed on the same Day.

Slope drains shall be constructed as a single control measure consisting of a corrugated pipe, two end sections including an inlet and an outlet, and a sediment trap constructed at the outlet end of the pipe.

The pipe inlet shall be placed through a berm barrier. Placement shall allow water to enter the pipe inlet without scouring of the berm. The toe plate of the inlet end section shall be fully imbedded into the ground surface.

Pipes shall be maintained in place without gaps and without undermining so that water is conveyed from the upstream side of the berm and collected in the sediment trap.

804.07.10 Diversion Ditches

Diversion ditches shall be constructed as specified in the Contract Documents.

When diversion ditches are specified to be lined with rolled erosion control blanket it shall be installed along their entire length.

When flow check dams are specified to be installed within diversion ditches, they shall be installed at regular intervals along the entire length of the diversion ditches according to this specification.

Where diversion ditches are specified to be lined with rip-rap or granular sheeting it shall be according to OPSS 511.

804.07.11 Monitoring and Documentation

All temporary erosion control shall be monitored to ensure it is effective. Monitoring shall be completed for the following conditions:

- a) A minimum of every seven Days.
- b) The 24 hours prior to a forecasted significant rainfall event.
- c) Within 24 hours after significant rainfall events.

Monitoring shall include the following:

- a) Visual inspection of the condition and effectiveness of all installed temporary erosion control; and
- b) visual inspection of slopes for signs of erosion including rills, gullies, channels and dust.

Observations shall be documented and any concerns such as observed erosion, issues with construction staging, or with stockpiles of erodible construction materials and excess or surplus materials, shall be reported immediately to the Contract Administrator. Monitoring documentation shall be provided to the Contract Administrator upon request within 24 hours.

804.07.12 Maintenance

Temporary erosion control shall be maintained and repaired or replaced as required, to function effectively until placement of the specified permanent cover.

When temporary cover is found by quality assurance check to be ineffective at any location, a different material, product or method more suitable for the site conditions shall be selected, applied and maintained within 48 hours.

804.07.13 Removal

Temporary erosion control shall be removed prior to the placement of permanent cover as specified in the Contract Documents. Temporary erosion control that will not interfere with the placement, establishment or performance of specified permanent cover, may be left in place as permitted by the Contract Administrator.

Any temporary sediment control that is located within and around the area protected by temporary erosion control shall be left in place and removed according to OPSS 805.

804.07.14 Cleanup

When temporary erosion control materials or products are applied to the foliage of trees, shrubs, or other susceptible plant material, the material or product shall be immediately removed, and trees, shrubs, and plant material shall be washed with clean water.

804.07.15 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

804.07.16 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

804.08 QUALITY ASSURANCE

804.08.01 Acceptance of Temporary Erosion Control

Temporary erosion control shall be acceptable if they meet the requirements of this specification and as specified in the Contract Documents.

The Owner may conduct random quality assurance checks on temporary erosion control measures, materials, and/or products that have been selected, installed or removed to verify they are in accordance with the requirements of this specification and as specified in the Contract Documents.

Temporary erosion control that is identified by the Owner as deficient shall be removed and replaced or reapplied to meet the requirements of this specification and as specified in the Contract Documents. Removal and replacement or reapplication shall be carried out at no additional cost to the Owner within 48 hours of the Owner providing notice to the Contractor, unless otherwise agreed to in writing.

804.09 MEASUREMENT FOR PAYMENT

804.09.01 Actual Measurement

804.09.01.01 Temporary Cover

Measurement shall be by area in square metres following the contours of the ground without any allowance for overlap.

804.09.01.02 Mulch

Measurement shall be by area in square metres following the contours of the ground without any allowance for overlap.

804.09.01.03 Matrix

Measurement shall be by area in square metres following the contours of the ground without any allowance for overlap.

804.09.01.04 Erosion Control Blanket

Measurement shall be by area in square metres following the contours of the ground.

804.09.01.05 Fibre Roll Grade Breaks

Measurement shall be the length of fibre rolls in linear metres from end to end following the contours of the ground.

**804.09.01.06 Flow Check Dams
Fibre Roll Flow Check Dams
Sandbag Flow Check Dams
Rock Flow Check Dams**

For measurement purposes, a count shall be made of the flow check dams constructed.

804.09.01.07 Slope Drains and Diversion Ditches

For measurement purposes, a count shall be made of the number of slope drains and diversion ditches constructed or installed. Component parts shall not be counted separately for payment.

804.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

804.10 BASIS OF PAYMENT

**804.10.01 Temporary Cover - Item
Mulch - Item
Matrix - Item
Erosion Control Blanket - Item
Fibre Roll Grade Breaks - Item
Flow Check Dams - Item
Fibre Roll Flow Check Dams - Item
Sandbag Flow Check Dams - Item
Rock Flow Check Dams - Item
Slope Drains - Item
Diversion Ditches - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Progress payments for temporary erosion control shall be made as follows:

- a) 30% for initial construction.
- b) 50% for monitoring and maintenance.
- c) 20% for removal.

When removal of measures is not required, progress payments for temporary erosion control shall be made as follows:

- a) 50% for initial construction.
- b) 50% for monitoring and maintenance.

Payment for temporary erosion control at additional locations if required and approved by the Contract Administrator shall be administered as a Change in the Work.



CONSTRUCTION SPECIFICATION FOR TEMPORARY SEDIMENT CONTROL

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805.01 SCOPE

This specification describes the requirements for the installation, maintenance, and removal of temporary sediment control during construction.

805.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 517	Dewatering
OPSS 803	Vegetative Cover
OPSS 804	Temporary Erosion Control

Ontario Provincial Standard Specifications, Material

OPSS 1860	Geotextiles

805.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Earth means as defined in OPSS 206.

Erosion means as defined in OPSS 804.

Fibre Roll means as defined in OPSS 804.

Significant Rainfall means as defined in OPSS 804.

Sediment means as defined in OPSS 804.

Sediment Barrier means a barrier used to trap sediment in overland flow.

Turbidity Barrier means turbidity curtains or turbidity dams used to isolate the Working Area to prevent the release of sediment and debris from the Working Area into the surrounding waterbody.

Turbidity Curtain means a flexible barrier used to trap sediment in waterbodies.

Turbidity Dam means a non-flexible barrier used to trap sediment in waterbodies.

Temporary Sediment Control means control of sediment produced by erosion some distance away from the sediment source using sediment barriers, bags and traps and turbidity barriers.

805.05 MATERIALS

805.05.02 Geosynthetics

805.05.02.01 Geotextile

Geotextile shall be free of holes, tears, and punctures.

805.05.02.02 Sediment Fence Geotextile

Geotextile for sediment fence shall be according to OPSS 1860, Table 3.

Geotextile for sediment fence may be separate from the stakes used to install it as a sediment barrier.

805.05.02.03 Berm Barrier Geotextile

Geotextile for berm barriers and rock flow check dams shall be a woven, Class II geotextile according to OPSS 1860. The filtration opening size (FOS) shall be no greater than 300 µm.

805.05.02.04 Turbidity Curtain Geosynthetic

Turbidity curtain geosynthetics shall have a grab tensile strength of at least 990 N, according to OPSS 1860 and be one of geotextile or geomembrane.

Geotextile shall be a woven material. The FOS shall be no greater than 300 µm, according to OPSS 1860.

Geomembrane shall be a low-permeability synthetic material or a geotextile impregnated with elastomeric spray.

805.05.02.05 Filter Bags

Geotextile for filter bags shall be non-woven, polypropylene, Class I according to Table 1 of OPSS 1860 or as specified in the Contract Documents.

805.05.03 Plastic Sheeting

Plastic sheeting shall be according to OPSS 804.

805.05.04 Stakes

Stakes shall be of sufficient strength and length to satisfy temporary sediment control installation, performance and maintenance requirements.

805.05.05 Wire Fence

Wire fence used in wire-backed sediment fence barrier shall be 1.63 mm diameter galvanized steel fence with a 5 cm by 10 cm weave and a 0.91 m height.

805.05.05.01 Posts

Posts to support wire-backed sediment fence barriers shall be metal T-posts. Metal ties shall be used to secure the sediment fence to the metal T-posts.

805.05.06 Berm Barriers

Berm barriers shall be constructed using non-erodible earth or organic materials such as, sand, gravel, brush or compost.

805.05.07 Sandbags

Sandbags shall be made from heavy gauge plastic, agricultural burlap, or sediment fence geotextile. Heavy gauge plastic shall contain stabilizers or inhibitors resistant to deterioration by ultraviolet radiation. Sandbags shall be filled with clean sand, 19 mm gravel or 6 mm pea gravel, containing no silt or clay.

805.05.08 Fibre Rolls

Fibre rolls shall be according to OPSS 804.

805.05.09 Turbidity Curtain

Turbidity curtain shall be weighted at the bottom to ensure that sediment does not travel under the curtain. Turbidity curtain shall be supported at the top through a flotation system.

805.05.09 Turbidity Dam

Turbidity dams shall be constructed with materials specified in the Contract Documents.

805.07 CONSTRUCTION**805.07.01 General****805.07.01.02 Protection of Stockpiled Materials**

All stockpiles of erodible construction materials, and excess or surplus materials, shall be protected from sediment transport within 48 hours of being built unless as specified in the Contract Documents.

805.07.01.03 Dewatering

Dewatering shall be according to OPSS 517.

805.07.01.04 Turbidity Curtains and Turbidity Dams

Equipment shall not be operated in a waterbody outside a turbidity curtain or turbidity dam other than hand held equipment or boats, unless specified in the Contract Documents.

805.07.01.05 Construction and Removal of Measures

The timing of construction and removal of temporary sediment control shall be as specified in the Contract Documents.

805.07.02 Light-Duty Sediment Barriers, General

Light-duty sediment barriers are sediment fence barriers, or fibre roll barriers.

Light-duty sediment barriers shall be constructed as specified in the Contract Documents.

Light-duty sediment barriers shall not be installed in or across waterbodies.

When the Light-Duty Sediment Barrier item is specified in the Contract Documents, any light-duty sediment barriers may be used. When a specific light-duty sediment barrier is specified in the Contract Documents, no substitution shall be permitted.

Light-duty sediment barriers shall be installed such that soil scour and erosion is prevented at the low points of the barrier on the downslope side.

805.07.02.02 Sediment Fence Barriers

Sediment fence barriers shall not have plastic or wire mesh backing.

Sediment fence barriers shall be constructed as specified in the Contract Documents and according to the following:

- a) Within a trench excavated along the contour of the ground such that the elevation of the above ground portion of the fence is the same along its entire length except at the ends.
- b) Without breaks or gaps along their entire length.
- c) On flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, additional sediment fence barriers shall be installed as specified in the Contract Documents.
- d) With the geotextile attached firmly, without sagging, to the upslope side of the stakes and the stakes spaced to ensure the geotextile remains vertical.
- e) With the geotextile joined to provide a continuous run, with the ends overlapped a minimum of 500 mm and securely fastened to the stakes using cable ties or soft wire at the top of the geotextile only.

- f) With the geotextile angled upslope at the ends of each run in a “J” pattern and so that the ends are at a higher elevation than the bottom of the run.

When geotextile is supplied without stakes attached, the geotextile shall be installed into the trench in the ground first, the stakes shall be driven into the ground behind the geotextile, and the geotextile shall be attached to the upslope side of the stakes using cable ties or soft wire at the top of the geotextile only.

805.07.02.03 Fibre Roll Barriers

Fibre roll barriers shall be sized and constructed as specified in the Contract Documents and according to the following:

- a) Along the contour of the ground into trenches that have been excavated into the soil perpendicular to the slope face to a depth of approximately one half the roll diameter across the width of the slope unless otherwise specified by the manufacturer of a commercial product.
- b) After any rills and gullies on the slope where fibre roll barriers are to be installed have been filled in.
- c) On flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, additional fibre roll barriers shall be installed tightly butted against each other as specified in the Contract Documents.
- d) With their base in continuous contact with the underlying soil along their entire length without gaps and angled upslope at end of each run in a “J” pattern.
- e) With the ends of adjacent fibre roll segments tightly butted against each other without being overlapped vertically or horizontally.

After placement, a metal bar shall be used to make pilot holes perpendicular to the slope face through the centre of the fibre rolls as specified in the Contract Documents. Pilot holes shall also be made at the ends of each fibre roll segment angled towards the next abutting fibre roll to hold adjacent rolls together.

Wooden stakes shall be driven into the pilot holes as specified in the Contract Documents.

Soil excavated from the trenches shall be placed along the upslope side of the fibre rolls and compacted into the front of the trench to minimize possible undermining by runoff.

The soil on the upslope and downslope sides of the fibre rolls shall be seeded as specified in the Contract Documents and according to OPSS 803.

805.07.03 Heavy-Duty Sediment Barriers, General

Heavy-duty sediment barriers are wire-backed sediment fence barriers, berm barriers, or sandbag barriers.

Heavy-duty sediment barriers shall be constructed as specified in the Contract Documents, without gaps and without undermining to prevent sediment passage through, under, or around the barrier.

When the Heavy-Duty Sediment Barrier item is specified in the Contract Documents, the option is available to select any of the heavy-duty sediment barriers or any combination of them. When a specific heavy-duty sediment barrier is specified in the Contract Documents, no substitution shall be permitted.

Heavy-duty sediment barriers shall be installed such that soil scour and erosion is prevented at the low points of the barrier on the downslope side.

805.07.03.01**Wire-Backed Sediment Fence Barriers**

Wire-backed sediment fence barriers shall not be used for perimeter control or property line delineation unless specified in the Contract Documents.

Wire-backed sediment fence barriers shall be constructed as specified in the Contract Documents and according to the following:

- a) Within a trench excavated along the contour of the ground such that the elevation of the bottom of the fence is the same along its entire length except at the ends.
- b) Without breaks or gaps along their entire length.
- c) On flat ground with a minimum offset of 2 m from the toe of the slope being protected. When a longer sediment barrier is required, additional wire-backed sediment fence barriers shall be installed as specified in the Contract Documents.
- d) With the wire fence installed into the trench first, the geotextile installed next on the upslope side of the wire fence and T-posts installed into the ground behind the geotextile and wire fence and spaced to ensure the geotextile and wire fence remain vertical.
- e) With the geotextile and the wire fence attached securely to the T-posts using wire ties at the top of the geotextile and wire fence only.
- f) With the geotextile and the wire fence joined to provide a continuous run, with their ends overlapped a minimum of 500 mm, and securely fastened to T-posts using wire ties at the top of the geotextile or wire fence only.
- g) With the wire-backed sediment fence angled upslope at the ends of each run in a "J" pattern and so that the ends are at a higher elevation than the bottom of the run.

805.07.03.02**Berm Barriers**

Berm barriers shall be constructed and wrapped in geotextile or plastic sheeting as specified in the Contract Documents unless they are constructed using compost. The geotextile or plastic sheeting shall be secured to the ground.

805.07.03.03**Sandbag Barriers**

Sandbags shall be securely tied at the top.

Sandbag barriers shall be constructed as specified in the Contract Documents.

Sandbags within each row shall be placed with the sides of the bags butted tightly against one another without gaps. The ends of sandbags in adjacent rows shall be butted tightly against one another without gaps.

When sandbag barriers are constructed on earth surfaces, they shall be placed into an excavated trench, backfilled with excavated material to existing grade and compacted.

When sandbag barriers are to be constructed on sod, erosion control blanket, existing turf, or bedrock, they shall be placed so there are no gaps between the sandbags and the underlying surface.

Sandbag barriers shall be maintained with undamaged bags that are firmly seated.

805.07.04 Sediment Trap in Ditch

Sediment traps in a ditch shall be constructed as specified in the Contract Documents to prevent sediment transport from the upstream to the downstream side of the trap and so that the majority of the sediment is collected in the excavated basin.

Sediment traps shall be constructed as a single control measure consisting of an excavated basin and a rock flow check dam according to OPSS 804.

805.07.05 Sediment Traps for Dewatering

Sediment traps for dewatering shall be according to OPSS 517 and as specified in the Contract Documents.

A sediment barrier shall be constructed as specified in the Contract Documents and according to this specification to completely surround the sediment trap for dewatering with its ends overlapping a minimum of 500 mm where they meet. The rock flow check dam shall be constructed according to OPSS 804 and be located at the low point of the sediment barrier.

A temporary construction fence shall be erected around the sediment trap to restrict public access.

805.07.06 Filter Bags

Filter bags, hoses and pumps shall be sized appropriately to the volume of water to be filtered as specified in the Contract Documents. Bags shall have a FOS as specified in the Contract Documents.

Filter bags shall be situated in a vegetated area or placed on a permeable surface on a slight slope with the opening of the bag facing upslope a minimum of 30 m away from waterbodies and sensitive environmental receptors or as far as practicable from the top of the bank of any waterbody.

All filter bags shall be completely surrounded at their perimeter by a sediment barrier constructed according to this specification with its ends overlapping a minimum of 500 mm where they meet.

The opening of the filter bag shall be securely attached with mechanical connections to the discharge hose using commercially available hose couplers and placed in the retention facility to be dewatered.

Discharge of water from filter bags shall be according to OPSS 517.

A filter bag shall be replaced when trapped sediment has accumulated to 50% of the bag capacity or in accordance with the manufacturer's recommendations.

805.07.07 Turbidity Barriers

Turbidity barriers shall be constructed as specified in the Contract Documents, without gaps and without undermining to prevent turbid water from passing through, under, or around the barriers.

805.07.07.01 Turbidity Curtains

Turbidity curtains shall be constructed as specified in the Contract Documents.

Turbidity curtains shall not be used across flowing watercourses.

Turbidity curtains shall be free of tears and gaps. The bottom edge of the curtain shall be in continuous and secured contact with the waterbody bed to prevent sediment passage from the enclosed area.

Turbidity curtains shall be constructed according to the following:

- a) Turbidity curtains shall be oriented parallel to the direction of flow to the greatest extent possible.
- b) Turbidity curtains shall be firmly anchored in place. The alignment of the curtain shall be set as close to the Working Area as possible but not so close as to be disturbed by construction equipment.
- c) The height of turbidity curtains shall be 20% greater than the depth of the water where they are to be installed to allow for water level fluctuations.
- d) The area that turbidity curtains protect shall not contain large culverts or drainage areas that if flows occur behind the curtain it would cause a breach or lost contact with the waterbody bed at the bottom surface of the curtain.
- e) When water depths at the design alignment are minimal, the toe of the curtain may be anchored in place by staking. Supplemental anchors of the toe of the curtain shall be used, as needed, depending on water surface disturbances such as from boats and wave action.
- f) Shallow installations may be made by securing the top of the curtain using staking rather than a flotation system.

805.07.07.02 Turbidity Dam

Turbidity dams shall be constructed as specified in the Contract Documents.

805.07.08 Monitoring and Documentation

All temporary sediment control shall be monitored to ensure it is effective. Monitoring shall be completed for the following conditions:

- a) A minimum of every seven Days.
- b) The 24 hours prior to a forecasted significant rainfall event.
- c) Within 24 hours after significant rainfall events.

Monitoring shall include the following:

- a) Visual inspection of the condition and effectiveness of all installed temporary sediment controls; and
- b) Visual inspection for sediment leaving the Working Area and for entering waterbodies and sensitive environmental receptors.

Observations shall be documented and any concerns such as observed breaches of temporary sediment control, or sediment transport to a waterbody, sensitive receptor or private property shall be reported immediately to the Contract Administrator. Monitoring documentation shall be provided to the Contract Administrator upon request within 24 hours.

805.07.09 Maintenance

All temporary sediment control constructed under this specification shall be maintained in an effective, functioning, stable condition.

When temporary sediment control is found to be ineffective at any location, a different material, product or method more suitable for the site conditions shall be selected, installed and maintained within 48 hours.

805.07.09.01**Sediment Removal**

Sediment contained by temporary sediment control shall be removed and managed as specified in the Contract Documents in a manner that avoids escape of the sediment to the downstream side and avoids damage to the temporary erosion control materials or products. Sediment shall be removed to the level of the grade existing at the time the temporary sediment control was constructed and be according to the following:

- a) For light-duty sediment barriers, accumulated sediment shall be removed once it reaches the lesser of the following:
 - i. A depth of one-half the effective height of the sediment barrier.
 - ii. A depth of 300 mm immediately upstream of the sediment barrier.
- b) For heavy-duty sediment barriers, sediment traps in ditches, and sediment traps for dewatering, accumulated sediment shall be removed once it reaches one-half the effective height or depth of the sediment barrier or trap.
- c) For sediment traps for dewatering, sediment shall be removed when sediment diminishes the storage volume by 50%.
- d) For all temporary sediment control, accumulated sediment shall be removed as necessary to perform maintenance repairs.
- e) Accumulated sediment shall be removed immediately prior to the final removal of the temporary sediment control.

805.07.10**Removal**

Temporary sediment control shall be removed, and associated excavations backfilled and compacted when the area being protected has been completely stabilized by final cover placement. When the final cover is vegetated and placement could not be advanced to allow establishment and stabilization of the site prior to Contract Completion, temporary sediment control shall be left in place.

Temporary sediment control shall also be removed without entry of equipment to any waterbody other than hand-held equipment or boats as may be required, and in a manner that minimizes release of sediment and debris to any waterbody, sensitive receptor or private property.

Prior to removal of in-water turbidity barriers, any sediment laden water shall be allowed to settle out or be pumped out of the area enclosed by the turbidity barrier.

Any existing, seed, sod, temporary erosion control, or final design cover disturbed by removal or backfilling of temporary sediment control and removal of accumulated sediment, shall be brought to final grade and restored as specified in the Contract Documents.

Filter bags that have reached capacity or are no longer in use, and any captured sediment within the filter bag or its light-duty sediment barrier enclosure shall be managed as excess material as specified in the Contract Documents.

805.07.11**Protection of Waterbodies and Sensitive Environmental Receptors**

Protection of waterbodies, waterbody banks and sensitive environmental receptors shall be as specified in the Contract Documents.

805.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

805.08 QUALITY ASSURANCE

805.08.01 Acceptance of Temporary Sediment Control

The acceptance of temporary sediment control shall be according to the requirements of this specification and, as specified in the Contract Documents. Acceptance for each type of temporary sediment control shall be determined through visual inspection by the Contract Administrator and random quality assurance checks by the Owner.

The Owner may conduct random quality assurance checks on temporary sediment control that has been installed or removed to verify they are in accordance with the requirements of this specification, and as specified in the Contract Documents.

Temporary sediment control that is identified by the Owner as deficient shall be removed and replaced or reapplied with measures that meet the requirements of this specification and, as specified in the Contract Documents. Removal and replacement or reapplication shall be carried out at no additional cost to the Owner within 48 hours of the Owner providing notice to the Contractor, unless otherwise agreed to in writing.

805.09 MEASUREMENT FOR PAYMENT

805.09.01 Actual Measurement

805.09.01.01 Light-Duty Sediment Barriers Sediment Fence Barriers Fibre Roll Barriers Heavy-Duty Sediment Barriers Wire-Backed Sediment Fence Barriers Berm Barriers Sandbag Barriers

Measurement shall be the length in linear metres from end to end of the barrier, following the contours of the ground.

805.09.01.02 Sediment Traps in Ditch Sediment Traps for Dewatering Filter Bags

For measurement purposes, a count shall be made of the number of sediment traps in a ditch, sediment traps for dewatering and filter bags constructed or installed. Component parts shall not be counted separately for payment.

805.09.01.03 Turbidity Curtains

Measurement of turbidity curtain shall be made in linear metres along its length from end to end between tie-downs for each turbidity curtain installed.

805.09.01.04 Turbidity Dams

For measurement purposes, a count shall be made of the number of turbidity dams constructed.

805.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

805.10 BASIS OF PAYMENT

805.10.01 **Light-Duty Sediment Barriers - Item**
Sediment Fence Barriers - Item
Fibre Roll Barriers - Item
Heavy-Duty Sediment Barriers - Item
Wire-Backed Sediment Fence Barriers - Item
Berm Barriers - Item
Sandbag Barriers - Item
Sediment Traps in Ditch - Item
Sediment Traps for Dewatering - Item
Filter Bags - Item
Turbidity Curtains - Item
Turbidity Dams - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

Progress payments for the sediment control measures shall be made as follows:

- a) 30% for initial construction.
- b) 50% for maintenance.
- c) 20% for removal.



CONSTRUCTION SPECIFICATION FOR ROOTWAD STRUCTURES

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810.10	BASIS OF PAYMENT

810.01	SCOPE

This specification covers the requirements for the installation of rootwad structures to provide waterbody bed and waterbody bank stabilization and to improve fish habitat.

810.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 517	Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1440	Steel Reinforcement for Concrete

810.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Anchoring Stone means large stones used to anchor rootwad structures into a waterbody bank.

Excavated Bank Material means the existing earth material removed from the waterbody bank prior to the installation of a rootwad structure and replaced on top of the anchoring stone when backfilling the installation.

Footer Log means a log used to provide support under the rootwad trunk of a rootwad structure installed into a waterbody bank.

Rootfan means the root mass at the end of a rootwad trunk.

Rootwad Structure means the trunk of a tree with the limbs removed and the rootfan attached and exposed from earth that is installed along the toe of a waterbody bank to stabilize the slope and provide fish habitat, and includes a footer log, anchoring stone, and may include reinforcing steel.

Rootwad Trunk means the trunk of a tree used in a rootwad structure.

810.05 MATERIALS

810.05.01 General

All materials shall be free of deleterious substances.

810.05.02 Trees

Trees used for rootwad structures and footer logs shall be natural and untreated oak, maple, cedar, spruce, pine, or beech, unless otherwise specified in the Contract Documents.

Preference shall be given to trees sourced on-site.

810.05.03 Rootwad Trunk

The rootwad trunk shall be sized as specified in the Contract Documents. All limbs shall be removed from the rootwad trunk.

810.05.04 Rootfan

The rootfan shall be maintained intact at the end of the rootwad trunk.

810.05.05 Footer Log

Footer logs shall be generally straight and sized as specified in the Contract Documents.

810.05.06 Anchoring Stone

Anchoring stone shall be large field stone or quarried bedrock.

810.05.07 Reinforcing Steel

Reinforcing steel shall be according to OPSS 1440.

810.07 CONSTRUCTION

810.07.01 General

Rootwad structures shall be installed in the dry. The outside edge of the rootfan of a rootwad structure shall be installed so that it is no lower than the bottom of the waterbody or otherwise so that it is 1/3 below the low water level of the waterbody as specified in the Contract Documents.

810.07.02 Installation

Installation of rootwad structures shall be completed in the following sequence:

- a) The waterbody bed and waterbody bank shall be excavated to accommodate the entire length of the rootwad trunk and the footer log. The excavation shall be slightly angled to become deeper further inland from the edge of the waterbody.
- b) The excavated bank materials shall be reused for the final layer when backfilling.
- c) The footer log shall be installed so that it sits at the waterbody edge of the excavation, parallel to the waterbody bank, and at the depth specified in the Contract Documents. When more than one rootwad structure is to be installed in series, the footer logs shall be installed starting at the downstream end of the installation.
- d) The rootwad trunk shall be placed in the excavation resting on the footer log so that it is embedded into the waterbody bank up to the rootfan. The rootwad trunk shall be angled slightly in the excavation so that the rootwad structure is facing upstream at an angle, as specified in the Contract Documents, to the waterbody bank and shall be anchored into the bank with reinforcing steel if specified in the Contract Documents.
- e) Anchoring stone shall be installed on the rootwad trunk and footer log to secure the rootwad structure in place. The anchoring stone shall cover minimum 1.5 times the diameter of the rootwad trunk, both in horizontal and vertical directions, and the entire length of the rootwad trunk and the footer log so that neither is visible from above.
- f) The previously excavated bank material shall be placed over the anchoring stone and graded according to OPSS 206.
- g) Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

810.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

810.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

810.07.05 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

810.09 MEASUREMENT FOR PAYMENT

810.09.01 Actual Measurement

810.09.01.01 Rootwad Structure

For measurement purposes, a count shall be made of the number of rootwad structures installed along the waterbody bank.

810.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

810.10 BASIS OF PAYMENT

810.10.01 Rootwad Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR LARGE WOODY DEBRIS

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811.10	BASIS OF PAYMENT

811.01	SCOPE

This specification covers the requirements for the installation of large woody debris to provide and improve fish habitat on waterbody beds and waterbody banks.

811.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 517	Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous

811.03

DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Backfill Stone means a stone mixture used to hold in place large woody debris installed at the toe of a waterbody bank.

Excavated Bank Material means the existing earth material removed from the waterbody bank prior to the installation of large woody debris and replaced on top of the backfill stone when backfilling the installation.

Large Woody Debris means one or more woody materials including, natural logs, tree trunks and limbs, or tree stumps with rootfans intertwined together and applied along the toe of a waterbody bank when the toe of the waterbody bank is being eroded and includes backfill stone.

Rootfan means the root mass at the end of the trunk of a tree.

811.05

MATERIALS

811.05.01

Large Woody Debris

Large woody debris materials shall be sized as specified in the Contract Documents.

Preference shall be given to wood debris and dead trees sourced on-site.

811.05.02

Backfill Stone

Backfill stone shall be pit run material according to OPSS 1004 and as specified in the Contract Documents. Alternatively, previously excavated waterbody bank material may be used if specified in the Contract Documents.

811.07

CONSTRUCTION

811.07.01

General

Large woody debris shall be installed in the dry.

Adjacent to, but not within the installation area, the large woody debris shall be intertwined to create a mass, sized as specified in the Contract Documents.

811.07.02

Installation

Installation of large woody debris shall be completed in the following sequence:

- a) The installation area shall be excavated as specified in the Contract Documents. Excavated material shall be reused for the final layer when backfilling.
- b) The large woody debris shall be intertwined together to create a mass. The mass shall be placed in the excavation, ensuring that the large woody debris is situated in an irregular fashion as specified in the Contract Documents. The large woody debris mass shall extend to the back of the excavation and also extend into the waterbody as specified in the Contract Documents.

- c) The large woody debris shall be covered with backfill stone as specified in the Contract Documents and tamped down. The backfill stone shall be covered with a layer of the previously excavated bank material and graded according to OPSS 206.
- d) Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

811.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

811.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

811.07.05 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

811.09 MEASUREMENT FOR PAYMENT

811.09.01 Actual Measurement

811.09.01.01 Large Woody Debris

Measurement of large woody debris shall be in linear metres, in place, as measured along the top of the waterbody bank.

811.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

811.10 BASIS OF PAYMENT

811.10.01 Large Woody Debris - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR LUNKERS

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812.09	MEASUREMENT FOR PAYMENT
812.10	BASIS OF PAYMENT

812.01 SCOPE

This specification covers the requirements for the construction of LUNKERS for the stability of waterbody banks and fish habitat enhancement.

812.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206 Grading
OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Materials

OPSS 1005 Aggregates - Waterbody
OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1440 Steel Reinforcement for Concrete

812.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Cover Stone means one or more large stones used to create the top of stone LUNKERS.

Excavated Bank Material means the existing earth material removed from the waterbody bank prior to the installation of LUNKERS and replaced on waterbody bank when backfilling the installation.

LUNKERS means an acronym for Little Underwater Neighbourhood Keepers Encompassing Rheotactic Salmonids that are crib-like, wooden, or stone structures installed along the toe of a waterbody bank.

Spacer Stone means a stone installed under the cover stone of stone LUNKERS and on top of the waterbody aggregate to create space under the cover stone.

812.05 MATERIALS

812.05.01 General

All materials shall be free of deleterious substances.

812.05.02 Wood

Wood LUNKERS shall be constructed of local wood, untreated lumber or rough-hewn logs.

Wood LUNKERS planks, stringers, backboards, and posts shall be as specified in the Contract Documents.

Planks shall be placed side-by-side, without any gaps.

812.05.03 Waterbody Aggregates

Waterbody aggregates shall be according to OPSS 1005 and as specified in the Contract Documents.

812.05.04 Granular B Aggregate

Granular B aggregate shall be according to OPSS 1010, except that it may not contain reclaimed asphalt pavement, reclaimed concrete material, glass, ceramic, fly ash, any type of slag, or any other industrial by-product, and shall be made from unwashed, quarried bedrock.

812.05.05 Spacer and Cover Stones

Spacer and cover stones shall be as specified in the Contract Documents.

812.05.06 Reinforcing Steel

Reinforcing steel shall be according to OPSS 1440.

812.07 CONSTRUCTION

812.07.01 General

LUNKERS shall be installed in the dry.

812.07.02 Installation

812.07.02.01 Wood LUNKERS

Wood LUNKERS shall be constructed on land outside the waterbody as specified in the Contract Documents, prior to installation in the waterbody bank.

Installation of wood LUNKERS shall be completed in the following sequence:

- a) The waterbody bed and bank shall be excavated to accommodate wood LUNKERS as specified in the Contract Documents. Excavated bank materials shall be reused for the final layer when backfilling.
- b) Wood LUNKERS shall be installed in the excavation as specified in the Contract Documents. Adjustments to level and stabilize wood LUNKERS shall be made by hand.
- c) Holes shall be drilled through the posts of wood LUNKERS to accommodate the reinforcing steel and the reinforcing steel shall be driven through wood LUNKERS and into the waterbody bed.
- d) Waterbody aggregates shall be placed on wood LUNKERS and extend to the high water level of the waterbody to re-establish the waterbody bank as specified in the Contract Documents. Granular B aggregate shall be installed at the rear of the excavation as specified in the Contract Documents.

The previously excavated waterbody bank material shall be installed on top of the waterbody aggregates I and Granular B aggregate as specified in the Contract Documents and graded according to OPSS 206. Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

812.07.02.02 Stone LUNKERS

Stone LUNKERS shall be installed in the dry.

Installation of stone LUNKERS shall be completed in the following sequence:

- a) The waterbody bed shall be excavated to accommodate stone LUNKERS as specified in the Contract Documents. Excavated bank material shall be reused for the final layer when backfilling.
- b) Waterbody aggregates shall be placed on the waterbody bed to create a flat, stable base for stone LUNKERS as specified in the Contract Documents.
- c) Spacer stones shall be installed on the waterbody aggregates as specified in the Contract Documents. Spacer stones shall be installed to be at the mid-point and at each end of the length of the cover stone. The cover stone shall then be lowered onto the spacer stones. Adjustments shall be made to level and stabilize stone LUNKERS.
- d) Waterbody aggregates shall be placed on the cover stone of stone LUNKERS to re-establish the waterbody bank as specified Contract Documents. Granular B aggregate shall be installed on top of the waterbody aggregates and extend to the high water level of the waterbody as specified in the Contract Documents.
- e) The previously excavated bank material shall be placed over the Granular B aggregate as specified in the Contract Documents and graded according to OPSS 206.
- f) Vegetative cover shall be applied to the graded area as specified in the Contract Documents.

812.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified in the Contract Documents.

812.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

812.07.05 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

812.09 MEASUREMENT FOR PAYMENT

812.09.01 Actual Measurement

**812.09.01 Wood LUNKERS
Stone LUNKERS**

Measurement of wood and stone LUNKERS shall be in linear metres, in place, as measured along the top of the waterbody bank.

812.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

812.10 BASIS OF PAYMENT

**812.10.01 Wood LUNKERS - Item
Stone LUNKERS - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR RIFFLES

TABLE OF CONTENTS

820.01	SCOPE
820.02	REFERENCES
820.03	DEFINITIONS
820.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
820.05	MATERIALS
820.06	EQUIPMENT - Not Used
820.07	CONSTRUCTION
820.08	QUALITY ASSURANCE - Not Used
820.09	MEASUREMENT FOR PAYMENT
820.10	BASIS OF PAYMENT

820.01 SCOPE

This specification covers the requirements for the construction of riffles to maintain and enhance fish passage in a waterbody.

820.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering
OPSS 823 Low Flow Channels

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates - Waterbody

820.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Anchor Stones means large waterbody aggregates used to create a stable base.

Interstitial Space means an empty space or gap between spaces full of structure or matter.

Low Flow Channel means as defined by OPSS 823.

Riffle means shallow areas of a waterbody with the steepest waterbody bed slopes and shallowest depths where waterbody aggregates that break up the flow of water.

Riffle Crest means the highest point of a riffle at its upstream end.

Waterbody Aggregates means as defined by OPSS 1005.

820.05 MATERIALS

820.05.01 Waterbody Aggregate

Waterbody aggregates shall be according to OPSS 1005 and as specified in the Contract Documents.

820.07 CONSTRUCTION

820.07.01 General

Riffles shall be constructed in the dry.

820.07.02 Waterbody Bed Excavation

All required waterbody bed excavation shall be carried out as specified in the Contract Documents.

820.07.03 Waterbody aggregates

The waterbody aggregates shall be blended on site and as specified in the Contract Documents. Approximately 10 - 20% of the largest size of waterbody aggregates to be used shall be set aside and positioned on top of the smaller waterbody aggregates to direct the stream flow.

Waterbody aggregates placement shall commence at the downstream end of the waterbody as specified in the Contract Documents and progress to the upstream end. Waterbody aggregates shall be compacted and interstitial spaces shall be filled as specified in the Contract Documents.

The riffle crest shall be constructed across the waterbody bed with large diameter waterbody aggregates backed up with the next largest waterbody aggregates size downstream. Anchor stones shall be placed on the waterbody bed to create the upstream slope of the riffle and shall extend to the high water level on both sides of the waterbody as specified in the Contract Documents. The thickness of each riffle crest shall be two to three times the diameter of the largest waterbody aggregates size.

The surface of the downstream face of the riffle shall have large waterbody aggregates placed so that they are spaced 20 - 30 cm apart to form gaps as specified in the Contract Documents.

Once placed, the waterbody aggregates shall form a non-uniform surface with larger stones protruding above smaller stones.

820.07.04 Low Flow Channel

A low flow channel shall be installed within the riffle according to OPSS 823.

820.07.05 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

820.07.06 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

820.07.07 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

820.09 MEASUREMENT FOR PAYMENT

820.09.01 Actual Measurement

820.09.01.01 Riffles

Measurement for riffles shall be by horizontal area in square metres.

820.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

820.10 BASIS OF PAYMENT

820.10.01 Riffles - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR POOLS

TABLE OF CONTENTS

821.01	SCOPE
821.02	REFERENCES
821.03	DEFINITIONS
821.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
821.05	MATERIALS
821.06	EQUIPMENT - Not Used
821.07	CONSTRUCTION
821.08	QUALITY ASSURANCE - Not Used
821.09	MEASUREMENT FOR PAYMENT
821.10	BASIS OF PAYMENT

821.01 SCOPE

This specification covers the requirements for the construction of pools in waterbody beds.

821.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates - Waterbody

821.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Pool means hydrologic segments of a waterbody where the water is deeper and slower.

Waterbody Aggregates means as defined by OPSS 1005.

821.05 MATERIALS

821.05.01 Waterbody Aggregates

Waterbody aggregates shall be according to OPSS 1005 and as specified in the Contract Documents.

821.07 CONSTRUCTION

821.07.01 General

Pools shall be excavated in the dry.

Any materials to be reused that must be temporarily removed from the waterbody bed shall be stored on-site as specified in the Contract Documents.

821.07.02 Pool Excavation

Pools shall be excavated in the waterbody bed as specified in the Contract Documents.

821.07.03 Waterbody Aggregates

Waterbody aggregates shall be installed as specified in the Contract Documents.

821.07.04 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

821.07.05 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control for construction in waterbodies shall be according to OPSS 517.

821.07.06 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

821.09 MEASUREMENT FOR PAYMENT

821.09.01 Actual Measurement

821.09.01.01 Pools

Measurement for pools shall be by horizontal area in square metres.

821.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

821.10 BASIS OF PAYMENT

821.10.01 Pools - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR ROCKY RAMPS

TABLE OF CONTENTS

822.01	SCOPE
822.02	REFERENCES
822.03	DEFINITIONS
822.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
822.05	MATERIALS
822.06	EQUIPMENT - Not Used
822.07	CONSTRUCTION
822.08	QUALITY ASSURANCE - Not Used
822.09	MEASUREMENT FOR PAYMENT
822.10	BASIS OF PAYMENT

822.01 SCOPE

This specification covers the requirements for the construction of rocky ramps on waterbody beds.

822.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates – Waterbody

822.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Anchor Stones means large waterbody aggregates used to create a stable base.

Boulder Weir means a grade control structure to slow water behind it.

Boulder Weir Crest means the top of the boulder weir.

In-stream Obstruction means a barrier in a waterbody that prohibits fish passage.

Pool means as defined by OPSS 821.

Rocky Ramp means a longitudinal series of boulder weirs and pools creating a low slope that simulates a rocky waterbody bed.

Waterbody Aggregate means as defined by OPSS 1005.

822.05 MATERIALS

822.05.01 Waterbody Aggregate

Waterbody aggregate shall be according to OPSS 1005 and as specified in the Contract Documents.

822.07 CONSTRUCTION

822.07.01 General

Rocky ramps shall be constructed in the dry.

822.07.02 Removal of In-Stream Obstructions to Fish Passage from Waterbodies

Pre-existing, in-stream obstructions to fish passage shall be removed from the waterbody as specified in the Contract Documents.

822.07.03 Waterbody Bed Excavation

Prior to construction of rocky ramps, the waterbody bed shall be graded to create the slope and pools as specified in the Contract Documents.

The top layer of the excavated waterbody bed material shall be stockpiled on-site and reused later as the top layer of the rocky ramp as specified in the Contract Documents.

822.07.04 Waterbody Aggregate

All imported waterbody aggregate shall be stockpiled within graded piles on-site adjacent to the rocky ramp construction location.

The downstream end of the rocky ramp shall be flatter than the rest of the ramp, approximately 10H:1V or as specified in the Contract Documents.

Waterbody aggregate placement shall commence at the downstream end of the waterbody as specified in the Contract Documents and progress to the upstream end. Waterbody aggregate shall be placed first in the centre of the boulder weir crest and then outwards toward the waterbody banks.

Each boulder weir shall be shaped like an arch so that adjacent waterbody aggregates support each other along the length of the boulder weir. Individual pieces of waterbody aggregate shall be carefully placed in a manner that allows the material to be rotated for precise alignment and fitting during construction.

Anchor stones shall form the first layer of waterbody aggregate and be placed below the elevation of the final grade to support a second row of waterbody aggregate.

The top row of waterbody aggregate shall then be placed against the anchor stones and slightly upstream of them so that they are supported with multiple points of contact.

When the arch of the boulder weir is complete, each boulder shall bear against its downstream neighbour and against the two anchor stones below it.

Anchor stones shall also be placed at the ends of each boulder weir well into the waterbody banks to the high water level and backfilled as specified in the Contract Documents.

Each pool shall be lined with waterbody aggregate as specified in the Contract Documents.

The bottom of each subsequent boulder weir shall be equal to the elevation of the crest of the boulder weir immediately downstream as specified in the Contract Documents.

Well-graded waterbody aggregate with some fines shall be placed on the upstream side of the boulder weir as specified in the Contract Documents.

Upon completion of construction of the rocky ramp, the center stone of each boulder weir crest shall be removed to form a notch for a low flow channel.

822.07.05 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

822.07.06 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

822.07.07 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

822.09 MEASUREMENT FOR PAYMENT

822.09.01 Actual Measurement

822.09.01.01 Rocky Ramps

Measurement for rocky ramps shall be by horizontal area in square metres.

822.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

822.10 BASIS OF PAYMENT

822.10.01 Rocky Ramps - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR LOW FLOW CHANNELS

TABLE OF CONTENTS

823.01	SCOPE
823.02	REFERENCES
823.03	DEFINITIONS
823.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
823.05	MATERIALS
823.06	EQUIPMENT - Not Used
823.07	CONSTRUCTION
823.08	QUALITY ASSURANCE - Not Used
823.09	MEASUREMENT FOR PAYMENT
823.10	BASIS OF PAYMENT

823.01 SCOPE

This specification covers the requirements for the construction of low flow channels to maintain and enhance fish passage in a waterbody or a culvert.

823.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Materials

OPSS 1005 Aggregates - Waterbody

823.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Low Flow Channel means the part of a waterbody bed occupied by water during periods of low flow.

Waterbody Aggregate means as defined by OPSS 1005.

823.05 MATERIALS

823.05.01 Waterbody Aggregate

When the installation of a low flow channel includes supply of waterbody aggregate, it shall be according to OPSS 1005 and as specified in the Contract Documents.

823.07 CONSTRUCTION

823.07.01 General

Low flow channels shall be installed in the dry.

Excavation of the waterbody bed and supply of waterbody aggregate from off-site may not be required if the existing waterbody bed material can be adjusted to create the required low flow channel as specified in the Contract Documents.

When excavation of the waterbody bed and supply of waterbody aggregate are required to achieve the design as specified in the Contract Documents, any materials that are suitable for reuse that must be temporarily removed from the waterbody bed shall be stored on-site as specified in the Contract Documents.

823.07.02 Low Flow Channel

Once the waterbody bed has been prepared, waterbody aggregate according to OPSS 1005 shall be installed as specified in the Contract Documents.

Waterbody aggregate placement shall be adjusted as necessary to achieve the design as specified in the Contract Documents.

Proper function shall be verified to ensure the flow is contained within the low flow channel, as constructed, when waterbody flow has been reinstated and that the grade and transition areas from the low flow channel to the waterbody do not present any barriers to flow or fish passage or direct flow outward towards the waterbody banks.

Waterbody aggregate placement may need to be adjusted to rectify any of these conditions.

823.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

823.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

823.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

823.09 MEASUREMENT FOR PAYMENT

823.09.01 Actual Measurement

823.09.01.01 Low Flow Channel

Measurement of low flow channels using existing waterbody aggregate shall be in linear metres installed.

Measurement of low flow channels that include supply of waterbody aggregate shall be by mass in tonnes of waterbody aggregate.

823.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

823.10 BASIS OF PAYMENT

823.10.01 Low Flow Channel - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR BAFFLES IN A CULVERT

TABLE OF CONTENTS

824.01	SCOPE
824.02	REFERENCES
824.03	DEFINITIONS
824.04	SUBMISSION AND DESIGN REQUIREMENTS - Not Used
824.05	MATERIALS
824.06	EQUIPMENT - Not Used
824.07	CONSTRUCTION
824.08	QUALITY ASSURANCE - Not Used
824.09	MEASUREMENT FOR PAYMENT
824.10	BASIS OF PAYMENT
APPENDICES	Not Used

824.01 SCOPE

This specification covers the requirements for the construction of baffles in culverts using streambed material to direct the flow of water within the culverts and to enhance fish passage through the culverts.

824.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are written to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

824.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

824.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Materials

OPSS 1005 Aggregates - Streambed Material

824.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Baffle means one or a series of partial obstructions in a channel designed to increase flow depth or dissipate the energy of water flowing at high velocity while at the same time providing fish passage.

Culvert means a structure that provides an opening through an embankment and to which roadway loads are distributed through fill or that is designated as a culvert in the Contract Documents.

Low Flow Channel means the part of a streambed occupied by water during periods of low flow.

Streambed Material means as defined by OPSS 1005.

824.05 MATERIALS

824.05.01 Streambed Material

Streambed material used to construct baffles in a culvert shall be according to OPSS 1005 and as specified in the Contract Documents.

824.07 CONSTRUCTION

824.07.01 General

All baffles shall be constructed in the dry.

824.07.02 Baffles in a Culvert

Baffles shall be installed in a culvert to be a permanent feature within the culvert as specified in the Contract Documents.

When the construction of the baffles in a culvert is complete and the waterbody flow has been reinstated, streambed material placement shall be adjusted by hand to achieve the design specified in the Contract Documents.

The baffles in a culvert shall be monitored after installation is complete to verify that the grade and transition of flow to the low flow channel within the culvert does not present any barriers to fish passage.

The placement of streambed material shall be adjusted to rectify any barriers to fish passage.

824.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

824.07.04 Dewatering and Temporary Flow Control

Dewatering and/or temporary flow control shall be according to OPSS 517.

824.07.05 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

824.09 MEASUREMENT FOR PAYMENT

824.09.01 Actual Measurement

824.09.01.01 Baffles in a Culvert

For measurement purposes, a count shall be made of the number of baffles installed in a culvert.

824.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

824.10

BASIS OF PAYMENT

824.10.01

Baffles in a Culvert - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



**CONSTRUCTION SPECIFICATION FOR
PLACEMENT OF AGGREGATES IN WATERBODIES**

TABLE OF CONTENTS

825.01	SCOPE
825.02	REFERENCES
825.03	DEFINITIONS
825.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
825.05	MATERIALS
825.06	EQUIPMENT - Not Used
825.07	CONSTRUCTION
825.08	QUALITY ASSURANCE- Not Used
825.09	MEASUREMENT FOR PAYMENT
825.10	BASIS OF PAYMENT

825.01 SCOPE

This specification covers the requirements for the placement of aggregates in waterbodies.

825.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 517 Dewatering

Ontario Provincial Standard Specifications, Material

OPSS 1005 Aggregates - Waterbody

825.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 shall apply.

825.05 MATERIALS

Aggregates in waterbodies shall be according to OPSS 1005 and as specified in the Contract Documents.

825.07 CONSTRUCTION

825.07.01 Waterbody Bed Excavation

Waterbody beds shall be excavated to the limits specified in the Contract Documents. The placement locations shall be graded to a uniform and even surface prior to material placement.

825.07.02 Placement

Placement of aggregates shall be at the locations specified in the Contract Documents.

Placement of aggregates shall occur in an isolated work area. Dewatering and/or temporary flow passage systems for the placement of aggregates shall be according to OPSS 517.

Where aggregate is to be placed on a slope with a grade greater than 2%, placement shall commence at the toe of the slope and progress up the slope from that point to the termination location as specified in the Contract Documents.

825.07.03 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

825.07.04 Management of Excess Materials

Management of excess materials shall be according to the Contract Documents.

825.09 MEASUREMENT FOR PAYMENT

825.09.01 Actual Measurement

825.09.01.01 Placement of Waterbody Aggregates

Measurement for the placement of aggregates shall be volume in cubic metres.

825.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

825.10 BASIS OF PAYMENT

825.10.01 Placement of Waterbody Aggregates - Item

Payment at the Contract price of the above tender item shall be full compensation for all labour, Equipment and Material to do the work.



CONSTRUCTION SPECIFICATION FOR BIOENGINEERING MEASURES

TABLE OF CONTENTS

832.01	SCOPE
832.02	REFERENCES
832.03	DEFINITIONS
832.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
832.05	MATERIALS
832.06	EQUIPMENT - Not Used
832.07	CONSTRUCTION
832.08	QUALITY ASSURANCE
832.09	MEASUREMENT FOR PAYMENT
832.10	BASIS OF PAYMENT

832.01 SCOPE

This specification covers the requirements for the installation of bioengineering measures.

832.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 802	Topsoil
OPSS 803	Vegetative Cover
OPSS 804	Temporary Erosion Control
OPSS 805	Temporary Sediment Control

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1005	Aggregates - Waterbody

Canadian and Provincial Statutes

Invasive Species Act, 2015, as amended

832.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 182 and the following definitions apply:

Basal End means the root producing end of a live cutting.

Bioengineering Measures means live stakes, brush layers, vegetated soil lifts and vegetated rock applied to waterbody banks for soil stabilization.

Brush Layers means alternating layers of live cuttings and soil placed along contours of a waterbody bank.

Dormant means after buds have closed or before buds open.

Invasive Species means as in the Invasive Species Act.

Live Cuttings means portions cut from dormant, live plants of a specified woody species that are not an invasive species, with branches and bark left intact.

Live Stakes means dormant, live cuttings with the branches trimmed off.

Significant Rainfall means a rainfall event exceeding 15 mm within a 24 hour period.

Soil Lifts means layers of soil wrapped in biodegradable erosion control blankets material placed along contours of a waterbody bank.

Vegetated Rock means live cuttings or plant material inserted between rocks placed along contours of a waterbody bank.

832.05 MATERIALS

832.05.01 Live Cuttings and Live Stakes

Live cuttings and stakes shall be as specified in the Contract Documents and shall be sourced on site or from a supplier.

Live cuttings and stakes shall be free of disease and damage.

832.05.02 Plant Material

Plant material shall be free of disease and damage and shall be as specified in the Contract Documents.

832.05.03 Rock

Rock shall be as specified in the Contract Documents.

832.05.04 Topsoil

Soil shall be according to OPSS 802.

832.05.05 Twine

Twine shall be inert and biodegradable.

832.07 CONSTRUCTION

832.07.01 Operational Constraints

Bioengineering measures shall not be installed during significant rainfall events or periods of drought. Dry soils shall be watered prior to installation.

Excavated materials that are suitable for reuse as backfill material shall be stockpiled on-site and controlled as specified in the Contract Documents.

Live cuttings shall be installed within 12 hours of collection on-site or arrival from a supplier or shall otherwise be stored according to this specification.

Live cuttings shall not be planted if buds have broken open or if they are split, dried out, sprouting, or moldy.

Material from the waterbody bank shall not enter the waterbody during grading.

832.07.02 Waterbody Bank Preparation

The waterbody bank shall be graded and prepared prior to placement of the bioengineering measures as specified in the Contract Documents and according to OPSS 206.

832.07.03 Harvest, Transport and Storage of Live Cuttings and Live Stakes

832.07.03.01 Harvest

Sharp, clean hand tools shall be used for harvesting live cuttings and stakes.

Live cuttings shall be harvested when they are dormant. Harvesting of live cutting and stakes shall not occur until October 15th.

Live cuttings collected on-site shall be cut from the crown of dormant plants. No more than 2/3 of the existing plant shall be removed.

Live stakes shall be taken from live cuttings with the basal ends cut at a 45 degree angle and the top cut square.

Live cuttings and live stakes shall be sized to the dimensions specified in the Contract Documents.

832.07.03.02 Transport

Live cuttings shall be bound in bundles with all of the growing tips aligned in the same direction and tied with twine for ease of transport.

Live cuttings and stakes being transported shall be covered to prevent them from drying out.

832.07.03.03 Storage

When live cuttings or stakes cannot be planted within 12 hours of collection on-site or arrival from a supplier, they shall be stored in locations that will be continually shaded and protected from the wind and shall have the basal ends kept in water, or heeled into damp soil.

832.07.04 Installation

832.07.04.01 Brush Layers

The waterbody bank shall be excavated, and the brush layers installed as specified in the Contract Documents and according to the following:

- a) Excavation shall begin at the base of the waterbody bank and proceed upland above a stable toe structure as specified in the Contract Documents,
- b) Excavation shall be 0.5 to 1.0 metres deep with the surface of the bench angling back into the waterbody bankmaking the back of the constructed bench 150 to 300 mm lower than the front edge.
- c) The brush layers shall be installed so that the branches of the live cuttings are long enough so that the cut basal ends touch the back of the excavation, and the growing tips protrude from the face of the fill no more than 1/3 their total depth once installed on the excavated benches.
- d) The brush layers shall be covered with topsoil. The topsoil shall be sifted onto the brush layers tamping them into place ensuring that there are no air voids.

832.07.04.02 Live Stakes

Live stakes shall be 15 to 40 mm in diameter and 600 to 900 mm in length.

Live stakes shall be installed the day that they are harvested or removed from storage.

Live stakes shall be installed into the ground as specified in the Contract Documents at a right angle to the slope using a rubber mallet. Once installed, live stakes should have 20 to 25 % of the stake exposed above ground. At least two buds or bud scars should be present above the ground in the final installation.

If live stakes cannot be inserted into the ground to meet the above requirements, pilot holes shall be made by driving a steel rod into the ground. The soil surrounding the live stakes shall be tamped down.

832.07.04.03 Soil Lifts

The waterbody bank shall be excavated, and the soil lifts installed as specified in the Contract Documents

The soil lift shall be graded so that the lift slopes back into the waterbody bank, making the back of the constructed bench 150 to 300 mm lower than the front edge.

Soil lifts should be a maximum of 300 mm high and as specified in the Contract Documents.

Biodegradable erosion control blankets shall be as specified in the Contract Documents and wrapped a minimum of 1 metre under the bank.

Soil shall be placed creating a lift and mechanically compacted to the depth as specified it the Contract Documents.

832.07.04.04 Vegetated Rock

The waterbody bank shall be excavated, and the vegetated rock installed as specified in the Contract Documents.

832.07.05 Vegetative Cover

Vegetative cover shall be applied as specified in the Contract Documents and according to OPSS 803.

832.07.06 Temporary Erosion and Sediment Control

Temporary erosion and sediment control measures shall be applied as specified in the Contract Documents and according to OPSS 804 and OPSS 805.

832.07.07 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be as specified the Contract Documents.

832.07.08 Management of Excess Materials

Management of excess materials shall be as specified the Contract Documents.

832.08 QUALITY ASSURANCE

Prior to use, live cuttings and stakes and plant material as specified in the Contract Documents may be inspected by the Contract Administrator. Any live material that has dried out or is damaged shall be rejected.

832.09 MEASUREMENT FOR PAYMENT

832.09.01 Actual Measurement

832.09.01.01 Live Stakes

For measurement purposes a count shall be made of the number of live stakes installed.

832.09.01.02 Brush Layers Vegetated Rock Soil Lifts

Measurement of brush layers, vegetated rock and soil lifts shall be by area in square metres following the contours of the ground.

832.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

832.10 BASIS OF PAYMENT

832.10.01
Brush Layers - Item
Live Stakes - Item
Soil Lift - Item
Vegetated Rock - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

832.10.02 Vegetative Cover

Payment for vegetative cover shall be according to OPSS 803.

832.10.03 Temporary Erosion and Sediment Control

Payment for temporary erosion and sediment control shall be according to OPSS 804 and OPSS 805.



CONSTRUCTION SPECIFICATION FOR EXCAVATING AND BACKFILLING - STRUCTURES

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902.10	BASIS OF PAYMENT

902.01	SCOPE

This specification covers the requirements for excavating and backfilling for structures, including dewatering.

902.02	REFERENCES

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 501	Compacting
OPSS 510	Removal
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1205	Clay Seal
OPSS 1860	Geotextiles

902.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bedding means granular material to be placed in areas so designated in the Contract Documents.

Channel means a natural or artificial watercourse.

Culvert means a structure that provides an opening through an embankment and to which roadway loads are distributed through fill or that is designated as a culvert in the Contract Documents.

Designated Payment Surface means the original ground surface shown in the Contract Documents, unless a specially designated payment surface is shown either by elevation or by profile. The specially designated payment surface is horizontal in the transverse direction.

For rock excavation the designated payment surface shall be the existing rock surface as established in the field before rock excavation begins, unless another designated payment surface is specified.

Dewatering System means as defined in OPSS 517.

Earth means all soils except those defined as rock, and excludes stone masonry, concrete and other manufactured materials.

Foundation means that portion of the ground below the structure base or footings that supports the structure or that portion of the ground supporting the pile caps.

Rock means natural beds or massive fragments, of the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin, which may or may not be weathered, and includes boulders having a volume of 1 cubic m or greater.

Soil means all loose or moderately cohesive organic or inorganic deposits of the earth's crust such as silt, sand, gravel, or clay or any of their mixtures.

Structure means any bridge, tunnel, concrete culvert, retaining wall, dock, guideway, or sign support.

902.04

DESIGN AND SUBMISSION REQUIREMENTS

902.04.01

Design Requirements

902.04.01.01

Dewatering

Where dewatering is required, the Contractor shall be responsible for the design of the dewatering system for the intended purpose.

902.04.02

Submission Requirements

902.04.02.01

Preconstruction Survey

Prior to commencing the work, a condition survey of property and structures that may be affected by the work shall be submitted to the Contract Administrator. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site.

902.05 MATERIALS

902.05.01 Granular

Granular material to be used for backfill, bedding, and frost tapers shall be according to OPSS 1010.

The 19.0 mm clear stone to be used for wall drains shall be according to OPSS 1004.

902.05.02 Native Backfill

Native and imported material shall be approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

902.05.03 Clay Seal

Clay seal shall be according to OPSS 1205.

902.05.04 Geotextile

Geotextile shall be according to OPSS 1860 and be of the type, class, and filtration opening size (FOS) range specified in the Contract Documents.

902.06 EQUIPMENT

902.06.01 Compaction Equipment

Compaction equipment shall be according to OPSS 501.

902.07 CONSTRUCTION

902.07.01 Removals

Removals shall be according to OPSS 510.

902.07.02 Removal of Ice and Snow

All ice and snow shall be removed from all portions of the work area before any excavation and backfill operations proceed. Frozen materials shall not be incorporated into the work. Material shall not be placed over frozen ground, ice, or snow.

902.07.03 Protection Systems

Protection systems shall be according to OPSS 539.

Protection systems shall be installed:

- a) Where the stability, safety, or function of an existing structure, roadway, railway, or other facility can be impaired by an excavation or temporary slope.
- b) To permit excavation where there is a necessity to retain the sidewalls of an excavation and to permit dewatering by restricting water flow and facilitating safe execution of the work.

902.07.04 Dewatering Structure Excavation

Until backfilling has been completed and to permit the placing of concrete in the dry, all work necessary to control the flow of water into the excavation and to prevent disturbance of the founding material shall be carried out.

902.07.05 Excavation

902.07.05.01 General

Deterioration of the foundation soil or rock, surface water from entering and eroding the face of the excavation, and build up of hydrostatic pressures that may have harmful effects upon the temporary or permanent structures shall be prevented.

902.07.05.02 Excavation for Foundations

Excavation for footings, working slabs, and granular pads shall be to the neat lines specified in the Contract Documents.

The bottom of the excavation on which the footing, working slab, or granular pad is to rest shall not be disturbed. In soft conditions, construction of the footing or structural slab shall commence immediately after the final removal of material to the foundation level has been completed.

In the case of concrete culverts of the open footing type, no excavation shall be made between the footings below the level of the stream bed or the top of the footings, whichever elevation is lower, unless authorized in writing by the Contract Administrator.

The elevation of the bottom of the footing, working slab, or granular pad shall not be changed without the approval of the Contract Administrator.

Overexcavated areas shall be restored to their original conditions. Overexcavated areas shall be backfilled with a material suitable for the particular application and approved by the Contract Administrator. Concrete fill shall be used for overexcavation in rock. Where material other than concrete is used, the material shall be compacted to the dry density specified in OPSS 501.

When authorized by the Contract Administrator, additional excavation, as may be required, shall be carried out.

902.07.05.03 Excavation for Backfill and Frost Tapers

Excavation for backfill and frost tapers shall be to the neat lines specified in the Contract Documents.

Overexcavated areas shall be restored with material approved by the Contract Administrator. The material shall be compacted to the dry density specified in OPSS 501.

902.07.05.04 Preservation of Channel

Where a channel cross-section is altered, it shall be restored to its original condition.

902.07.06 Backfilling

902.07.06.01 General

Frozen materials shall not be incorporated into the work.

Footings shall be protected against frost action.

Other than the backfill placed to the tops of the footings, no fill shall be placed against an abutment, wingwall, retaining wall, or concrete culvert until the concrete has reached 70% of its design strength.

Backfilling around culverts, arches, rigid frames, and piers shall proceed simultaneously and evenly on both sides of the structure. The differential in surface elevation of the backfill material on each side of the structure and individual component shall not be greater than 500 mm.

All voids around abutments, piers, or other permanent work shall be backfilled to the level of the surrounding ground or to the grade specified in the Contract Documents, whichever is the lower before the general backfilling commences.

When rock fill is to be placed around a structure the structure shall be protected to prevent damage from the rock fill.

The minimum height of fill specified in the Contract Documents shall be placed before traffic or construction equipment shall pass over the culvert.

Granular material shall be placed within the lines and grades specified in the Contract Documents.

Wall drains shall have a 0.05 m³ pocket of 19 mm minimum size clear stone wrapped in geotextile placed over the opening of the wall drain at the backfilled side of the wall.

902.07.06.02 Compaction

Backfill shall be placed according to OPSS 206, except the Modified Layer Compaction Method shall not apply, and compacted according to OPSS 501.

Only hand operated vibratory type compaction equipment shall be used for compaction of fill material within the restricted zone behind all earth retaining structures.

902.07.07 Clay Seal

When specified in the Contract Documents, clay seals shall be placed to the dimensions shown.

902.07.08 Inspection for Dewatering, Excavation and Backfilling

A Request to Proceed shall be submitted to the Contract Administrator prior to the commencement of dewatering of the excavation for the structure and completion of the excavation for the foundation.

The next operation after the completion of the excavation for the foundation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

A Request to Proceed shall be submitted to the Contract Administrator upon completion of the excavation for backfill and frost tapers and prior to the commencement of backfilling of excavation.

The next operation prior to the commencement of backfilling of excavation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

902.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

902.09 MEASUREMENT FOR PAYMENT

902.09.01 Actual Measurement

902.09.01.01 Excavation for Structure

Measurement of earth or rock excavation for structure shall be by volume in cubic metres.

Measurement of excavation for footings shall be based on the neat horizontal dimensions of the footing to the depth of the bottom of the footing, working slab, or granular pad.

Except as noted below, the quantity of excavation shall include only the quantities below the designated payment surface within the neat lines specified in the Contract Documents.

The above measurement also includes:

- a) Removal of asphalt pavement, except where there is a separate tender item for pavement removal that includes pavement overlapping the area of structure excavation.
- b) The excavation quantities, below the designated payment surface, required for placing granular backfill and granular frost tapers.
- c) For open footing culverts, the excavation quantities as measured below the designated payment surface but between the plan areas of the footings and above the stream bed or the tops of the footings, whichever is higher.

Where the structure excavation overlaps excavation required for other work, the measurement shall be made as specified in the Contract Documents with no deductions for overlap.

The volume of boulders in an excavation shall be calculated from the three maximum rectilinear dimensions. The following provisions shall apply:

- a) Only the amount removed shall be considered for payment.
- b) The volume of the boulders removed shall be deducted from the volume of excavation as calculated above.

The measurement of the total volume of materials considered for payment shall not exceed the calculated volume of excavation within the theoretical lines.

902.09.01.02 Granular Backfill

Measurement for payment of granular backfill shall be by volume in cubic metres or tonnes as specified in the Contract Documents.

The quantity of granular backfill and granular bedding shall include only those quantities measured below the subgrade and as measured within the theoretical line and grades specified in the Contract Documents.

Where the Contractor has excavated beyond the limits specified in the Contract Documents, the conversion factor of 2 t/m³ shall be used in measurement of the excess volume when it is replaced with granular on a tonne basis.

The weighing of granular material supplied on a tonnage basis shall be according to the Contract Documents.

902.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

902.10 BASIS OF PAYMENT

902.10.01 Earth Excavation for Structure - Item Rock Excavation for Structure - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract Administrator requests excavation for concrete working slabs, granular working pads, or granular bedding, payment shall be at the Contract price for the type of excavation required.

902.10.02 Dewatering Structure Excavations - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

902.10.03 Granular Backfill to Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material required to do the work.

When the Contract Documents do not include a separate item for granular backfill to structure, the Contract price for the items directly associated with the granular backfill to structure shall be full compensation for all labour, Equipment, and Material required to do the work.

902.10.04 Clay Seal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

902.10.05 Overexcavation

Payment shall not be made for overexcavation that has not been approved by the Contract Administrator or for backfill restoration of such overexcavation.



CONSTRUCTION SPECIFICATION FOR DEEP FOUNDATIONS

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903-A	Commentary

903.01	SCOPE

This specification covers the requirements for the supply and installation of deep foundation units.

903.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

903.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

903.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 909	Prestressed Concrete - Precast members
OPSS 911	Coating Structural Steel Systems

Ontario Provincial Standard Specifications, Material

OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

CSA Standards

G40.20-04/G40.21-04 (R2009)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
CAN3-056-1962(R2006)	Round Timber Piles
O80 Series-08	Wood Preservation
W47.1-03 (R2008)	Certification of Companies for Fusion Welding of Steel
W48-06	Filler Materials and Allied Materials for Shielded Metal Arc Welding
W59-03(R2008)	Welded Steel Construction (Metal Arc Welding)
W178.1-08	Certification of Welding Inspection Organizations
W178.2-08	Certification of Welding Inspectors

Canadian General Standards Board (CGSB)

48.9712-2006 Non-destructive Testing, Qualification and Certification of Personnel

ASTM International

A 252-98(2007) Welded and Seamless Steel Pipe Piles
A 328/A 328M-07 Steel Sheet Piling
D 1143/ D 1143M-07 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
D 3689-07 Standard Test Methods for Deep Foundations Under Static Axial Tensile Load
D 3966-07 Standard Test Method for Deep Foundations Under Lateral Loads

American Petroleum Institute (API)

API 13A Drilling Fluid Materials, 17th Edition, 10.00.08
RP 13B-1 Standard Procedure for Field Testing Water Based Drilling Fluids, 4th Edition,

Steel Structures Painting Council (SSPC)

SP10/NACE No.2-Jan. 1, 2001 Near-White Blast Cleaning

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025 General Requirements for the Competence of the Testing and Calibration Laboratories

903.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anvil means the component of a diesel hammer that acts as an impact block for the ram

Bedrock means a natural solid bed of the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin that may or may not be weathered.

Caisson Pile means a cast in place deep foundation unit with or without an enclosing liner formed by placing concrete in a bored or excavated hole.

Cap Block means a material placed on top of the helmet to cushion the blow of the hammer and to attenuate the peak impact energy without causing excessive loss of the impact energy.

Casing means open ended enclosing cylindrical steel tubing or pipe permanently installed in the ground. Casings are structurally required and can be used to stabilize and excavated hole.

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Deep Foundation Unit means a structural member, driven or otherwise, installed in the ground to transfer the loads from a structure to soil or rock and derives supporting resistance from the surrounding soil or rock or from the soil or rock strata below its tip or a combination of both.

Displacement Caisson Pile means a pile formed in the ground by driving a casing or liner with a concrete plug or an expendable metal plate attached to it and replacing the displaced soil with unreinforced or reinforced concrete.

Driven Pile means one of the following pile types: steel H, tube, or sheet piles; wooden pile; or precast reinforced concrete pile that has been installed by means of a pile driver.

Driving Shoe means reinforcement attached to the bottom of the pile and designed to protect the pile during driving or to penetrate into a hard stratum.

Driving to a Set means driving the pile to the requirement that satisfies pile driving criteria correlated to a required pile resistance.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Follower means a removable extension that transmits the hammer blows to the head of the pile.

Helmet means a formed steel cap that fits over the top of a pile head to retain in position a resilient cap block.

Jetting means the use of a jet of water at high pressure directed into the ground below the pile tip to assist its penetration

Liner means open ended enclosing steel tubing or pipe temporarily installed in the ground to facilitate the construction of caisson piles

Pile means a relatively slender structural element that is installed, wholly or partly in the ground by driving, drilling, auguring, jetting, or other means.

Pile Cap means a footing or some other structural component used to transfer the load to the piles as well as maintaining them in position.

Pile Cushion means a pad of resilient material placed between the helmet and the top of a precast reinforced concrete or wooden pile to minimize damage to the head during driving.

Pile Group means the piles supporting a pile cap.

Pumped Concrete means a method of transporting concrete through hose or pipe by means of positive and continuous pressure.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Ram means the moving or driving part of an air, steam, diesel, or drop pile hammer that delivers an impact blow to an anvil and to the pile.

Retapping means verifying that the specified resistance previously attained has been sustained by imparting appropriate hammer energy to the pile and monitoring pile penetration.

Rock Points means a specially designed steel tip fitted to piles to enable them to be driven into hard, sound sloped bedrock.

Sheet Pile means a pile that is designed to interlock with adjacent piles and form a continuous wall for the purpose of resisting mainly lateral forces and to reduce seepage.

Slurry means a drilling fluid, consisting of water mixed with one or more of various solids or polymers, used to maintain the stability of the side walls and bottom of an excavation.

Tremie means a hopper with a vertical pipe used for placing concrete under water. The foot of the pipe is always submerged in concrete except during commencement of concreting and the upper level of the concrete in the pipe is always above water level.

903.04 DESIGN AND SUBMISSION REQUIREMENTS

903.04.01 Design Requirements

903.04.01.01 Concrete

The Contractor is responsible for providing plastic concrete with suitable characteristics for installation. The concrete shall be flow able, non-segregating concrete that does not exhibit rapid slump loss.

903.04.02 Submission Requirements

903.04.02.01 General

All submissions shall bear the seal and signature of an Engineer experienced in the field of deep foundations.

When welded field splices are used, welding procedures according to the Canadian Welding Bureau shall be submitted to the Contract Administrator.

903.04.02.02 Preconstruction Survey

A condition survey of property and structures that may be affected by the work shall be submitted to the Contract Administrator prior to commencing the work. The survey shall include the locations and conditions of adjacent properties; buildings; underground structures; Utility services; and structures, such as walls abutting the site.

903.04.02.03 Materials

903.04.02.03.01 Mill Certificates

One copy of the mill certificates, indicating that the steel meets the requirements for the appropriate standards for H-piles, tube piles, casings, and sheet piles shall be submitted to the Contract Administrator at the time of delivery.

Where mill test certificates originate from a mill outside Canada or the United States of America, the information on the mill certificates shall be verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory.

903.04.02.03.02 Concrete

A suitable, site-specific concrete mix design that meets the requirements of the hardened concrete shall be submitted to the Contract Administrator 14 Days prior to construction, for information purposes only.

903.04.02.03.03 Slurry

The following shall be submitted to the Contract Administrator 14 Days prior to construction, for information purposes only:

- a) The type, source, and physical and chemical properties of the bentonite or polymer.
- b) The source of water.
- c) Method of mixing slurry.
- d) The water solids ratio and the mass and volumes of the constituent parts, including any chemical admixtures or physical treatment employed to produce slurry with the required physical properties.
- e) Details of procedure to be used for monitoring the quality of the slurry.
- f) A test report showing the properties of the slurry and certifying that the slurry meets the requirements of API RP 13B-1.
- g) Method of disposal of the slurry.

903.04.02.04 Installation

903.04.02.04.01 Driven Piles

The following shall be submitted to the Contract Administrator as least 14 Days prior to construction, for information purposes only:

- a) A schedule of work identifying time and sequence of activities.
- b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, and weight of ram.
- c) Working Drawings of precast concrete piles showing the pile dimensions, concrete strength, tendon arrangement, working stresses and arrangement of steel reinforcement, schedules, elongation calculations, method and sequence of casting, complete specifications and details of the prestressing steel, and lift anchors and lifting point locations.
- d) The method of maintaining the steel reinforcement cages in position, when steel reinforcement cages are used in tube piles.
- e) Procedure for monitoring pile installation.
- f) Details of the method of attaching proprietary driving shoes.
- g) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation and the details of the load application, components, equipment, testing apparatus, and method of monitoring.
- h) Information pertinent to establishing the resistance of a pile when the wave equation analysis method is used.

903.04.02.04.02 Caisson Piles

The following shall be submitted to the Contract Administrator at least 14 Days prior to construction, for information purposes only:

- a) A schedule of work identifying time and sequence of activities.
- b) Detailed procedures for caisson excavation in overburden and rock.

- c) Detailed procedures for casing and liner installation and for the withdrawal of the liner.
- d) Detailed procedures for slurry displacement method of excavation, including disposal of slurry upon completion.
- e) Detailed procedures for tremie concrete, including the size of tremie delivery pipe.
- f) Detailed procedure for placing concrete in the dry.
- g) Method of maintaining the steel reinforcement cages in position in the caisson.
- h) Details of filling the annular void around a casing.
- i) Details of procedure to be used for monitoring installation.
- j) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, details of the load application, components, equipment, testing apparatus, and method of monitoring.

903.04.02.04.02.01 Milestone Inspections

The Quality Verification Engineer shall witness the following interim inspections of the work for caisson piles:

- a) Excavation
- b) Steel reinforcement installation
- c) Placing of concrete

A copy of the written permission to proceed shall be submitted to the Contract Administrator prior to commencement of the next operation.

903.04.02.04.03 Displacement Caisson Piles

The following shall be submitted to the Contract Administrator as least 14 Days prior to construction, for information purposes only:

- a) A schedule of work identifying time and sequence of activities.
- b) Type of equipment, anvil, helmet, and hammer details, including the hammer energy assumed by the Contractor, stated potential energy (rated energy) of the hammer, operating efficiency, maximum stroke or drop, and weight of the ram.
- c) Details of procedures used for installation of displacement caisson piles, including detailed procedures for liner installation and withdrawal.
- d) Method of maintaining the steel reinforcement cages in position in the pile.
- e) Details of procedure to be used for monitoring pile installation.
- f) When load testing is specified in the Contract Documents, details of the full-scale test, including site preparation, and the details of the load application, components, equipment, testing apparatus, and method of monitoring.

903.04.02.04.04 Steel Reinforcement Cages

Working Drawings showing the fabrication details of the steel reinforcement cages, including the lifting points and lifting lugs, shall be submitted to the Contract Administrator at least 14 days prior to fabrication, for information purposes only.

903.04.02.05 Qualifications

Copies of the Canadian Welding Bureau's certification of the Independent Testing Company, the Non-destructive Testing Technician, and the Welding Inspector shall be submitted to the Contract Administrator at least 5 Days prior to the commencement of any non-destructive testing, for information purposes only.

903.04.02.06 Review of Splice Test Results and Permission to Proceed

Upon completion of the testing of the splices, the Quality Verification Engineer shall review all test results to verify that all the welds were done according to the welding procedures and Contract Documents and issue the Contractor written permission to proceed with the work.

903.05 MATERIALS

903.05.01 Wooden Piles

Wooden piles shall be according to CAN3-056 and shall be clean and peeled. Treated piles shall be pressure treated with creosote according to CAN/CSA-080.

Wooden piles shall be provided with collars sufficiently strong to prevent splitting of the head of the wooden pile during driving.

903.05.02 Steel Piles

903.05.02.01 H-Piles

Steel H-piles shall be according to CAN/CSA G40.20/G40.21, Grade 350 W.

903.05.02.02 Tube Piles

Steel tube piles shall be according to ASTM A 252, minimum Grade 2.

903.05.02.03 Sheet Piles

Steel sheet piles shall be according to ASTM A 328M.

903.05.02.04 Straightness Tolerance for Steel Piles, Casings, and Liners

Steel piles, casings, and liners shall conform to a straightness tolerance of 1.5 mm maximum per metre of length.

Steel sheet piles shall be sufficiently straight to prevent binding in the interlock during driving.

903.05.03 Driving Shoes and Rock Points

Rock points and driving shoes shall be as specified in the Contract Documents.

Driving shoes shall transfer the driving stresses to the pile over the full cross-sectional area of the pile.

Where precast concrete piles are driven into dense or hard material, a steel driving shoe cast into the concrete shall be provided.

Where wooden piles are driven into dense material, a steel plate driving shoe shall be provided to prevent damage to the bottom of the pile.

903.05.04 Casing for Caissons

Casings shall be according to ASTM A 252, Grade 2. If welded, they shall be welded by the electric arc method according to CSA W59.

The casing wall thickness specified is the minimum that shall be supplied. The wall thickness shall be increased as required to ensure the casing is not damaged during handling and installation.

903.05.05 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

903.05.06 Concrete

903.05.06.01 General

Concrete shall be according to OPSS 1350.

903.05.06.02 Tube Piles

Concrete shall have a slump of 150 to 180 mm.

903.05.06.03 Caisson Piles

Concrete shall have a slump of 150 to 180 mm. When approved by the Contract Administrator in writing, admixtures may be used. Where the liner is to be withdrawn, sufficient retarder shall be added to prevent arching of concrete during liner withdrawal and to prevent setting of concrete until after the liner is withdrawn.

903.05.07 Precast Concrete Piles

The production of precast reinforced concrete piles shall be according to OPSS 904, OPSS 905, and OPSS 909.

Steel reinforcement shall be placed such that direct loading during the ram stroke shall not occur.

Lifting anchors shall be at least 25 mm clear from reinforcement or prestressing steel in the pile.

Concrete in precast reinforced concrete piles shall be according to OPSS 1350 and have a nominal minimum 28-Day compressive strength of 45 MPa.

Concrete for precast reinforced concrete piles shall be cured according to OPSS 904.

Concrete for precast reinforced concrete piles shall be placed in smooth mortar-tight forms that are supported to prevent excessive deformation or settlement during placing or curing.

Unformed surfaces shall be finished smooth.

When removed from the form, the pile shall present true, smooth, even surfaces free from honeycombs and voids. The pile shall be straight so that a line stretched from butt to tip on any face shall not be more than 25 mm from the face of the pile at any point.

Each precast reinforced concrete pile shall have the date of manufacture (i.e., yyyy-mm-dd) inscribed on it.

903.05.08 Slurry

903.05.08.01 Solids

Bentonite and polymers shall be according to API Spec 13A.

903.05.08.02 Water

Water shall be according to OPSS 1302.

903.05.08.03 Slurry Composition

The slurry shall consist of a stable colloidal suspension of pulverized solids or polymers thoroughly mixed with water. The density, viscosity, sand content, and pH of the slurry being used during excavation shall be according to API RP 13B-1.

903.06 EQUIPMENT

903.06.01 Hammers

Hammers shall be capable of installing the piles, casings, and liners to the depth or resistance specified in the Contract Documents, without damage to the portions that are not cut off.

The hammer used to chisel the rock point into the rock shall be capable of delivering a controlled blow in 10% increments ranging in energy from zero to the maximum hammer energy.

For precast reinforced concrete piles, the heaviest hammer practicable shall be employed and the stroke limited so as not to damage the piles. When choosing the size of the hammer, consideration shall be given to whether the pile is to be driven to a resistance or to a given depth.

903.06.02 Helmets and Striker Plates

The head of steel piles shall be protected by a striker plate or a helmet. Helmets shall have adequate and suitable cushioning material. Helmets and striker plates shall distribute the blow of the hammer evenly throughout the cross-section of the pile head.

903.06.03 Leads

Pile driver leads shall be built to afford freedom of movement for the hammer and shall be held in position at the top and bottom by guys, stiff braces, or other approved means to ensure support of the pile, casing, or liner while it is being driven. Swinging leads shall not be permitted.

Batter piles, casings, or liners shall be driven with leads aligned parallel to the axis of the pile, casing, or liner. The leads shall be equipped with a fixed, rigid, adjustable kicker.

903.06.04 Followers

When use of followers are specified in the Contract Documents, followers shall be of type, size, shape, length, and weight as to permit driving the pile, casing, or liner at the location and to the required depth or ultimate resistance specified in the Contract Documents. The follower shall be provided with a socket or hood carefully fitted to the top of the pile, casing, or liner to minimize loss of energy and to prevent damage to the pile, casing, or liner, and shall have sufficient rigidity to prevent "whip" during driving.

When followers are permitted, an identical follower shall be used when the set is being determined.

903.07 CONSTRUCTION

903.07.01 Transporting, Storing, and Handling Piles, Casings, Liners, and Reinforcing Steel Reinforcement Cages

903.07.01.01 General

Piles, casings, liners, and steel reinforcement shall be transported, stored, and handled in such a manner that damage is prevented and the strength of the components is not affected by deterioration or deformation.

Components shall be lifted and placed using appropriate lifting equipment, temporary bracing, guys, or stiffening devices so that the components are at no time overloaded, unstable, or unsafe.

Material shall be supported to prevent unequal settlement when stacked.

903.07.01.02 Wooden Piles

Canthooks, dogs, pile pulls, or use of other lifting methods that might damage the integrity of the pressure treated surface shall not be used. Cuts or breaks in the surface of treated piling shall be given three brush coats of hot creosote oil. Bolt holes shall be treated with three applications of hot creosote oil applied with a bolt hole treater.

903.07.01.03 Handling Holes in Steel Piles

Unless otherwise approved by the Contract Administrator, holes shall only be made in the portion of the pile to be cut off or in the portion of the pile to be encased in concrete.

When other holes are approved to be cut in a pile they shall be covered by splice plates placed on both sides of the section. The thickness and the mechanical properties of the plate material shall be at least equivalent to the pile material.

903.07.01.04 Precast Reinforced Concrete Piles

Precast concrete piles shall be handled only from the designated lifting points.

When lifting or transporting precast reinforced concrete piles lift anchors, slings, or other approved means shall be used. Care shall be taken when lifting and transporting to avoid any overstressing of the pile or cracking of the concrete.

Precast reinforced concrete piles shall be so handled to avoid breaking or chipping their edges.

Lift anchors shall be removed and the holes filled with a non-shrink grout or epoxy installed according to the manufacturer's recommendations.

903.07.01.05 Caisson Casings and Liners

Casings and liners shall be handled and stored in such a manner to avoid damage or distortion to them. The casings and liners shall be maintained circular within $\pm 2\%$ of the casing or liner diameter.

903.07.02 Driven Piles

903.07.02.01**Pile Driving Requirements and Restrictions**

Piles shall not be driven until embankment work or excavation work has been completed to the underside of the footing. When driving of the piles is completed, all material between the piles shall be removed to the correct elevation and any holes or voids created shall be filled to the correct elevation with compacted material approved by the Contract Administrator.

Piles shall be installed at the locations specified in the Contract Documents and to the set or depth specified without being damaged. Damage to the pile, casing, or liner during driving shall be prevented by limiting the drop or energy and number of blows of the hammer. The hammer, helmet, cap block, striker plate, and pile shall be coaxial and shall sit squarely upon each other.

A shorter stroke shall be used and proper precaution shall be taken when there is a danger of damaging or over driving the piles, casing, or liners under conditions such as:

- a) In the early stages of driving a long pile where a hard layer near the ground surface has to be penetrated.
- b) Where there is very soft material of a considerable depth and a large penetration is achieved at each hammer blow.
- c) Where it is anticipated the pile shall meet refusal on rock or other impenetrable soil.
- d) When piles are driven onto sloping bedrock.

Damage to adjacent structures, Utilities, and fresh concrete shall be prevented during pile installation. Piles shall not be driven within a radius of 8 m of concrete that has been in place for less than 72 hours. Piles shall not be driven within a radius of 15 m of concrete that has been in place for less than 72 hours without the approval of the Contract Administrator.

The tops of all piles shall be either square to the longitudinal axis of the pile or horizontal as indicated in the Contract Documents.

Piles shall not be forced into their proper position by the use of excessive manipulation. Pile damage due to excessive driving shall be avoided.

903.07.02.02**Driving Shoes and Rock Points**

Driving shoes and rock points shall be installed in locations specified in the Contract Documents.

Driving shoes shall be welded in accordance with the Contract Documents.

When driving shoes are specified in the Contract Documents, the Titus H bearing pile point or APF Hard Bite, standard model, may be substituted for the driving shoes.

When Oslo points are specified in the Contract Documents, the Titus H bearing pile point or APF, rock injector model, may be substituted for the pile points.

Where proprietary driving shoes are used, they shall be welded or otherwise attached to the driven piles according to the manufacturer's specifications.

903.07.02.03**Splicing****903.07.02.03.01****General**

Any damaged material shall be cut-off prior to splicing.

903.07.02.03.02 Wooden Piles

Wooden piles shall not be spliced.

903.07.02.03.03 H-Piles, Tube Piles, and Sheet Piles

Welding shall be according to CSA W59 and shall be done by a qualified welder employed by a firm certified according to CSA W47.1, Division 1 or Division 2.1.

Steel H-piles and steel tube piles may be spliced providing the pieces being spliced are not less than 3 m long. Splices in marine structures shall be located below the low water level, unless otherwise encased in concrete.

Sheet piles shall not be spliced without approval by the Contract Administrator.

903.07.02.03.04 Precast Reinforced Concrete Piles

Precast reinforced concrete piles shall only be spliced when specified in the Contract Documents and the splices shall only be made with approved mechanical splicing devices.

903.07.02.04 Concrete in Steel Tube Piles

Concrete in steel tube piles shall be placed according to OPSS 904.

903.07.02.05 Cutting Off Piles

903.07.02.05.01 General

Driven piles shall be cut to the elevation as specified in the Contract Documents.

The length of pile supplied shall be sufficient to ensure there is no damaged material below the cut off. Damaged material at the pile head shall be cut off.

Piles shall not be cut off until retapping, redriving, and specified load testing are complete.

903.07.02.05.02 Wooden Piles

Where wooden piles are broomed, splintered, or otherwise damaged below the cut-off elevation, the pile shall be considered defective and shall be replaced.

903.07.02.06 Protective Coating for Steel H and Steel Tube Piles

Exposed steel H and steel tube piles shall have a coal tar epoxy protective coating applied from an elevation 600 mm below the low water level or finished ground surface up to the top of the exposed steel.

The steel surfaces shall be cleaned according to SSPC-SP10 prior to application of a coal tar epoxy system that shall be according to OPSS 911.

903.07.02.07 Monitoring Driven Piles

903.07.02.07.01 General

The driving of piles shall be carefully monitored and controlled and pile driving records produced for each pile. The QVE or an individual under the direct supervision of the QVE shall verify the work.

Piles shall not be overdriven. When driving to a specified ultimate resistance, driving to a set or driving to bedrock, the piles shall be driven to the anticipated tip elevation. The Contract Administrator shall be notified if

the piles do not reach set at the anticipated tip elevation, .

In soils where there is a possibility of piles moving upward due to ground heave, elevations of completed pile tops shall be measured at intervals while nearby piles are being installed. The readings shall be recorded and submitted to the Contract Administrator as the work proceeds.

903.07.02.07.02 Driving to a Specified Elevation

Piles shall be driven to an elevation specified in the Contract Documents. Driving piles to other elevations shall only be done when approved in writing by the Contract Administrator.

903.07.02.07.03 Driving to a Specified Ultimate Resistance

903.07.02.07.03.01 General

The Quality Verification Engineer shall establish the reference set used to determine ultimate resistance and measure and record the set for individual pile acceptance.

The set and rebound measurements shall be obtained by the Quality Verification Engineer. The Quality Verification Engineer shall determine the measured ultimate resistance and verify that the design ultimate resistance has been achieved.

903.07.02.07.03.02 Driving to a Set

The founding elevation shall be established by driving to a set determined in accordance with the dynamic formula specified in the Contract Documents or by the application of the wave equation analysis procedure that verifies the pile resistance. This set shall be established on the first pile of every ten piles driven in a pile group.

The other piles shall be controlled by the pile penetration rate in blows per millimetre that correlates to the set.

When new conditions, such as change in hammer size, change in pile size, or change in soil material occur, new sets shall be determined.

903.07.02.07.03.03 Driving to Bedrock

When driving piles to bedrock, the pile shall be adequately seated on bedrock without damaging the pile.

Where rock points are used, the rock points shall penetrate into the rock. Piles driven using rock points shall be driven to ensure adequate seating on the bedrock without damaging the pile.

Driving of piles on sloping bedrock shall be stopped when initial contact is made with the bedrock. The bedrock elevation shall be recorded. Driving shall then continue, commencing with energy of 10% of the maximum energy of the hammer. The pile shall be driven in sets of 20 blows at this energy until no penetration is observed. Twenty additional blows shall be applied, and, if no penetration is observed, the energy shall be increased by an additional 10% and the above procedure repeated.

Driving shall continue with these stepped increases in energy and with the same series of blows as described above, until the pile has been seated on the bedrock.

If unrealistic excessive penetration per blow is observed, driving shall be stopped and this excessive penetration immediately reported to the Contract Administrator.

The Quality Verification Engineer shall determine when the hammer energy can be increased and when the driving is complete for each pile.

903.07.02.07.04 Wave Equation Analysis

When requested by the Contract Administrator, all equipment, material, and personnel shall be supplied to conduct the wave equation analysis procedure. The Quality Verification Engineer shall review the results of the analysis.

903.07.02.07.05 Hammer Performance

When requested by the Contract Administrator, the hammer performance using the pile driving analyzer or other approved equivalent shall be verified in the presence of the Contract Administrator. Hammer performance shall be verified to ensure that the actual potential energy (rated energy) is not less than 90% of the stated potential energy. All instrumentation, access, and assistance for the testing and monitoring as directed by the Contract Administrator shall be provided.

903.07.02.07.06 Retapping Tests on Piles

In each pile group, 10% of the piles rounded up to the next whole number, but no fewer than two piles, shall be retapped no sooner than 24 hours after installation of the individual pile to confirm that the ultimate axial resistance has been sustained.

Retapping of piles driven to bedrock is not required.

903.07.02.07.07 Retapping and Redriving Piles

When the retapping tests indicate that the ultimate axial resistance has not been achieved on any one pile, all piles in the group shall be retapped.

Where the retapping reveals that the ultimate axial resistance of the piles has not been achieved, the piles that have not achieved the ultimate axial resistance shall be redriven to the specified resistance.

Where piles have risen, the piles shall be redriven to the original depth.

903.07.02.08 Jetting

Jetting shall be carried out in such a manner that the resistance of the piles already in place and the safety of adjacent structures shall not be impaired. Jetting shall be stopped at least 1 m above the final expected pile-tip elevation and at least 1 m above the tip elevation of any piles previously driven within 2 m of the jet. Where piles are to be end bearing on rock, jetting may be carried to the rock surface.

The driving and jetting of precast reinforced concrete piles shall not be carried out simultaneously.

903.07.03 Caisson Piles

903.07.03.01 General

Caissons shall be constructed as specified in the Contract Documents.

The final bearing elevation shall be as specified in the Contract Documents or as determined by the Contract Administrator. When permanent casings are not specified, the caisson shall be constructed in a drilled hole with or without the use of a temporary liner or slurry as determined by the Contractor.

903.07.03.02 Excavation

903.07.03.02.01 General

Sidewall stability shall be maintained throughout the excavation and concrete placement operation. Soil

cave-in into the excavation hole shall be prevented.

The bottom of the excavation shall be cleaned before the start of concrete placement.

Excavation methods shall be such that the sides and bottom of the hole are straight and free of loose material that might prevent intimate contact of the concrete with undisturbed soil or bedrock.

Except when founded on sloping rock, the caisson bottom shall be level. On sloping rock, the caisson bottom may be stepped, with each step not greater than $\frac{1}{4}$ the diameter of the bearing area.

903.07.03.02.02 Casings

When an auger is used to excavate for a casing, the diameter of the auger shall be no greater than the outside diameter of the casing.

903.07.03.02.03 Liners

The diameter of the excavation for the installation of liners shall not exceed the diameter of the liner by more than 150 mm.

903.07.03.02.04 Slurry Method

The level of slurry in the excavation shall be sufficient to prevent the intrusion of water and to maintain a stable wall with no cave-in, sloughing, or basal heave.

Slurry shall be tested as specified in API RP 13B-1. All test equipment required for the tests shall be provided. A slurry sampler capable of obtaining samples at any depth within the caisson hole shall be available at all times.

At least 1 set of tests shall be completed every 4 hours during the slurry operation. Samples shall be taken from the mud tank and from within the caisson at a depth within 300 mm of the bottom.

903.07.03.03 Inspection of the Excavation

The bottom of excavations shall be visually inspected.

903.07.03.04 Dewatering

Where dewatering is required, a dewatering scheme shall be employed in such a manner as to prevent any disturbance to the base founding material. The dewatering shall not create subsidence or cause ground loss that may adversely affect the work or adjacent structures.

903.07.03.05 Backfilling Liners Left in Place

The annular space between a liner permanently left in place and shaft excavation shall be filled with concrete or fluid grout.

903.07.03.06 Steel Reinforcement

Steel reinforcement steel shall be installed according to OPSS 905. Steel reinforcement cages shall be checked to ensure conformance to the Working Drawings prior to installation and during placement of concrete.

The steel reinforcement cage shall be fabricated in one piece.

Welding of steel reinforcement and use of splices shall not be done unless specified in the Contract

Documents.

The steel reinforcement shall not be displaced or distorted during the construction of the caisson.

903.07.03.07 Concrete

903.07.03.07.01 General

Concrete shall be placed in the caisson according to OPSS 904 and as specified herein. Concrete shall be placed immediately following interim inspection of the caisson hole by the Quality Verification Engineer.

The reinforcement shall not be displaced or distorted during the construction of the caisson.

Arching of concrete during casing withdrawal shall be prevented.

903.07.03.07.02 Concrete Placed in the Dry

The concrete may be placed free fall provided the fall is vertically down the centre of the opening and transverse ties, spacers or other objects do not impede the free fall. In the event of interference with the concrete free fall, an elephant trunk or other means shall be used to prevent concrete segregation.

Concrete shall be placed in a continuous operation from the bottom to the top of the caisson or, where columns are cast integral with the caisson, to the elevation of the bottom of the column steel reinforcement cage. The concrete shall be vibrated for the last 1.5 m of the pour.

903.07.03.07.03 Concrete Placed Under Water or Under Slurry

Tremie or pumped concrete shall be carried out in one continuous operation. The tremie or pumping operation shall be a continuous flow of concrete that prevents the inflow of water or slurry.

Where tremie concrete is to be placed in a caisson under water, the Contractor shall maintain an adequate head of water within the excavations to prevent the inflow of water through the base or walls of the caisson as the concrete is being placed.

Where tremie is placed under slurry, the caisson shall be filled with concrete entirely by tremie and the method of deposition shall not be changed part way up the caisson.

When concrete placement is not started within 6 hours of acceptance of the excavation, the excavation shall be redrilled, cleaned, and the slurry tested before concrete placement commences.

903.07.03.07.04 Withdrawal of Liners

Arching of concrete during withdrawal of the liner shall be prevented.

During withdrawal, the bottom of the liner shall have a minimum embedment into the concrete being placed and a sufficient head of concrete shall be maintained above the bottom of the liner at all times to prevent intrusion of soil and water into the hole.

During withdrawal, upward or downward movement of the steel reinforcement shall be monitored. Upward or downward movement shall be restricted to 150 mm.

A theoretical concrete level shall be calculated based on the quantity of concrete placed and the caisson dimensions, and this theoretical level shall be compared to the actual level of concrete in the caisson to provide a check for possible separation of shaft concrete during liner withdrawal.

903.07.03.07.05 Founding Elevation

The final founding elevation shall be as specified in the Contract Documents or an elevation approved in writing by the Contract Administrator. When casings are not specified in the Contract Documents, the caisson shall be constructed in a drilled hole with or without the use of a liner or slurry as determined by the Contractor.

Except when founded on sloping unweathered bedrock, the caisson bottom shall be level. On sloping unweathered bedrock, the caisson bottom may be stepped, with each step not greater than one quarter the diameter of bearing area.

The bearing area of the caisson pile shall be approved by the Quality Verification Engineer prior to placing concrete.

903.07.04 Displacement Caisson Piles

Work shall be carried out in accordance with the displacement caisson pile suppliers' installation procedures. A permanent liner shall be used when specified in the Contract Documents.

The sequence of installation shall be such as to prevent damage to any recently completed piles.

The pile shall not be founded above or below the specified pile tip elevation without approval in writing from the Contract Administrator.

The QVE or an individual under the direct supervision of the QVE shall verify the installation of displacement caisson piles.

903.07.05 Tolerances

903.07.05.01 Driven Piles

- a) Cut-off elevation ± 25 mm.
- b) Deviation from vertical not more than 1H:50V, except in the case of a pile cap or footing supporting only a single row of piles the deviation shall not be more than 1H:75V in the direction of the span.
- c) The deviation from the specified inclination for battered piles shall not exceed 1H:25V.
- d) The centre of the pile at the junction with the pile cap shall be within 150 mm measured horizontally of that specified except in the case of a pile cap or footing supported on a single row of piles the deviation shall not be more than 75 mm measured horizontally in the direction of the span.

903.07.05.02 Caissons and Displacement Caisson Piles

- a) Cut-off elevation ± 25 mm.
- b) Horizontal location at cut-off not more than 5% of shaft diameter or 75 mm, whichever is less.
- c) Vertical alignment not more than 2% of the caisson length from vertical for vertical caissons, or 2% of the caisson length from the specified inclination for battered caissons.

903.07.06 Load Test

When a load test is specified in the Contract Documents, the testing shall be according to ASTM D 1143M for piles under vertical static load, ASTM D 3689 for piles under tensile load, and ASTM D 3966 for piles under lateral loads. The Quality Verification Engineer shall witness the pile load test. All records and results of the

pile load test attached with the Certificate of Conformance shall be submitted to the Contract Administrator.

All necessary personnel, equipment, and material to make adjustments during the tests shall be provided and at least one skilled worker shall be present for the complete duration of each test. This worker shall have demonstrated experience in load testing of piles.

The following shall be provided for the duration of all testing:

- a) A level dry working area at the test location
- b) An adequate enclosure sufficient to provide complete protection from adverse weather conditions
- c) All temporary work required to obtain access to the site for the personnel, equipment, and materials.

Upon completion of the tests, the site shall be cleared and restored to the satisfaction of the Contract Administrator. Piles that are not part of the finished work shall be cut off 1.2 m below ground level or 0.6 m below stream bed level. Any resulting void shall be backfilled with suitable fill material.

903.07.07 Repair of Welds

Any section of weld that does not meet the requirements of the Contract Documents shall be removed and rewelded.

903.07.08 Quality Control

903.07.08.01 Inspection and Testing of Welds

903.07.08.01.01 Qualifications of Companies and Individuals

An independent testing company with no corporate affiliation with the Contractor shall be employed to carry out the non-destructive testing of welds. The independent testing company shall be certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for bridge structures by radiographic or ultrasonic test methods.

Testing shall be done by a non-destructive testing technician employed by an independent testing company. The non-destructive testing technician shall have documented evidence of training and professional knowledge, skill, and experience in non-destructive testing of structural steel welds and material and have a valid certificate showing qualification to a Level II or III according to CAN/CGSB-48.9712 and the Canadian Welding Bureau for the non-destructive testing specified.

Visual inspections shall be performed by a welding inspector employed by an independent testing company. The welding inspector shall have documented evidence of training, professional knowledge, skill and experience in the visual inspection of structural steel welds and material, and have a valid certificate showing qualification to Level II or III according to CSA W178.2.

903.07.08.01.02 Visual Inspection of Welds

A representative sample of not less than 30% of the welds, as determined by the Quality Verification Engineer, shall be visually inspected for conformance to the requirements of CSA W59, the Contract Documents, and the Working Drawings.

903.07.08.01.03 Non-Destructive Testing of Welds

Radiographic or ultrasonic testing shall be carried out using procedures according to CSA W59.

Ultrasonic or radiographic testing shall be carried out on the entire length of selected splice welds chosen at

random by the Quality Verification Engineer or the Welding Inspector assigned to carry out visual inspection.

Selection shall be based on the following criteria:

- a) For pile groups other than at integral abutments, 10% of the splice welds, rounded to the next highest number, but no fewer than two.
- b) For pile groups at integral abutments, 10% of the splice welds, rounded to the next highest number, but no fewer than two of when the welds are below 6 m of the pile cut-off elevation.
- c) For pile groups at integral abutments, all splice welds within 6 m of the pile cut-off elevation.

903.07.08.01.04 Repaired Welds

All welds that have been repaired shall be visually inspected and shall undergo non-destructive testing.

903.07.08.02 Non-Destructive Test Reports and Visual Inspection Reports

Within 7 Days from completion of the inspection and testing, two copies of all inspection and testing reports shall be submitted to the Contract Administrator, for information purposes only.

903.07.08.03 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the deep foundation work. The Certificate of Conformance shall be sealed and signed by the Quality Verification Engineer and shall state that the deep foundation work has been carried out in general conformance with the Contract Documents and Working Drawings. The Certificate of Conformance shall also certify that the interim milestone inspections have been completed as specified.

When the specified horizontal tolerances are not achieved, the process for "Non-Conforming Work by the Contractor" as specified elsewhere in the Contract Documents shall be followed unless the pile discrepancies are minor and do not require a detailed design evaluation.

For these minor cases, a proposal for an amendment to the Contract Documents stating that the pile discrepancies are minor and do not require detailed design evaluation shall be submitted to the Contract Administrator for acceptance.

The proposal shall be signed by an Engineer and shall be accompanied by a drawing containing the following information:

- a) Specified pile locations;
- b) Actual pile locations; and
- c) Proposed adjustments to the footing and reinforcement.

903.09 MEASUREMENT FOR PAYMENT

903.09.01 Actual Measurement

903.09.01.01 H-Piles, Tube Piles, Wooden Piles, and Precast Reinforced Concrete Piles

Measurement of piles shall be by length in metres of the piling left in place after cut-off.

903.09.01.02 Sheet Piles

Measurement of sheet piles shall be by area in square metres based on the driving lines specified and the length of piling left in place after cut-off.

903.09.01.03 Driving Shoes

For measurement purposes, a count shall be made of the number of drive shoes used.

903.09.01.04 Rock Points

For measurement purposes, a count shall be made of the number of rock points used.

903.09.01.05 Caissons and Displacement Caisson Piles

Measurement of caissons and displacement caisson piles shall be by length in metres of the depth along the centreline between the approved bearing surface at the bottom and the specified elevation at the top.

903.09.01.06 Retapping Piles

For measurement purposes, a count shall made of the number of piles retapped above and beyond the minimum number described in the Retapping Tests on Piles clause.

Piles retapped as part of the minimum number required for the retapping tests described in the Retapping Tests on Piles clause shall not be measured for payment.

903.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

903.10 BASIS FOR PAYMENT

**903.10.01 Supply Equipment for Installing Driven Piles - Item
Supply Equipment for Installing Caisson Piles - Item
Supply Equipment for Installing Displacement Caisson Piles - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material required to do the work.

For payment purposes, 50% of the work under this item is completed when the satisfactory performance of the equipment has been demonstrated to the Contract Administrator by the installation of 1% of piles. The remaining 50% shall be paid on the satisfactory completion of the installation of piles.

When the hammer performance is requested to be verified, such verification shall be completed at no extra cost to the owner when the energy delivered is less than 90% of the stated potential energy (rated energy) specified in the submission.

When the energy is equal to or greater than 90% of the stated potential energy stated in the required submission, the cost verifying the hammer performance shall be administered as a Change in the Work.

**903.10.02 H-Piles - Item
Tube Piles - Item
Precast Concrete Piles - Item
Wood Piles - Item
Displacement Caisson Piles - Item**

Caisson Piles - Item
Driving Shoes - Item
Rock Points - Item
Sheet Piles - Item
Load Test - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Payment for redriving piles shall be at the Contract price for the applicable tender item above.

When the Contractor substitutes driving shoes or Oslo points with Titus H bearing pile points, the cost of such substitutions shall be at no extra cost to the Owner.

903.10.03 Retapping Piles - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Retapping the minimum specified number of piles for retapping tests shall include all labour, Equipment, and Material to do the work and shall be included in the Contract price for the appropriate pile tender item.

Where additional retapping is required, payment shall be made based on the ratio of the number of piles retapped in a pile group above the minimum requirement, up to the total number of piles in that pile group, times the tender price for retapping all piles for that pile group.

Appendix 903-A, April 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONCRETE STRUCTURES

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904.01 SCOPE

This specification covers the requirements for the construction of concrete structures.

904.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 905	Concrete Reinforcement
OPSS 908	Metal Traffic Barriers and Metal Railings for Structures
OPSS 919	Formwork and Falsework
OPSS 920	Deck Joint Assemblies, Waterstops, Joint Fillers, Joint Seals and Joint Sealing Compounds - Structures
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation - Concrete Patches and Overlays
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1202	Bearings - Elastomeric Plain and Steel Laminated
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-413	Method of Test for Non-Volatile Content of Chemical Admixtures, Latex Admixtures and Curing Compounds
LS-414	Method of Test for Relative Density of Chemical Admixtures, Air Entraining Admixtures, Latex Admixtures and Curing Compounds
LS-416	Method of Test for Settling Rate - Curing Compound

CSA Standards

G30.18.09 (R2018)	Carbon Steel Bars for Concrete Reinforcement

ASTM International

A 955M/A 955M-16a	Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
C 171-16	Sheet Materials for Curing Concrete

American Association of State Highway and Transportation Officials (AASHTO)

M 182-05 (2017)	Standard Specification for Burlap Cloth Made from Jute or Kenaf

904.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bridge means a structure that is greater than 3 m in span that provides a roadway, carriageway, or walkway for the passage of vehicles or pedestrians or both across an obstruction or gap or facility.

Cold Joint means the interface surface other than at a formed joint that occurs when plastic concrete is placed against concrete that has taken its initial set.

Cold Weather means those conditions when the ambient air temperature is at or below 5 °C. It is also considered to exist when the ambient air temperature is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Concrete Toe Wall means a low unreinforced concrete gravity type retaining wall no greater than 2 m in height.

Construction Joint means the surface where two successive placements of concrete meet or where new concrete is placed against old concrete across which it is desirable to achieve bond between the two concrete placements and through which steel reinforcement may be continuous.

Culvert means a structure that provides an opening through an embankment and in which roadway loads are distributed to the structure through fill or that is designated as a culvert in the Contract Documents.

Designated Limits means the dimensions of the component as shown on the Contract Drawings or the limits of the component as revised in the field in writing by the Contract Administrator.

High Performance Concrete (HPC) means concrete with a minimum specified 28-Day compressive strength of at least 50 MPa that includes silica fume and may include other supplementary cementing materials and having a specified rapid chloride permeability at 28 to 32 Days of 1,000 coulombs or less.

Honeycombing means rough and stony concrete surface with voids where the mortar did not fill the spaces between the coarse aggregate particles.

Reinforcing Steel Bars means deformed steel bars made of carbon steel as defined in CAN/CSA G30.18, used for the reinforcement of concrete.

R Value means the metric thermal resistance value that is a measurement of the resistance to heat transfer of insulation.

Segregation means visible separation of the mortar and coarse aggregate particles in the plastic concrete resulting in concrete that is not uniform in appearance or proportions.

Stainless Steel Reinforcing Bars means deformed stainless steel bars as defined in ASTM A 955 used for the reinforcement of concrete.

Steel Reinforcement means all types of steel reinforcement for concrete, including reinforcing steel bars, stainless steel reinforcing bars, splice bars, welded steel wire fabric, and prestressing strands and bars.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings. For the purposes of this specification, a working slab is not considered a structural component.

Tremie means a hopper with a vertical pipe extending from the bottom of the hopper to the lowest point of concrete deposit, used to place concrete under water.

904.04 DESIGN AND SUBMISSION REQUIREMENTS

904.04.01 Submission Requirements

904.04.01.01 Request to Place Structural Concrete

Prior to each placement of concrete operation, a Request to Place Structural Concrete form accompanied with all supporting documentation as specified on the form, shall be submitted to the Contract Administrator.

The placement of concrete shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

904.04.01.02 Bridge Deck Placement Plan

A work plan shall be submitted to the Contract Administrator a minimum of seven Days prior to commencement of placing concrete in bridge decks, for information purposes. The work plan shall include:

- a) The proposed methods and sequence of placing operations to be used.
- b) Complete details of all equipment to be used during the concrete placement.

904.04.01.03**Temperature Control Plans**

A temperature control plan shall be submitted to the Contract Administrator a minimum of seven Days prior to commencement of placing any concrete that requires temperature control for review of compliance with the requirements as specified in the Contract Documents.

The plan shall include methods for monitoring and controlling concrete temperature and the temperature difference prior to, during, and after placement for:

- a) Concrete subject to cold weather.
- b) HPC.
- c) Bridge decks.
- d) Large concrete components where the smallest dimension is 1.5 m.

The temperature control plan shall include, as a minimum, the following:

- a) Concrete element for which the plan applies.
- b) Temperature monitoring system, including the locations and depths, number of thermocouples, and frequencies of recordings to be used in each placement.
- c) Method of ensuring concrete temperature and temperature difference are maintained for the duration of the protection period.
- d) Any alterations to work schedule, production, delivery schedule, and time of placement for temperature control purposes.
- e) Any modification to mix design for temperature control purposes.
- f) Any other specific measures to be taken.
- g) Method of withdrawal of protection.

In addition, for concrete subject to cold weather the temperature control plan shall also include the following:

- a) Type of insulation, R value and number of layers, including test data verifying the R value. The submission for cold weather protective measures shall be accompanied by samples of insulation, if requested by the Contract Administrator.
- b) Type and layout of heaters and type and extent of housing.

904.04.01.04**Curing Compound**

A minimum of seven Days prior to the application of the curing compound, the following shall be submitted to the Contract Administrator, for information purposes:

- a) Literature stating the manufacturers recommended rate of application.
- b) Description of the equipment to be used.
- c) A statement from the manufacturer of the curing compound approving the equipment.

904.04.01.05 Approach Slab Seat Elastomers and Ballast Wall Elastomers

A copy of the manufacturer's certificate verifying compliance with OPSS 1202 shall be submitted to the Contract Administrator prior to installation of the approach slab seat elastomer or ballast wall elastomer or both.

904.05 MATERIALS

904.05.01 Concrete

Concrete shall be according to OPSS 1350.

904.05.02 Portland Cement

Portland cement shall be according to OPSS 1301.

904.05.03 Sand

Sand shall be according to OPSS 1002.

904.05.04 Bonding Agents

Bonding agent shall consist of Portland cement, Type GU, and sand in the ratio of 1:1 by volume and sufficient water to produce a consistency so that it can be applied with a stiff brush to the existing concrete in a thin even coating that shall not run or puddle.

904.05.05 Mortar

Mortar shall be a 2:1 mixture by volume of sand and Portland cement, Type GU, and shall contain 12% entrained air with water sufficient to make a stiff mix.

904.05.06 Burlap

The burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

904.05.07 Water

Water used for curing and fog misting of concrete, including pre-soaking of burlap, and for making bonding agents and mortar and mixing proprietary patching materials shall be according to OPSS 1302.

904.05.08 Moisture Vapour Barrier

The material shall be a white opaque polyethylene film according to ASTM C 171, at least 100 µm thick.

904.05.09 Curing Compound

Curing compound shall be according to OPSS 1315.

904.05.10 Approach Slab Seat Elastomers and Ballast Wall Elastomers

Elastomers delivered to the site shall exceed the required length to allow for a 600 mm test sample to be taken from the approach slab seat or ballast wall elastomers on each structure.

The elastomer shall be according to the plain bearing requirements of OPSS 1202.

904.05.11 Insulation Material

Insulation material shall be mineral wool, glass fibre, plastic foam or other suitable material, having an R value not less than 0.02 m² C/W per 1 mm thickness.

Straw insulation shall not be used. Loose or absorbent insulation material shall not be used, unless it is completely contained within waterproof wrapping.

904.06 EQUIPMENT

904.06.01 General

Equipment made of aluminium material shall not come in contact with the plastic concrete.

904.06.02 Concrete Pump

The concrete pump shall be a reciprocating pump equipped to fit a pipeline at least 100 mm in diameter.

904.06.03 Consolidating Equipment

Internal vibrators shall be of the high frequency type with 8,000 minimum to 12,000 maximum vibrations per minute when immersed in concrete.

External vibrators shall have a minimum frequency of 3,600 vibrations per minute.

904.06.04 Mixer for Bonding Agents

The mixer for the bonding agent shall be a stationary mixer, power driven, and capable of uniformly mixing the materials.

904.06.05 Bridge Deck Finishing Machine

The bridge deck finishing machine shall:

- a) Be self-propelled and capable of forward and reverse movement under positive control.
- b) Be fitted with wheels that travel on adjustable screed rails.
- c) Be fitted with a reversing rotating cylinder screed capable of finishing the concrete without subsequent hand finishing.
- d) Be fitted with a reversing screw power auger.
- e) Be capable of externally vibrating the surface of the concrete by means of a plate or roller.
- f) Be fitted with a means to raise all screeds to clear the screeded surface and to accurately reposition them without adjusting the legs.
- g) Have adjustable legs fitted with locking devices.

904.06.06 Screed Rails

The rails shall be made of metal and be straight to within 3 mm in a 3 m length. Screed rail chairs shall be adjustable in height, made of metal, and spaced at a maximum of 1.2 m and be placed under all rail joints. Maximum deflection of the screed rails under load shall be 2 mm in a 1.2 m length.

904.06.07 Work Bridges

Work bridges shall be provided to facilitate surface finishing of unscreeded areas, corrections to surface finish, concrete inspection, and placing of curing materials.

Work bridges shall ride on the screed rails and the top surface of a work bridge shall not be higher than 1.0 m above the finished surface.

904.06.08 Hand Finishing Tools

Floats shall be made of magnesium or wood. Magnesium bull floats shall be commercially made.

904.06.09 Straight Edges

Two straight edges commercially made of metal, one 3 m and one 500 mm long shall be used.

904.06.10 Tremie

The tremie shall be equipped with a foot valve at the bottom of the pipe. The pipe shall have a 300 mm $\pm$ 50 mm inside diameter and shall be long enough to extend to the lowest point of concrete deposit.

904.06.11 Spray Equipment for Curing Compound

The curing compound shall be applied to the concrete surface by means of motorized spraying equipment approved by the manufacturer of the curing compound. The equipment shall include a mechanical agitator.

904.06.12 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/minute. The compressed air shall be free of oil or other contaminants.

904.07 CONSTRUCTION

904.07.01 Formwork and Falsework

Formwork and falsework shall be according to OPSS 919. Textile form liners shall not be used.

904.07.02 Steel Reinforcement, Mechanical Connectors, and Associated Hardware

Steel reinforcement, mechanical connectors, and associated hardware shall be according to OPSS 905.

Where the superstructure is continuous over a support, all the deck steel reinforcement shall be placed in the entire deck prior to any concrete is placed. This requirement does not apply to the bottom slab of post-tensioned decks with trapezoidal voids.

904.07.03 Deck Joint Assemblies and Joint Material

Deck joint assemblies, joint fillers, joint seals, joint sealing compounds, and external waterstops shall be according to OPSS 920.

904.07.04 Preparation for Concrete Placement

904.07.04.01 General

All concrete surfaces against which new concrete is to be placed, including formed and sawcut surfaces, shall be clean, solid, and free from loose or unsound fragments, coatings, and any other foreign substances or debris and shall be sufficiently rough to ensure that a full bond is developed with the new concrete. The concrete surface shall be uniformly roughened to a surface profile of 5 ± 2 mm by means of methods such as scabbling, chipping, or bush hammering to expose the aggregates across the entire surface. Roughening is not required for the vertical faces of slope paving or for new concrete substrate with a roughened finish imparted at the time of placement meeting the profile requirement.

904.07.04.02 Abrasive Blast Cleaning

The following surfaces shall be abrasive blast cleaned according to OPSS 929:

- a) All existing steel reinforcement that shall be incorporated into the rehabilitation of a concrete structure component.
- b) All surfaces of existing structural steel against which new concrete shall be placed for the rehabilitation of a concrete structure component.
- c) All new or existing concrete surfaces against which new concrete shall be placed.

904.07.04.03 Cleaning

All concrete and structural steel surfaces against which new concrete is to be placed shall be cleaned by power washing no more than 24 hours prior to placing concrete.

904.07.04.04 Pre-Wetting

All concrete surfaces to receive concrete shall be maintained in a wet condition for a period of one hour prior to placing any new concrete.

Immediately prior to wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air.

Prior to placing concrete, excess water shall be removed from the surface using compressed air.

904.07.04.05 Bonding Agent

A bonding agent shall be used for:

- a) Exposed vertical surfaces of concrete, less than 300 mm in height, against which new concrete is to be placed.
- b) Blockouts in concrete for installation and modification of deck joint assemblies.
- c) Stressing tendon anchorage recesses.

A thin uniform coating of bonding agent shall be brushed onto the prepared surface immediately prior to placing fresh concrete. Bonding agents shall be mixed by means of a mixer. Any bonding agent not used within 30 minutes of mixing shall be discarded. Bonding agent that has dried shall be removed and replaced prior to placing concrete against it.

904.07.04.06**Element-Specific Preparation**

For concrete in footings; when specified in the Contract Documents that the concrete is to be placed against undisturbed soil or set in rock, any over-excavation shall be filled with concrete of the same strength as the footing concrete.

For parapet and barrier walls and curbs on structures; all anchorages shall be fastened in place accurately and securely prior to proceeding with concrete placement. The railing anchorage inserts shall be fastened in place according to OPSS 908.

For concrete in approach slabs; the approach slab seat elastomer, polystyrene, and joint filler shall be installed and the grade thoroughly wetted down prior to placing the concrete in the approach slab.

For concrete in slope paving; the slope face shall be shaped, excavation completed, granular A placed and compacted according to OPSS 501 and the crushed rock, moisture vapour barrier, wood strips, and joint filler placed as required prior to placing the concrete. Sealant shall be installed as specified in the Contract Documents.

904.07.05**Placing of Concrete****904.07.05.01****General**

The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation.

Concrete placing and transporting devices shall not be supported by the steel reinforcement.

Concrete shall be deposited within 1.5 m of its final position. Chutes shall have sufficient slope to deliver concrete of the approved consistency and shall have a maximum length of 15 m.

When concrete is to be dropped more than 1.5 m, fully enclosed vertical drop chutes extending to the point of deposit shall be used. Drop chutes are not required for placing concrete in steel tube piles of 0.6 m diameter or less. Concrete shall be placed at a steady rate such that a monolithic concrete is obtained without the formation of cold joints.

When there is an interruption in placing concrete greater than 20 minutes, the surface of the concrete shall be covered with wet burlap. The Contractor shall notify the Contract Administrator immediately of any interruption resulting in a cold joint and shall submit a proposal for remedial action for approval.

904.07.05.02**Concrete Placing Restrictions**

The placement of concrete shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

No concrete shall be placed until all curing material and, in cold weather, all cold weather protection material has been delivered to the site.

Barrier and parapet walls on structures shall not be slipformed.

When concrete is to be placed on a surface that has a slope greater than 3%, the placing operation shall begin at the lower end of the slope and progress upwards.

All surfaces against which concrete is to be placed shall be free of standing water, except for tremie concrete. Fresh concrete shall be protected from contact with rain or snow.

The temperature of formwork, steel reinforcement, or any other material on which the concrete is to be placed shall not exceed 30 °C.

Debris shall be removed from the area where concrete is to be placed.

Ice and snow shall be removed from the area where concrete is to be placed. Deicing chemicals shall not be used. Concrete shall not be placed on or against frozen ground. Excavations prepared for concreting and any existing concrete, steel reinforcement, structural steel, forms, or other surfaces against which concrete shall be placed shall be at a minimum temperature of 5 °C for a period of 12 hours prior to commencement of placing concrete.

904.07.05.03 Concrete in Structure and in Deck

Concrete diaphragms shall be placed monolithically with the deck.

All bridge deck placements 3 m or wider shall be finished using a finishing machine and a work bridge. Where placements are longer than 40 m or wider than 10 m, a second work bridge shall be used. For deck placements narrower than 3 m, the Contractor shall submit a proposal detailing a method of finishing to the Contract Administrator for approval. Small localized areas may be hand finished subject to approval by the Contract Administrator.

Where the superstructure is continuous over a support, the screed rails shall be placed for the entire length of the structure prior to any concrete is placed.

A dry run shall be carried out in the presence of the Contract Administrator to ensure that the specified camber, crown, slab thickness, and concrete cover are achieved. In those areas of the deck where a finishing machine will be used to finish the concrete, the dry run shall be carried out by means of the finishing machine fitted with an attachment suitable for checking the required cover, securely fastened to the finishing machine strike-off with the strike-off set in its lowest position. This operation shall be repeated to cover the entire area to be concreted.

For HPC and silica fume overlay, at the time of the dry run the Contractor shall demonstrate that the performance of the fog misting equipment meets the specified requirements.

Screed rails and the supports for the screed rails shall not be removed until the concrete has hardened sufficiently to withstand the weight of workers and equipment used to remove them without marring the surface of the concrete. Any part of the screed rail supports that remain in the deck shall have 100 mm of concrete cover. Chairs used to support screed rails shall not be welded to structural steel but may be welded to shear connectors.

The holes in the deck resulting from removal of the screed rail supports shall be thoroughly cleaned of all deleterious material and abrasive blast cleaned immediately prior to filling with proprietary patching material. The work of cleaning and filling the holes shall be completed within 96 hours after the end of the deck curing period.

904.07.05.04 Tremie Concrete

Concrete shall be placed using a tremie or concrete pump. No air or water pockets shall be introduced into the tremie concrete by the placing equipment.

Pipe of a tremie or hose of a concrete pump shall be positioned vertical and shall be long enough to reach the lowest point of concrete deposit. A continuous flow of concrete at a minimum rate of 15 m³/h shall be maintained through the pipe or hose. The concrete shall be placed in its final position and to its full depth in a continuous placing operation without interruption. The top under water surface of the concrete shall be kept level during concrete placement. After placement, the concrete shall not be disturbed, puddled, or vibrated. Tremies or concrete pumps shall be located a maximum distance of 5 m apart and a maximum of 2.5 m from forms.

Concrete shall only be placed in water that has a temperature of 2 °C or greater. The velocity of water flow inside the forms shall not be more than 3 m/min.

When placing the tremie pipe or concrete pump hose and at the start of the concreting operation, the pipe or hose shall be sealed at the bottom to prevent ingress of water. Once concrete is flowing through the pipe or hose, the discharge end shall be kept continuously immersed in the freshly placed concrete. If the seal is lost, thereby allowing the pipe or hose to fill with water, the pipe or hose shall be withdrawn, the seal re-established, and the concreting operation restarted. Separate cranes shall be used to deliver the tremie concrete and to move and position the tremie or concrete pump.

Tremie concrete shall not be placed above the existing water level.

When a placement operation is interrupted below water level, the surface laitance shall be removed to expose the coarse aggregate within 36 hours after the interruption and prior to continuation of the operation.

When a placement operation is completed, and work is to continue in the dry, a construction joint shall be prepared by removing surface laitance to expose the coarse aggregate.

Unwatering shall not be permitted until at least 24 hours after the concrete placement is completed.

904.07.06 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate concrete at the point of deposit within 15 minutes of placement.

Each layer of concrete shall be vibrated. Vibrators shall extend into the previous layer to produce a homogenous mixture at the layer interface.

Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.

904.07.07 Concrete Finishing

Finishing of the concrete surface shall be done immediately following placement.

No material shall be applied to the concrete surface or the finishing tools to aid in the finishing.

The surface shall be smooth, free from open texturing, undulations, projections, and ridges and shall be struck off true to grade and cross-section and, except as specified for bridge deck placements, shall be hand finished with a float.

Bridge decks shall be finished according to the Concrete in Structure and in Deck clause. In addition, for bridge decks where the concrete forms the wearing surface, the surface shall be textured. After a tight, uniform surface has been achieved, texturing shall be done with a wire broom or comb having a single row of tines. The required texture shall be transverse grooves that may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 to 4.5 mm. The texture shall extend uniformly to within 150 to 300 mm of the curb.

Bearing seats and expansion joint dams shall receive a wooden float finish. The top surface of sidewalks and curbs shall be given a broomed finish.

Concrete surfaces against which new concrete is to be placed shall be left with a rough surface finish.

904.07.08 Curing

904.07.08.01 General

Curing shall be applied immediately after finishing the concrete surface. For continuing operations, such as barrier wall or sidewalk, the curing shall be applied within 2 to 4 m of the finishing operation, and for bridge decks, within 2 to 4 m of the pan or screed of the finishing machine.

Any concrete containing silica fume shall be cured according to the HPC curing requirements.

The curing period shall be a minimum of seven Days for concrete subject to cold weather, concrete cured with curing compound, and HPC. For all other concrete, the curing period shall be a minimum of four Days.

When the ambient air temperature is 0 °C or higher at the time of placing, components of structures shall be cured with burlap and water, except as specified in the Curing Formed Surfaces clause. When the ambient air temperature is below 0 °C at the time of placing, components shall be cured with moisture vapour barrier, except for HPC, which shall be moist cured with burlap and water, regardless of ambient air temperature. During cold weather, burlap shall be prevented from freezing.

Curing compound shall only be permitted for non-structural elements such as slope paving and shall not be used when cold weather concreting is in effect.

Where waterproofing is to be applied to a structure deck following curing with burlap and water or moisture vapour barrier, the deck shall be air cured for at least 72 hours prior to the application of waterproofing.

904.07.08.02 Fog Misting of High Performance Concrete

Fog misting for high performance concrete shall be provided by means of hand held fogging wands; a fogging system mounted on the finishing machine may be used, in addition to hand held fogging wands.

Fog mist shall be applied from the time HPC is deposited in the deck, approach slab, median, curb, or sidewalk until it is covered with burlap.

Fog mist shall be applied using a misting nozzle in such a way as to maintain a fog mist above the concrete surface to maintain high relative humidity above the concrete and prevent drying of the concrete. No accumulation of water shall be permitted on the concrete surface. Water from fog misting nozzles shall not be worked into the concrete surface or used as a finishing aid.

904.07.08.03 Curing with Burlap and Water

Burlap shall be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. Two layers of burlap shall be applied to the surface of the concrete. Burlap strips shall overlap 150 mm and shall be held in place without marring the surface of the concrete.

The burlap shall be maintained in a continuously wet condition throughout the curing period by means of a soaker hose. The burlap shall be covered with a layer of moisture vapour barrier within 12 hours of placing of the concrete in a manner that shall prevent deformation of the surface of the concrete.

Air flow in the space between the moisture vapour barrier and the burlap shall be prevented.

Water shall not be allowed to drip, flow, or puddle on the concrete surface when placing the burlap or at any time prior to the concrete has achieved final set.

904.07.08.04 Curing with Moisture Vapour Barrier

Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. The moisture vapour barrier strips shall overlap 150 mm and shall be held in place at the edges and laps to prevent displacement without marring the surface of the concrete.

904.07.08.05 Curing with Curing Compound

Immediately prior to application, the curing compound shall be agitated by mechanical means to provide a homogeneous mixture. It shall be applied to completely cover the surface of the concrete. A second application of curing compound shall be applied within 30 to 60 minutes after the first application. Each application shall be such that the membrane formed is uniform in thickness and colour and free of breaks and pinholes.

The rate of each application shall not be less than the rate specified by the manufacturer of the compound.

904.07.08.05.01 Curing Compound Sampling

The Contractor shall be responsible for sampling of curing compounds and handling, identification, and delivery of curing compound samples to Regional Quality Assurance Laboratory for Quality Assurance testing. Curing compounds shall be sampled at the site from the spray nozzle during application. Samples shall be taken at a frequency of one sample per Contract or one sample per 1,000 lineal meters, whichever provides the greater number of samples.

904.07.08.06 Curing Formed Surfaces

Forms for structure barrier wall, parapet wall, and curb on deck shall be removed no later than 24 hours after concrete placement, and the concrete shall be cured according to the Curing with Burlap and Water clause for the remainder of the minimum curing period.

For all concrete other than HPC, when ambient air temperatures are 5 °C or less, forms for concrete barrier wall, parapet wall, and curb on deck may be left in place for the duration of the curing period.

Other formed surfaces shall require no additional curing where the formwork is left in place for the minimum specified curing period. Where the formwork is removed prior to the curing period is completed, formed surfaces shall be cured with burlap and water according to the Curing with Burlap and Water clause for the remainder of the minimum curing period.

904.07.09 Control of Temperature and Temperature Difference

904.07.09.01 General

During the curing period, the concrete temperature shall not fall below 10 °C or exceed 70 °C. The temperature difference between the centre of the concrete component at a location where the concrete is expected to reach the highest temperature and the surface shall not exceed 20 °C, for:

- a) All bridge decks.
- b) HPC.
- c) Large concrete components where the smallest dimension is 1.5 m.
- d) Any concrete subject to cold weather.

904.07.09.02**Monitoring**

The Contractor shall monitor, record, and submit records for the concrete and ambient air temperature for:

- a) All bridge decks.
- b) HPC.
- c) Large concrete components where the smallest dimension is 1.5 m.
- d) Any concrete subject to cold weather.

The Contractor shall supply and install thermocouple wires and associated instrumentation with a combined accuracy of ± 1.5 °C capable of recording and displaying temperature. The instrumentation shall include data loggers capable of recording at hourly intervals or less and shall allow direct reading of temperature.

The thermocouples for concrete temperature measurement shall be installed as shown in Table 1 prior to placing concrete. Thermocouples for monitoring ambient air temperature shall be installed in the shade close to the surface of the concrete at a minimum frequency of one thermocouple per stage.

Recording of concrete temperatures shall begin at the start of placement. The temperature shall be recorded automatically at intervals no greater than one hour until the end of the monitoring period. The monitoring period shall be seven Days, or longer when necessary, in order to meet the requirements of the Withdrawal of Protection clause. The digital temperature indicators shall be left in place until the end of the monitoring period.

The Contractor shall also physically monitor and verify concrete and ambient air temperature readings every six hours, or more frequently, for the first three Days and every 12 hours for the remainder of the monitoring period. The Contractor shall take necessary action to maintain the temperature within the specified limits.

The Contract Administrator shall be provided access to verify temperature readings. If the datalogger does not have a digital display that allows the Contract Administrator to verify temperature, the Contractor shall provide the Contract Administrator with the necessary instruments to allow the Contract Administrator to verify thermocouple function and readings.

The Contractor shall prepare a record of temperatures for each Day during the temperature monitoring period and at the end of the temperature monitoring period shall prepare complete temperature records, including graphical plot of temperature versus time.

904.07.09.02.01**Submission of Temperature Records**

Datalogger temperature records and a record of any actions taken to maintain control of temperature and temperature difference shall be forwarded to the Contract Administrator at the end of each Business Day during the temperature monitoring period. At the end of the temperature monitoring period, the Contractor shall submit to the Contract Administrator a complete temperature record.

904.07.09.03**Concrete Subject to Cold Weather**

For concrete subject to cold weather, a protection system shall be designed for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required. The conditions shall be monitored and the protection system modified as required.

For cold weather conditions, minimum protection of concrete shall be as shown in Table 2 and shall be maintained for the duration of the curing period. This period may need to be extended in order to meet the requirement of the Withdrawal of Protection clause.

904.07.09.03.01 Housing and Heating

The design of the protective housing shall take into account the effects of construction activities such as placing concrete, stressing, and grouting. Heating equipment of sufficient capacity to establish and maintain the specified curing conditions shall be used throughout the curing period and for such time thereafter, as is necessary, for the completion of the work. Heating equipment used within the housing shall be vented outside the housing. Heating equipment having an open flame shall not be permitted.

The ambient air temperature adjacent to the concrete or formwork within the housing shall not be permitted to vary by more than 8 °C.

904.07.09.04 Withdrawal of Protection

For concrete subject to cold weather and for large concrete components where the smallest dimension is 1.5 m, the protection shall be gradually removed or reduced in such a manner that the maximum allowable drop of concrete temperature, as shown in Table 3, for each 24-hour period is not exceeded.

The protection shall not be totally removed, nor shall the concrete be fully exposed to the air until the average concrete temperature is within 10 °C of the ambient air temperature.

904.07.10 Removal of Formwork and Falsework

The removal of formwork and falsework shall be according to OPSS 919 and as specified in the Contract Documents.

904.07.11 Construction Joints

Construction joints shall be formed at the locations specified in the Contract Documents.

In addition, construction joints can be formed where control joints are specified in barrier walls and parapet walls. No other construction joints shall be permitted, unless approved in advance by the Contract Administrator.

A straight 20 mm V-groove shall be formed at the exposed face of the concrete at all construction joints. V-grooves shall not be used on bridge deck surfaces, except for the bottom slab of post tensioned box voided slabs.

A bulkhead shall be used to form vertical or inclined construction joints.

904.07.12 Surface Finish

904.07.12.01 General

Concrete surfaces shall not be treated with cement slurry or paste.

Within 3 Days following the removal of forms or curing materials, all holes left in the concrete surface with any dimension greater than 15 mm and less than 50 mm shall be filled with mortar or a proprietary patching material. The holes shall be moist at the time of filling. Mortar shall be tamped into place. Proprietary patching materials shall be placed according to the manufacturer's instructions.

Surfaces with cavities with any dimension greater than 50 mm or with honeycombing are considered deficient and shall be repaired. A repair proposal shall be submitted to the Contract Administrator for approval.

904.07.12.02 Exposed Surfaces

The appearance of the concrete shall be uniform in colour, pattern, and texture when viewed from a distance of 15 m. Care shall be taken to select material, including proprietary patching materials, to achieve uniformity of colour and appearance.

All projections, such as fins and bulges, and all blemishes, such as stains and rust marks shall be removed.

904.07.12.03 Surface Tolerance

Formed and unformed surfaces shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete. When the straight edge is placed across a construction joint, the gap between the straight edge and the surface of the concrete shall not be greater than 3 mm.

All unformed construction joint surfaces against which sidewalks, curbs, medians, and barrier walls are to be placed shall be such that when tested with a 500 mm straight edge placed anywhere in any direction on the surface, there is no gap greater than 20 mm between the bottom of the straight edge and the surface of the concrete.

904.07.12.04 Contamination of Surface

Contamination by oil or other deleterious substances shall be prevented. Contaminated concrete in bridge decks or against which new concrete is to be placed shall be removed according to OPSS 928, procedure for Concrete Removal-Partial Depth, Type A, B, and C.

904.07.13 Alignment of Components

The position of the inner and outer top edges of structural components shall be set true to the elevations, alignment, and camber as specified in the Contract Documents without visible deviation from one end of the structure to the other. All concrete items or structural components shall be constructed to the specified geometry.

Variations from plumb or a specified slope shall not exceed 1H:400V. Departure from specified alignment shall not exceed ± 25 mm.

904.07.14 Testing for Early Strength

The Contractor may elect to prepare sets of cylinders for early strength determination in addition to the cylinders required for determination of strength at 28 Days.

The Contractor shall be responsible for all aspects of the preparation, storing, and transportation of cylinders for early strength determination. Curing of cylinders for early strength determination shall consist of storing the cylinders in or on the structure as near as possible to the component that they represent. The cylinders shall receive the same protection from the elements on all surfaces as is given to the portions of the structure that they represent. The Contractor shall identify the time of testing for early-break cylinders and provide the Contract Administrator with one Business Day advance notice to arrange testing. The Contractor shall deliver cylinders for early strength determination immediately prior to the time of testing. The Owner shall test a reasonable number of cylinders for early strength determination at the laboratory designated in the Contract Documents.

Early strength determination of concrete in post-tensioned structures shall be carried out on a minimum of four sets of cylinders representative of the concrete placed in the structure. At least one set of cylinders from the start, middle, and end of the deck section being placed shall be cast. All cylinder test results shall reach the minimum stressing strength as specified in the Contract Documents prior to stressing can commence.

904.07.15 Early Loading of Structural Concrete

Full design loads shall not be applied to the structure until the specified 28-Day compressive strength has been attained. Early loading of a structural component is permitted, unless expressly stated otherwise in the Contract Documents, subject to the following conditions:

- a) Prior to any early loading, the Contractor shall demonstrate that the concrete has reached a compressive strength of 20 MPa by preparing, curing, and transporting early strength cylinders according to the Testing for Early Strength subsection.
- b) Subsequent placement of reinforcement, formwork and falsework on a footing, culvert base slab, or caisson shall not begin until at least 24 hours after concrete placement, provided that concrete in the footing, culvert base slab, and caisson can withstand the forces exerted. Placement of concrete on the footing, culvert base slab, or caisson shall not be carried out until the concrete has reached a compressive strength of 20 MPa.
- c) Subsequent placement of reinforcement, formwork, falsework, and concrete on all other structural components shall not be carried out until the concrete has reached a compressive strength of 20 MPa.
- d) Early loading of concrete is not permitted where cold weather protection is required.
- e) Construction vehicles shall not be permitted on bridge decks until the concrete has reached a compressive strength of 20 MPa and construction vehicles shall not be permitted on the cantilever portion of the bridge deck until the specified 28-Day compressive strength has been achieved. Gross vehicle weight of the construction vehicles shall not exceed 20,000 kg.
- f) Full curing is to be maintained at all times as specified in the Contract Documents.

904.07.16 Cracks in Formed and Unformed Surfaces

All concrete shall be inspected to identify and document any cracks including, their location, width, and density. The results of the inspection shall be reported to the Contract Administrator. Cracks shall be inspected and monitored up to the date of Completion of the Work.

Based on criteria as shown in Table 4, the limits of areas requiring repair or replacement and shall be identified and provided to the Contract Administrator along with a proposal for remedial action to be taken. No repairs shall proceed until the proposal has been accepted by the Contract Administrator in writing.

Repairs shall be according to OPSS 932. Where removal is required, the removals and preparation of concrete shall be according to OPSS 928 and OPSS 930.

For bridge decks to be waterproofed, the inspection of the surface to be waterproofed shall be carried out after completion of curing and prior to application of tack coat for waterproofing. Waterproofing of a bridge deck shall not proceed until repairs have been completed and permission to waterproof has been given by the Contract Administrator.

For all other concrete, the inspection shall be carried out in a timely manner, but no later than one month following completion of curing.

904.07.17 Concrete Cover

All debris and obstructions shall be cleared to provide unhindered access to allow the Contract Administrator to carry out the concrete covermeter survey as specified in the Concrete Cover subsection of the Quality Assurance section. The Contract Administrator shall be notified in writing when the test area is ready for the concrete covermeter survey.

The Contract Administrator shall be allowed a time period of three Business Days to complete the survey, including review of the survey by the Owner. This time period shall commence upon receipt of the Contractor's written notification to carry out the survey. The time period required to complete the concrete survey shall be extended if inclement weather or the ambient air temperatures below 5 °C fall within that time period.

Where the cover does not meet the requirements as specified in the Contract Documents, a proposal for remedial action shall be submitted to the Contract Administrator for approval.

Waterproofing of a bridge deck shall not proceed until the survey has been completed and permission to waterproof has been given by the Contract Administrator.

For all other components, the inspection of the surface shall be carried out in a timely manner, not more than one month after removal of curing.

904.07.18 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

904.08 QUALITY ASSURANCE

904.08.01 Acceptance

Acceptance shall be according to OPSS 1350 and this specification, including satisfactory completion of all remedial action associated with surface tolerance, surface finish, concrete cover, alignment, cracks, and any other deficiencies.

904.08.02 Concrete Cover

The concrete cover shall meet the requirements as specified in the Contract Documents. Concrete cover determination shall be carried out by the Contract Administrator on the front faces of barrier or parapet walls, and the top surface of decks, including medians and sidewalks. The Contract Administrator shall provide the survey report to the Contractor.

904.08.03 Approach Slab Seat and Ballast Wall Elastomers

The Contract Administrator shall select a random sample of the approach slab seat and ballast wall elastomers, 600 mm in length each, from each structure for testing.

Elastomers that do not meet the requirements as specified in the Contract Documents shall be considered unacceptable and a financial penalty shall be applied.

904.08.04 Curing Compounds

Curing compounds shall be tested for relative density, non-volatile content, and settlement according to LS-413, LS-414, and LS-416. The individual test results shall be forwarded to the Contractor as they become available.

Curing compound that fails to fall within the specified tolerances for relative density, non-volatile content, or settlement shall be deemed unacceptable and curing compound represented by samples that do not comply with the requirements of this specification shall not be used for curing of concrete.

904.09 MEASUREMENT FOR PAYMENT

904.09.01 General

No deductions from the volume of concrete shall be made for any of the following:

- a) Drainage openings, load reducing devices, embedded timbers, and Utility and prestressing steel ducts, each of which has a cross-sectional area of less than 0.1 m².
- b) Timber, steel, concrete, or concrete filled tubular piles.
- c) Steel reinforcement, miscellaneous hardware, and structural steel.

904.09.02 Actual Measurement

904.09.02.01 Concrete in Culverts Mass Concrete Tremie Concrete Concrete in Footings Concrete in Barrier Wall Footings

Measurement of concrete shall be by volume in cubic metres.

Measurement shall be made within the designated limits of the work.

Tremie concrete volume may be measured using the concrete delivery tickets, when so designated by the Contract Administrator.

904.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

904.10 BASIS OF PAYMENT

904.10.01 Concrete in Culverts - Item Mass Concrete - Item Tremie Concrete - Item Concrete in Footings - Item Concrete in Barrier Wall Footings - Item Concrete in Structure - Item Concrete in Substructure - Item Concrete in Substructure and Retaining Walls - Item Concrete in Deck - Item Concrete in Barrier Walls - Item Concrete in Parapet Walls - Item Concrete in Approach Slab - Item Concrete in Slope Paving - Item Concrete in Toe Wall - Item Prestressed Concrete Bridge Deck - Item

High Performance Concrete in Substructure - Item
High Performance Concrete in Structure - Item
High Performance Concrete in Approach Slab - Item
High Performance Concrete in Deck - Item
High Performance Concrete in Barrier Walls - Item
High Performance Concrete in Parapet Walls - Item
High Performance Concrete in Substructure and Retaining Walls - Item

Payment at the Contract price for the concrete tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments as specified in the Contract Documents.

Surface cavities greater than 50 mm and honeycombing shall be repaired at no additional cost to the Owner.

904.10.02 Formwork and Falsework

Payment for formwork and falsework shall be included in the work in which it is used.

Where formwork is required for the work under a concrete tender item, it shall be deemed for progress payment purposes that the formwork, together with its supporting falsework, when installed, constitutes 35% of the work to be carried out under the tender item.

Partial payment for construction of the formwork and falsework shall be made on a prorated basis.

904.10.03 Working Slabs

When a concrete working slab is required by the Contract Administrator, payment shall be made as a Change in the Work at the unit price of the concrete in the footing to be placed on it.

904.10.04 Deck Joint Assemblies, Bearings, and Deck Drains

When the Contract does not contain a separate tender item for deck joint assemblies, bearings, and deck drains, the Contract price for the concrete tender items in which the deck joint assemblies, bearings, and deck drains are incorporated shall include full compensation for all labour, Equipment, and Material to place the deck joint assemblies, bearings, and deck drains.

904.10.05 Reinforcing Steel Bars, or Stainless Steel Reinforcing Bars

When the Contract does not contain a separate tender item for reinforcing steel bar or stainless steel reinforcing bar, the Contract price for the concrete tender item in which the steel reinforcement is incorporated shall include full compensation for all labour, Equipment, and Material to place the reinforcing steel bars or stainless steel reinforcing bars.

TABLE 1
Minimum Number of Thermocouple Sets for Concrete Temperature Measurement

	Concrete Elements Requiring Temperature Monitoring	Number of Thermocouple Sets in Each Element	Number of Thermocouples in Each Set	Thermocouple Set Locations
Cold Weather Protection	Each concrete element.	Minimum of 3 per element or stages thereof.	2	At locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Bridge Decks	All.	a) Minimum of 3 per stage, or per deck if deck is not placed in stages. b) When diaphragm is cast together with a deck, a minimum of 4 per stage.	3	The beginning, middle, and final portion of the deck placement and in the diaphragm. At locations where the concrete is expected to reach the highest temperature and at the surfaces of concrete. (Note 1)
HPC	Substructure elements: abutments, pier columns, and pier caps.	Minimum of 3 per element or stages thereof.	2	At locations where the concrete is expected to reach the highest temperature and at the surface of concrete.
Large Concrete Components Where the Smallest Dimension is 1.5 m	Elements with smallest dimension of 1.5 m or more.	Minimum of 3 per element or stages thereof.	2	At locations where the concrete is expected to reach the highest temperature and at the surface of concrete.

Notes:

1. For bridge decks, thermocouples shall be installed in sets of three consisting of one mid-depth thermocouple and two surface thermocouples. The surface thermocouples shall be placed immediately above or the shortest distance from the corresponding mid-depth thermocouple. The surface thermocouples shall be installed beneath the burlap in contact with the surface concrete or imbedded in the concrete within 5 mm of the surface and, for bridge decks, the second surface thermocouple shall be placed inside the bottom form.

TABLE 2
Minimum Cold Weather Protective Measures

Footings and Slabs on the Ground				
Anticipated Minimum Ambient Air Temperature °C	Thickness			
	> 1.0 m	1.0 - 0.5 m	< 0.5 - 0.25 m	< 0.25 m
+5 to 0	PM1	PM1	PM1	PM2
-1 to -10	PM2	PM2	PM2	PM3
-11 to -20	PM3	PM3	PM4	PM5
Less Than -20	PM3	PM4	PM5	PM5
All Other Components				
+5 to 0	PM1	PM1	PM1	PM2
-1 to -10	PM2	PM2	PM3	PM4
-11 to -20	PM3	PM3	PM4	PM5
Less Than -20	PM4	PM5	PM5	PM5
Notes: A. Protective Measures PM1 - Cover components with a moisture vapour barrier as specified for curing with moisture vapour barrier. PM2 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 0.67. PM3 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 1.33. PM4 - Cover components as for PM1, then cover the moisture vapour barrier with insulation having an R-Value of 2.00. PM5 - Housing and heating. B. All R-Values are metric. C. The conversion factor from metric to imperial units is: Metric R-Value x 5.678 = Imperial R-Value.				

TABLE 3
Maximum Allowable Drop in Concrete Temperature

Thickness	> 2.0 m	1.0 - 1.99 m	< 1.0 m
Maximum Allowable Drop in Concrete Temperature per 24 hours	10 °C	15 °C	20 °C

TABLE 4
Criteria for Treatment of Cracks

Components	Width of Crack at Widest Point mm	Treatment of Cracked Areas
Decks to be Waterproofed and Paved	≥ 0.50	Repair.
Exposed Decks	> 0.30	Repair cracks in the areas where total linear measurement of crack per m ² is < 5 m. Remove and replace the cracked areas where total linear measurement of crack per m ² is ≥ 5 m.
Barrier Wall, Parapet Wall, Sidewalk, and Median on a Structure	> 0.30	Repair cracks in the areas where the total linear measurement of crack per linear meter of the wall, sidewalk or median measured along the side facing traffic is < 5 m. Remove and replace the cracked areas where the total linear measurement of crack per lineal meter of the wall, sidewalk, or median measured along the side facing traffic is ≥ 5 m.
	≤ 0.30	Apply sealer acceptable to the ministry to cracked areas where total linear measurement of crack per m ² is ≥ 5 m.
Curb on a Structure	> 0.30	Repair cracks in the areas where the total linear measurement of crack per linear meter of the curb is < 1.5 m. Remove and replace the cracked areas where the total linear measurement of crack per linear meter of the curb is ≥ 1.5 m.
Piers, Pier Caps, Abutments, and Other Structural Components Within 3 m of Roadway	> 0.30	Repair.
	≤ 0.30	Apply sealer acceptable to the ministry to cracked areas where total linear measurement of crack per m ² is ≥ 5 m.
All Other Components	≥ 1.00	Repair.



CONSTRUCTION SPECIFICATION FOR STEEL REINFORCEMENT FOR CONCRETE

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905.01	SCOPE

This specification covers the requirements for the placement of all steel reinforcement and mechanical connections for concrete structures.

905.02	REFERENCES

This specification refers to the following standards, specifications or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 909	Prestressed Concrete - Precast Members
OPSS 910	Stressing Systems for Post-Tensioning

Ontario Provincial Standard Specifications, Material

OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Structural Manual

Laboratory Testing Manual:

LS-434 Method of Test for Mechanical Connectors Used to Splice Steel Reinforcement

LS-448 Method of Test for Determination of Tensile Properties of Welded Wire Reinforcement

CSA Standards

G30.18-09 (R2019) Carbon Steel Bars for Concrete Reinforcement

S6-19 Canadian Highway Bridge Design Code

W186-M1990 (R2012) Welding of Reinforcing Bars in Reinforced Concrete Construction

ASTM International

A276 / A276M - 17 Stainless Steel Bars and Shapes

A421 / A421M - 15 Stress - Relieved Steel Wire for Prestressed Concrete

A955 / A955M - 20 Deformed and Plain Stainless Steel Bars for Concrete Reinforcement

905.03 DEFINITIONS

For the purpose of this specification the following definitions apply:

Fabrication means the cutting, bending, storing, bundling, tagging and delivery of stainless and uncoated reinforcing steel bars.

Mechanical Connection means a joining of two reinforcing steel bars, stainless steel reinforcing bars, or post-tensioning tendons by means of a mechanical connector.

Post-Tensioning means a method of prestressing in which tendons are stressed after the concrete has reached a predetermined strength.

Prestressing Steel means steel strand or bar that exhibits the principal attributes of high tensile strength and ductility because of its composition and method of production.

Reinforcing Steel Bars means uncoated deformed steel bars made of carbon steel as defined in CSA G30.18, used for the reinforcement of concrete.

Slip means the axial displacement of the reinforcing bars measured relative to the mechanical connector. Displacement is measured at a rebar stress of 5% of specified yield after the mechanical connection has been loaded to a rebar stress of 50% of specified yield and then unloaded to a bar stress of 5% of specified yield.

Splice Bar means a reinforcing steel bar or stainless steel reinforcing bar that is further manufactured, other than by solely cutting threads, to be compatible with a specific mechanical connector.

Stainless Steel Reinforcing Bars means deformed stainless steel bars as defined in ASTM A955 used for the reinforcement of concrete.

Steel Reinforcement means all types of steel reinforcement for concrete including reinforcing steel bars, stainless steel reinforcing bars, splice bars, steel welded wire reinforcement, and prestressing strands and bars.

Steel Welded Wire Reinforcement means a wire mesh fabricated by means of resistance welding the crossing joints, available in rolls or flat sheets.

Strand means a group of wires laid helically over a central-core wire. A seven-wire strand would consist of six outer wires laid over a single wire core.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

Swaged means to apply circumferential pressure to a sleeve surrounding a bar to deform the sleeve sufficiently to achieve bearing between the deformed sleeve and the deformations on the bar.

Ultimate Tensile Strength means the breaking load of the material per unit area established by tensile testing.

Yield Strength means the stress at which the material exhibits a specified deviation of proportionality of stress and strain.

905.04 DESIGN AND SUBMISSION REQUIREMENTS

905.04.01 Submission Requirements

905.04.01.01 Working Drawings

905.04.01.01.01 Steel Reinforcement Working Drawings

Three sets of steel reinforcement Working Drawings shall be submitted to the Contract Administrator for information purposes only at least seven Days prior to the commencement of placing steel reinforcement. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The Working Drawings shall include at least the following: quantity, bar size, grade, mark number, location, and spacing for all steel reinforcement.

When a metric to imperial bar size substitution is made, the placing drawings shall include the quantity, bar size, grade, location, and spacing of both the metric and the substitute imperial bar.

When bar marks are indicated on the Contract Documents and reinforcing bar lists show the same bar marks, Working Drawings are not required.

The fabricator shall not commence fabrication until he has received one set of steel reinforcement Working Drawings sealed and signed by an Engineer. The fabricator shall have a copy of the Working Drawings at the manufacturing plant during fabrication.

A sealed and signed copy of these drawings shall be kept at the site before and during placing of steel reinforcement.

905.04.01.01.02 Steel Reinforcement Schedule

Three sets of steel reinforcement schedules shall be submitted to the Contract Administrator for information purposes only at least seven Days prior to the commencement of placing steel reinforcement. An Engineer's seal and signature shall be affixed on the steel reinforcement schedule verifying that they are consistent with the Contract Documents. The steel reinforcement schedules shall include at least: quantity, bar size, grade, reinforcing steel bars, stainless steel reinforcing bars, welded wire reinforcement, type if applicable, length, and bending dimensions.

When bar marks are shown on the Working Drawings, they shall be used in the schedule.

Steel reinforcement shall be detailed according to CSA-S6, and the Structural Manual.

The fabricator shall not commence fabrication until he has received one set of the steel reinforcement schedule sealed and signed by an Engineer. The fabricator shall have a copy of the steel reinforcement schedule at the manufacturing plant during fabrication.

A sealed and signed copy of the steel reinforcement schedule shall be kept at the site prior to and during placement of steel reinforcement.

905.04.01.02 Prestressed Concrete - Precast Members

Submission of proposals and shop drawings for prestressed concrete-precast members shall be according to OPSS 909.

905.04.01.03 Prestressed Concrete - Post-Tensioning

Submissions for post-tensioning shall be according to OPSS 910.

905.04.01.04 Welding Details

Three sets of welding details shall be submitted to the Contract Administrator for information purposes only at least seven Days prior to the commencement of steel reinforcement welding. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents. The welding details shall include materials, procedures, bars to be welded, location, and type of welds, as well as details of tack welds. Details shall be designed to prevent notching effects in the bars.

A sealed and signed copy of the welding details shall be kept at the site prior to and during welding of reinforcing.

905.04.01.05 Mechanical Connections Details

Three sets of mechanical connection details shall be submitted to the Contract Administrator for information purposes only at least seven Days prior to the commencement of installation of the connectors. Prior to making a submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the Contract Documents.

The connections details shall contain the following information:

- a) The type or series identification of the connector.
- b) The grade and size of the reinforcement to be joined by the connector.
- c) A copy of the manufacturer's catalogue giving complete data on the connector material and installation procedures.
- d) Location of splices, including type of splice.

905.05 MATERIALS

905.05.01 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

905.05.02 Post-Tensioning Materials

Post-tensioning materials shall be according to OPSS 910.

905.05.03 Mechanical Connections Details

905.05.03.01 Post-Tensioning Tendons

When tested in an unbonded condition, mechanical connections for post-tensioning tendons shall develop at least 100% of the ultimate tensile strength of the tendons, without exceeding the anticipated set.

The mechanical connection shall withstand without failure, two million cycles of stress through a range of 245 MPa for plain bars and 195 MPa for strands and ribbed bars. The upper limit of the range shall be 70% of the nominal tensile strength.

905.05.03.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars

The mechanical connections shall be qualified by tests made on sample splices according to the Job Control Tests clause.

Mechanical connections for steel reinforcement shall develop, in tension, the greater of 120% of the specified yield strength of the bars or 110% of the mean yield strength of the actual bars used to test the mechanical connection.

The total slip of the reinforcing bars shall not exceed the following measured displacements between gauge points straddling the mechanical connector:

a) For bar sizes up to and including No. 45M	0.25 mm
b) For No. 55M bars	0.75 mm

Splice bars shall be supplied by the manufacturer of the associated mechanical connector.

Stainless steel splice bars shall be used with stainless steel reinforcing bars and shall be of a type according to OPSS 1440.

905.05.04 Mechanical Connectors

905.05.04.01 Post-Tensioning Tendons

Mechanical connectors shall be supplied by the manufacturer of the prestressing system.

905.05.04.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars

Mechanical connectors shall be of an approved type and design and may be the form saver type, the filled sleeve type, the swaged sleeve coupler type, the threaded coupler type, the hot rolled thread bar coupler type, or the forged bar coupler type.

Stainless steel mechanical connectors shall be used with stainless steel reinforcing bars and shall be of a type according to OPSS 1440.

905.05.05 Associated Hardware

Only hardware, including spacers and support devices, approved by the Owner shall be used with steel reinforcement and the hardware shall meet the following requirements:

- a) All supports or support systems shall be capable of withstanding the loads to be placed on them.

- b) Except for tie wire, embedded hardware within 50 mm of exposed surfaces shall be stainless steel, galvanized steel, or of a non-metallic material verified not to react with concrete and approved by the ministry prior to use.
- c) Tie wire shall be 1.2 or 1.6 mm in diameter and shall be annealed ferrous wire except for the tie wire used to tie stainless steel reinforcing bars to stainless steel reinforcing bars, reinforcing steel bars, and shear studs, which shall be Type 316 LN or Type 316L, stainless steel wire.
- d) Bar chairs for supporting steel reinforcement shall be non-metallic.
- e) Concrete chairs shall not be used to support steel reinforcement except in footings and against granular surfaces.

905.07 CONSTRUCTION

905.07.01 General

All steel reinforcement and accessories shall be kept clean of all mud, oil, and other deleterious materials and stored clear of ground contact.

Steel reinforcement shall be placed according to the tolerances shown in Table 1. The tolerances listed include fabrication tolerances.

905.07.02 Reinforcing Steel Bars, Stainless Steel Reinforcing Bars, Splice Bars, Stainless Steel Splice Bars and Steel Welded Wire Reinforcing

905.07.02.01 Storage and Protection of Stainless Steel Reinforcing Bars

Stainless steel reinforcing bars shall be stored separately from reinforcing steel bars with the bar tags maintained and clearly visible until ready for placement.

905.07.02.02 Placing

Steel reinforcement shall be accurately placed in the positions as specified in the Contract Documents and held in the correct location during the operations of placing and consolidating concrete.

Bars shall be tied at least at every fourth intersection. The maximum untied length of any bar shall be 1 m.

For slab-on-girder type decks, the top layer of deck reinforcement shall be tied to the shear studs or shear stirrups on each girder at approximately 1.5 m centres.

Spacers for spirals shall be equally spaced around the spiral and shall be so that the specified pitch of the spiral is maintained.

905.07.02.03 Surface Condition

Steel reinforcement other than stainless steel reinforcing bars with rust, mill scale, or a combination of both shall be acceptable, provided the minimum physical properties including height of deformations and mass of a wire brushed test specimen are not less than the applicable specification requirements. Loose scale shall be removed.

Stainless steel reinforcing bars at the time the concrete is placed shall be free of deposits of iron and non-stainless steels.

905.07.02.04 Cutting

The cutting of stainless steel reinforcing bars, reinforcing steel bars, welded wire reinforcement, and splice bars by oxyacetylene torch may be carried out only when permitted in writing by the Contract Administrator.

905.07.02.05 Bending

Field bending of stainless steel reinforcing bars and reinforcing steel bars shall not be permitted, except when specified in the Contract Documents or authorized by the Contract Administrator.

905.07.02.06 Welding

Welding, including tack welding, shall not be permitted except as specified in the Contract Documents or as shown on the welding details submitted to the Contract Administrator.

The welding of stainless steel reinforcing bars and reinforcing steel bars shall be according to CSA W186 and shall be performed by companies certified by the Canadian Welding Bureau according to CSA W186.

Welding shall not be permitted within 3 m of any prestressing steel. Grounding welding equipment to prestressing steel or sheath shall not be permitted.

Except for splicing of stainless spirals, welding of stainless steel reinforcing bars shall not be permitted.

905.07.02.07 Splicing

Welded splices shall develop 100% of the tensile strength of the bar.

Splices for stainless steel reinforcing bars and reinforcing steel other than spirals shall be made as specified in the Working Drawings.

End anchorage of column spiral reinforcement shall be provided either by one and one half extra turns of spiral bar at each end of the spiral, one end embedded in the footing and the other end in the component supported above, or by a 90 degree bend around a longitudinal reinforcing bar plus an extension of at least 24 bar diameters into the core of the column.

Splicing of spiral reinforcing bars by means of a non-welded splice shall be made as specified in the Working Drawings. Non-welded splices shall be affected by mechanical connections or anchoring the ends of the spiral bars by means of a 90 degree bend around a longitudinal reinforcing bar with extensions of at least 24 bar diameters into the core of the column.

905.07.02.08 Mechanical Connections

905.07.02.08.01 General

Mechanical connections shall only be permitted as specified in the Contract Drawings. Locations of mechanical connections shall be as specified in the Working Drawings.

When a mechanical connector type is specified in the Contract Documents, only the specified mechanical connector type shall be used for that application.

The form saver type of mechanical connector shall only be used at construction joints.

The mechanical connections shall be qualified by tests made on sample splices according to the Job Control Tests clause.

All procedures and equipment for mechanical connections shall be according to the manufacturer's recommendations.

Ends of reinforcing bars to be joined shall be cut nominally square.

Connector sleeves shall have the clear cover as specified for the reinforcing steel in that location.

Stirrups, ties, and other reinforcement shall be adjusted or relocated, if necessary, to provide the required clear cover to the reinforcement.

Threads cut on the ends of the reinforcing steel bars shall match the internal threads in the connector.

905.07.02.08.02 Job Control Tests

When mechanical connectors are used, sample connections shall be assembled at the work site in the presence of the Contract Administrator. Frequency of sampling and method of sample assembly shall be according to the Quality Assurance section. Sample connections for testing shall be assembled on site in exactly the same manner as the connectors used in the Work. Sample connections fully assembled anywhere other than on site and in the presence of the Contract Administrator shall not be submitted for testing.

Samples for testing shall be submitted at least 10 Days prior to intended start of concrete placement.

905.07.03 Prestressing Steel for Prestressed Concrete

905.07.03.01 Surface Condition

All prestressing steel shall be clean and free of all rust, oil, dirt, scale, and pitting. Prestressing steel may have a light oxide coating.

905.07.03.02 Placing

Prestressing steel shall be accurately placed in the positions as specified in the Contract Documents and held in the correct location during the operations of placing and compacting concrete.

Prestressing steel shall be placed according to the tolerances shown in Table 1.

Mechanical connections in strand or high strength bars shall not be permitted in the Work, unless specified in the Contract Documents.

Mechanical connections shall be installed according to the recommendations of the manufacturer of the prestressing system used.

905.07.03.03 Welding

Welding of prestressing strand shall not be permitted.

905.07.04 Stressing Systems for Post-Tensioning

Construction requirements for stressing systems for post-tensioning shall be according to OPSS 910.

905.07.05 Inspection after Installation of Steel Reinforcement and Mechanical Connectors

A Request to Proceed shall be submitted to the Contract Administrator upon completion of the installation of the steel reinforcement and, if any, mechanical connectors.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

905.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

905.08 QUALITY ASSURANCE

905.08.01 Sampling

905.08.01.01 Prestressing Steel

The Contractor shall notify the Contract Administrator when prestressing steel is available for sampling.

Samples selected by the Contract Administrator shall be properly labeled by the Contractor for submission at least three weeks in advance of anticipated use to the Owner's laboratory or as directed by the Contract Administrator.

Samples of prestressing steel shall be provided as follows:

- a) For strand; one sample, 1.0 m long from each reel.
- b) For anchorages and connectors; samples shall be selected by the Contract Administrator on a random basis.

905.08.01.02 Reinforcing Steel Bars and Stainless Steel Reinforcing Bars

Reinforcing steel bars and stainless steel reinforcing bars shall be sampled for acceptance on a lot basis. A lot shall consist of reinforcing steel of the same grade, or stainless steel of the same Type and grade, of a single nominal size, and from the same mill and heat.

Three 1.5 m long samples shall be selected on a random basis at the site by the Contract Administrator and shall be accompanied by the mill certificate for that lot.

905.08.01.03 Mechanical Connectors - Sampling for Job Control Test

Mechanical connectors shall be sampled for acceptance on a lot basis. A lot shall consist of all connectors of one size and type from one supplier. If a lot contains more than 300 connectors, it shall be divided into sublots of a maximum of 300 connectors. Sublots shall be of approximately equal size.

The Contractor shall assemble six sample connections per subplot or six sample connections per lot if there are less than 300 connectors. The reinforcing bars from which the test samples are to be fabricated shall be selected on a random basis at the site by the Contract Administrator. The length of each bar to be joined shall be at least 500 mm. The same materials, position, location, equipment, and procedures as are being used to make connections in the reinforcing bars in the work shall be used when making the sample connections.

The Contractor shall complete Owner Standard Form, PH-CC-812, Field Sample Data Sheet-Mechanical Connectors, for each assembled sample. The Contractor shall submit the samples and the completed forms along with mill test certificates corresponding to the bars used, to the Contract Administrator for delivery to the laboratory designated by the ministry.

905.08.01.04 Steel Welded Wire Reinforcement- Sampling for Tensile Strength

Welded wire reinforcement shall be sampled for acceptance on a lot basis. A lot shall be 7000 m² of welded wire reinforcement or fraction thereof.

A minimum of five samples shall be taken per lot for testing and shall be extracted from the same sheet of mesh. Each specimen shall be a minimum length of 500 mm and shall contain at least one cross-wire in its middle section. The sampling time and location shall be determined by the Contract Administrator.

905.08.02 Testing

905.08.02.01 Prestressing Steel

The testing of prestressing steel shall be according to ASTM A421.

905.08.02.02 Reinforcing Steel Bar and Stainless Steel Reinforcing Bar

The testing of reinforcing steel bar shall be according to CSA G30.18 and the testing of stainless steel reinforcing bar shall be according to ASTM A276 and ASTM A955. Testing shall be carried out at the discretion of the ministry.

905.08.02.03 Mechanical Connections

905.08.02.03.01 Testing for Torque

When required by the manufacturers' installation procedure, torque shall be checked on 5% of the splices. Formwork that limits access to connectors for testing purposes shall not be placed until testing has been completed.

905.08.02.03.02 Job Control Test

Three of the six sample connections for each lot or subplot shall be tested for acceptance and the remaining three samples shall be retained by the testing laboratory for referee testing, if invoked.

The samples shall be tested for slip and tensile strength according to LS-434.

If one or more of the three test samples fails to meet the requirements of this specification for either the slip or tensile strength, the lot or subplot represented by the samples shall be rejected.

Individual test results shall be forwarded to the Contractor, as they become available.

905.08.02.03.03 Job Control Test - Referee Testing

Referee testing of mechanical connectors may be invoked by the Contractor within five Business Days of receiving the test result.

When referee testing is invoked, the three retained referee samples will be tested by the referee laboratory designated by the ministry. The samples shall be tested for slip and tensile strength according to LS-434.

Referee test results shall be forwarded to the Contractor, as they become available.

If one or more of the referee samples fails to meet the requirements of this specification for either the slip or tensile strength, the Acceptance Testing results are confirmed and shall be the basis of acceptance.

When all three referee samples meet the requirements of this specification for slip and tensile strength, the Acceptance Testing results are not confirmed and the referee test results shall replace the Acceptance Testing results as the basis of acceptance.

905.08.02.03.04 Referee Testing Cost

The cost of mechanical connector referee testing shall be as specified in the Contract Documents. When the referee results indicate that the acceptance test results for refereed lot or subplot are not confirmed, the Owner shall bear the cost. When the referee results indicate that the acceptance test results for refereed lot or subplot are confirmed, the Contractor shall be charged the cost of mechanical connector testing.

905.08.02.04 Steel Welded Wire Reinforcement for Tensile Strength

Testing of tensile strength of welded wire reinforcement shall be according to LS-448.

The lot of material shall be considered acceptable if the average of the valid test results meet or exceed 4% elongation, the specified yield strength and none of the individual valid test results have less than 3.2% elongation.

A minimum of three valid test results is required for acceptance. If less than three valid test results are obtained then the lot of material shall be resampled and tested until a total of five valid test results are obtained. No valid test results shall be discarded.

Unacceptable lots shall be rejected and replaced.

905.09 MEASUREMENT FOR PAYMENT

905.09.01 Actual Measurement

**905.09.01.01 Mechanical Connectors
Stainless Steel Mechanical Connectors**

For measurement purposes, a count shall be made of the number of connectors installed.

905.09.02 Plan Quantity

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

905.10 BASIS OF PAYMENT

**905.10.01 Reinforcing Steel Bar - Item
Stainless Steel Reinforcing Bar - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

**905.10.02 Mechanical Connectors – Item
Stainless Steel Mechanical Connectors – Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Tolerances for Cover and Placing Accuracy

TYPE	TOLERANCE (mm)	
Steel Reinforcement	Cast-in-Place Concrete	Precast Concrete
	Cover to Surface of Concrete and Placing Accuracy (Notes 1 and 2)	
a) Principal Steel Reinforcement	± 20	± 10
b) Concrete Cast Against and Permanently Exposed to Earth	± 25	
c) Stirrups in Webs		+ 5, - 3
d) Stirrups, Ties, Spirals	± 20	± 10
e) Deck Slab i) Top ii) Bottom	± 20	± 15
	± 10	± 10
f) Remainder	± 30	± 30
g) Lateral spacing in slabs and walls	± 30 (Note 3)	± 30 (Note 3)
h) Longitudinal location of bends and ends of bar in continuous member	± 50	± 50
i) Longitudinal location of bends and ends of bar at discontinuous end	± 20	± 20
Prestressing Steel	Placing Accuracy Horizontal and Vertical	
a) Prestressing strands or bars		± 5
Notes: 1. The cover to the concrete surface shall not be reduced by more than one-third of the specified cover. 2. The clear distance between bars shall not be less than one and one-half times the nominal diameter of the bar, one and one-half times the nominal size of the coarse aggregate, or 40 mm. In two or more layers, the rebar shall be directly above one another and the clear distance between layers shall not be less than 25 mm. The tolerances e) through f) do not apply to the lateral spacing of bars in slabs and walls. 3. The number of bars specified per metre width shall be placed in the metre width.		



CONSTRUCTION SPECIFICATION FOR STRUCTURAL STEEL FOR BRIDGES

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906.10	BASIS OF PAYMENT

906.01	SCOPE

This specification covers the construction requirements for the fabrication, delivery, and erection of structural steel for highway bridges.

906.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 911	Coating Structural Steel Systems
OPSS 919	Formwork and Falsework
OPSS 922	Installation of Bearings

Ontario Provincial Standard Specifications, Materials

OPSS 1202	Bearings-Elastomeric Plain and Steel Laminated
OPSS 1203	Bearings-Rotational and Sliding Surface

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

B95-1962 (R2002)	Surface Texture (Roughness, Waviness and Lay)
G40.20/40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
S6-19	Canadian Highway Bridge Design Code
W47.1-09 (R2014)	Certification of Companies for Fusion Welding of Steel
W48-18	Filler Metals and Allied Materials for Metal Arc Welding
W59-18	Welded Steel Construction (Metal Arc Welding)
W178.1-18	Certification of Welding Inspection Organizations
W178.2-18	Certification of Welding Inspectors

ASTM International

A108 - 18	Steel Bar, Carbon and Alloy, Cold-Finished
A563M - 07(2013)	Carbon and Alloy Steel Nuts (Metric)
A588 / A588M - 19	High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, With Atmospheric Corrosion Resistance
A709 / A709M - 18	Structural Steel for Bridges
F436 / F436M - 18	Hardened Steel Washers Inch and Metric Dimensions
F3125 / F3125M - 19	High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025:2017	General Requirements for the Competence of the Testing and Calibration Laboratories

Joint Publications of the Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE)

SSPC-SP6/NACE No. 3-2007	Commercial Blast Cleaning

906.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bearing Contact Area means two planes that are in contact or have a separation between them not exceeding 0.12 mm.

Erection Diagrams means drawings showing the dimensioned layout of the steel structure, from which shop details are made, and that correlate the fabricator's piece markings with the location in the structure.

Faying Surface means the mating surface of a member that is in contact with another member to which it is to be joined.

Flush means a profile of weld reinforcement in which there is a smooth gradual transition between the base and weld metal involving grinding where necessary. Weld reinforcement not exceeding 1 mm in height may remain on each surface, unless the weld is part of a faying surface when all reinforcement is removed.

Fracture Critical Member means a member, including attachments, in a single load path structure that is subject to tensile stress and whose failure could lead to collapse of the structure.

Inspector means an individual who is a Canadian Welding Bureau (CWB) certified Level 2 or Level 3 inspector according to the requirements of CSA W178.2 and has documented evidence of professional knowledge, skill, and experience in the inspection of fabrication and erection of steel bridges.

New Steel means structural steel that has not previously been used.

Non-Destructive Testing Technician means an individual who has documented evidence of training, professional knowledge, skill, and experience in non-destructive testing of structural steel welds and material, and has a valid certificate showing qualification to a Level 2 or 3 according to CGSB 48.9712 for the non-destructive testing specified.

Primary Tension Member means a member including attachments that are subject to tension stress.

Smooth means a profile of weld reinforcement, in which the surface finish or weld reinforcement has sufficiently smooth gradual transition, involving grinding where necessary. Weld reinforcement not exceeding the following limits, may remain on each surface:

2 mm for plate thickness ≤ 50 mm

3 mm for plate thickness > 50 mm

Snug Tight means the tightness attained by a few impacts of an impact wrench or the full effort of a person using a spud wrench.

906.04 DESIGN AND SUBMISSION REQUIREMENTS

906.04.01 Design Requirements

906.04.01.01 General

Design shall be according to CSA-S6 and the Structural Manual.

906.04.01.02 Welding

Welding design shall be according to CSA W59.

Welding procedures shall be according to CSA W47.1 and CSA W59, except where modified by CSA-S6, Clause A10.1.5.

Symbols for welding and non-destructive testing shall be according to CSA W59.

906.04.02 Submissions

906.04.02.01 General

When other authorities are involved in the approval of the design or construction of a highway structure, submissions shall be made at least 35 Days prior to commencement of work and one additional copy of the submission shall be provided for each authority.

The requirements of each authority shall be satisfied prior to commencement of fabrication.

906.04.02.02**Shop Drawings and Welding Procedures**

Three sets of the shop drawings and welding procedures shall be submitted to the Contract Administrator at least seven Days prior to commencement of fabrication, for information purposes only. Prior to making a submission, an Engineer's seal and signature shall be affixed on the shop drawings and welding procedures verifying that the details and procedures are in conformance with the Contract Documents.

The shop drawings shall include at least the following:

- a) Full detail dimensions and sizes of all component parts of the structure. These dimensions shall make allowance for changes in shape due to weld shrinkage, camber, and any other effects that cause finished dimensions to differ from initial dimensions.
- b) Identification marking of each member for erection.
- c) All necessary specifications and standards for the materials to be used.
- d) Identification of areas requiring special surface treatment.
- e) Identification of fracture-critical and primary tension members and component parts. Attachments having a length of more than 100 mm in the direction of tension and welded to the tension zone of a fracture-critical or primary tension member shall be treated as part of that member.
- f) Bolt installation requirements, including number of fitting up bolts required at each connection and oversize and slotted holes.
- g) Details of all welds, including the identification of any welds which require a surface finish of smooth or flush.
- h) Identification of material and welds requiring non-destructive testing, including the limits of the weld undergoing testing and the frequency and type of testing.
- i) Temporary welds.
- j) Location of shop and field splices.

Fabrication shall not commence until the fabricator has received one set of shop drawings and welding procedures sealed and signed by an Engineer.

A copy of the shop drawings and welding procedures shall be at the fabrication facility during fabrication.

906.04.02.03**Erection Diagrams and Erection Procedure Drawings and Calculations**

Three sets of the erection diagrams and erection procedure drawings and calculations shall be submitted to the Contract Administrator at least seven Days prior to commencement of erection, for information purposes only. Prior to making a submission, an Engineer's seal and signature shall be affixed on the erection diagrams and erection procedure drawings and calculations verifying that the erection diagrams and erection procedure drawings and calculations are consistent with the Contract Documents.

Erection diagrams and erection procedure drawings shall include at least the following:

- a) Principal dimensions of the bridge.
- b) Identification marking of each member for erection.
- c) Sizes of all members.

- d) Field welding requirements, including identification of welds requiring non-destructive testing.
- e) Size and type of bolts.
- f) Bolt installation requirements, including the number of fitting up bolts required at each connection and identification of oversize and slotted holes.
- g) Bracing during erection of structural steel.
- h) Treatment at faying surfaces for joints designed as slip critical.

Erection shall not commence until one set of erection diagrams and erection procedure drawings and calculations sealed and signed by an Engineer have been received.

A copy of the erection diagrams and the erection procedure drawings and calculations shall be at the site during erection.

906.04.02.04 Mill Test Certificates

Prior to the use of any material in fabrication, two copies of the mill test certificates for that material shall be submitted to the Contract Administrator, confirming that the material is according to the Contract Documents.

Copies of the mill test certificates for all material to be used in the fabrication shall be available for review at the fabricating plant during fabrication. The certificates shall show that the material is according to the Contract Documents.

Material used in fabrication shall be directly traceable to the mill test certificate. When material is divided, identification marking shall be transferred to all pieces.

When mill test certificates originate from a mill outside of Canada or the United States of America, the information on the mill test certificate shall be verified by testing at a Canadian laboratory. This laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The Canadian laboratory's test certificate shall be identified with the name of the laboratory and appropriate wording stating that the material is according to the specified Contract requirements. The certificate shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), signature of an authorized officer of the Canadian laboratory, and be traceable to the original mill test certificate. Material coupons to be tested in the Canadian Laboratory for the purpose of verifying mill test certificates originating from a mill outside of Canada or the United States of America shall be taken from the material sample once the material has arrived in Canada.

906.04.02.05 Test Reports for Fasteners

Proof that the bolts, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as required by ASTM F3125, ASTM A563, or ASTM F436 shall be submitted to the Contract Administrator. Verification of the acceptability of assemblage of zinc-coated bolts, nuts, and washers delivered to the job site shall also be submitted to the Contract Administrator.

For bolts, nuts, and washers supplied from a manufacturer outside Canada or the United States of America, the above information shall be verified by testing at a Canadian laboratory as outlined in the Mill Test Certificates clause.

906.04.02.06**Independent Testing Organization and Technician Information**

The name of the independent testing organization and the non-destructive testing technicians, together with proof of certification, shall be submitted to the Contract Administrator a minimum of seven Days prior to the commencement of fabrication, for information purposes only.

906.04.03**Inspection after Fabrication of the Structural Steel**

A Manufacturer's Certificate of Conformance and a Request to Proceed shall be submitted to the Contract Administrator upon completion of the fabrication of the structural steel and prior to shipping from the plant.

The structural steel shall not be delivered from the plant until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

906.05**MATERIALS****906.05.01****Steel**

Structural steel shall be new steel and of the grade and category specified in the Contract Documents and shall be according to CSA G40.20/G40.21.

ASTM A588 may be substituted when either of the following steel grades have been specified:

- a) CSA G40.20/G40.21, Grade 350A.
- b) CSA G40.20/G40.21, Grade 350AT, when the Charpy impact energy requirements are verified by the submission of test documentation.

ASTM A709, Grade 345 or Grade 345S may be substituted when either of the following steel grades have been specified:

- a) CSA G40.20/G40.21, Grade 350W.
- b) CSA G40.20/G40.21, Grade 350WT, when the Charpy impact energy requirements are verified by the submission of test documentation.

Substitution of other material for size and grade is not permitted unless approval is received from the Contract Administrator.

Material testing shall confirm that all structural steel to be used in welded fabrication contains less than 0.0008% boron. Boron content shall be reported on the mill test certificate. When verification by testing at a Canadian laboratory is required as outlined in the Mill Test Certificate clause, the boron content shall also be verified and reported.

The steel shall be identified as specified in the Control of Material clause.

906.05.02**High Strength Bolts, Nuts, and Washers**

High strength bolts shall be according to ASTM F3125, Grade A325M or Grade A490M.

High strength nuts, and hardened washers shall be suitable for use with the types of bolts being specified and shall be according to ASTM A563 and ASTM F436.

The nuts, bolts, and washers shall be supplied and shipped together as an assembly from the same manufacturer.

High strength bolts, nuts, and washers for use with unpainted corrosion-resistant steel shall be Type 3. Bolts, nuts, and washers used with steel specified in the Contract Documents to receive a paint coating or galvanizing shall be Type 1 and shall be galvanized. High strength Grade A490M bolts shall not be galvanized or plated.

906.05.03 Electrodes

Welding electrodes, electrode and flux or electrode and gas combinations shall be low hydrogen (level H16 or less) and shall be according to CSA W47.1, CSA W48, and Section 12 of CSA W59.

The weld metal shall meet the Charpy V notch impact energy requirements of CSA-S6, Table 10.15 for fracture-critical members and Table 10.14 for primary tension members.

Weld metal used with corrosion resistant steels shall have similar corrosion resistance and colour to the base metal and shall be according to CSA W59.

906.05.04 Stud Shear Connectors

Stud shear connectors shall meet the requirements of ASTM A108 Grades G10100 to G10200. All stud shear connectors shall meet the requirements of CSA W59, Annex H. Only studs of Type B as defined by CSA W59, Annex H, shall be used.

906.05.05 Pins and Rollers

Pins and rollers more than 175 mm in diameter shall be forged and annealed or forged and normalized. Pins and rollers 175 mm or less in diameter shall be forged and annealed, forged and normalized, or cold-finished carbon-steel shafting.

906.05.06 Bearings

Bearings shall be according to OPSS 1202 or OPSS 1203 or both.

906.07 CONSTRUCTION

906.07.01 Fabrication

906.07.01.01 General

The fabrication shall be according to CSA-S6, Clause A10.1.4.

All Atmospheric Corrosion Resistant (ACR) steel components shall be abrasive blast-cleaned according to SSPC-SP6/NACE No. 3 to completely remove mill scale, rust, coating, oxides, corrosion products, oil, grease, dust, dirt, and other foreign matter.

906.07.01.02 Plate Edges

Plasma arc cutting of plates up to and including 25 mm in thickness is permitted. Plasma arc cutting of plates thicker than 25 mm shall not be permitted unless approval is received in writing from the Contract Administrator. Plasma arc cutting of plates shall use oxygen as the cutting gas and all edges shall be square and free of dross.

The quality of cut edges and the inspection and repair of planar discontinuities shall be according to CSA W59.

Corners of oxygen cut girder flanges shall be chamfered 1.5 to 2.0 mm by grinding.

906.07.01.03 Straightening Material

Material with sharp kinks shall be rejected. Straightening of bends shall only be done using mechanical means or by the application of controlled heating according to CSA W59. Details of the straightening procedure including testing requirements, sealed and signed by an Engineer shall be submitted to the Contract Administrator prior to the straightening, for information purposes only.

Straightening shall only be carried out in the presence of the Owner's inspector. The Contract Administrator shall be given seven Days prior notice to arrange for the inspection.

If necessary, the Contract Administrator shall specify additional testing to be performed by the Contractor. If evidence of damage is discovered, the material shall be rejected, and the cost of testing shall be at the expense of the Contractor.

906.07.01.04 Cambering

When rolled sections are heat cambered, the details of the heat cambering procedure, sealed and signed by an Engineer, shall be submitted to the Contract Administrator seven Days prior to cambering, for information purposes only.

Plate girders shall have the required camber cut into the web with suitable allowance for camber loss due to cutting and welding.

Steel box girders fabricated with webs in an upright position shall have the fabricated camber verified by subtracting ordinates for deflections for girder segments from the relaxed camber diagram ordinates.

The use of heat to alter the camber of fracture critical or primary tension members shall be subject to approval by the Contract Administrator prior to the application of heat.

The ends of cambered girders shall be vertical under full dead load.

906.07.01.05 Horizontally Curved Girders

906.07.01.05.01 Heat Curving of Rolled Beams and Welded Girders

Girders shall be cambered before heat curving.

A detailed procedure for the heat curving operation, sealed and signed by an Engineer, shall be submitted to the Contract Administrator 14 Days prior to heat curving, for information purposes only.

906.07.01.06 Identification Marking for Erection

Each member shall carry an erection mark for identification.

Permanent marking shall be affixed in an area not exposed to view in the finished structure.

906.07.01.07 Welded Construction

906.07.01.07.01 General

All welded construction shall be according to CSA W59 and Clause A10.1.5 of CSA-S6.

All welding shall be carried out by welders having a CSA W47.1 identification card valid for the type of welding to be done and for the duration of the welding work.

The fabrication weld metal requirements, base metal repairs, and repairs of weld in fracture critical and primary tension members shall be according to CSA-S6, Clause 10.23.6.

Any company responsible for welding structures fabricated or erected according to CSA-S6 shall be certified according to CSA W47.1, Division 1 or 2.

906.07.01.07.02 Altering the Sweep of Fracture-Critical and Primary Tension Members

The use of heat to alter the sweep of fracture critical or primary tension members shall be subject to approval by the Contract Administrator, prior to the application of heat.

906.07.01.07.03 Submissions of Repair Procedures

Canadian Welding Bureau (CWB) approved welding procedure specifications, data-sheets, and repair procedures for prequalification sealed and signed by an Engineer, shall be submitted for approval to the Contract Administrator 14 Days prior to commencement of work.

906.07.01.07.04 Assembly for Welding

Assembly for welding shall be according to CSA W59 and the following:

- a) Bearing stiffeners shall be vertical under full dead load.
- b) Intermediate stiffeners shall be either true vertical or perpendicular to the horizontal work lines used to layout the girder.
- c) Bearing stiffeners fitted to bear shall have a minimum bearing contact area of 75% and a maximum separation of 1 mm over the remaining area.
- d) Fitted intermediate stiffeners shall have a minimum bearing contact area of 25% and a maximum separation of 2 mm.

906.07.01.07.05 Temporary Welds

Temporary welds shall not be used on fracture-critical and primary tension members.

Temporary welds shall not be used on flange material in compression, unless approved by the Contract Administrator.

906.07.01.07.06 Preheat, Interpass Temperature, and Heat Input Control

When making welding repairs to fracture-critical and primary tension members, the preheat requirements shall be according to CSA-S6, Table 10.16.

906.07.01.07.07 Profile of Welds

Profile of welds shall be according to CSA W59 and the Structural Manual.

906.07.01.07.08 Corrections

Welding corrections and repairs to fracture-critical and primary tension members shall be according to CSA-S6, Clause 10.23.6.

Any steel members subjected to shape corrections or straightening shall be allowed to cool in still air.

906.07.01.07.09 Peening

Peening, when required, shall be subject to approval by the Contract Administrator.

906.07.01.07.10 Stress Relief-Heat Treatment

Stress relief-heat treatment temperatures shall be recorded using thermo-couples or other methods acceptable to the Contract Administrator. A record showing temperature and time data of the heat-treating operation shall be maintained and be made available to the Contract Administrator upon request.

906.07.01.07.11 Welding Inspection

906.07.01.07.11.01 General

All welding inspection shall be according to CSA W59.

906.07.01.07.11.02 Identification Cards - Canadian Welding Bureau

Prior to commencement of welding, the Canadian Welding Bureau's transferable or non-transferable identification cards for each tacker, welder, or welding operator to be employed on the work shall be made available to the Contract Administrator. Such identification cards shall be currently valid and shall indicate the welding processes and the welding positions at which the personnel are qualified to weld.

906.07.01.07.11.03 Certification of the Independent Testing Organization

The independent organization undertaking welding testing under the Quality Control subsection shall be certified for testing bridges according to CSA W178.1. The certification shall encompass at least the following methods: radiographic, ultrasonic, and magnetic particle.

906.07.01.07.11.04 Certification of the Non-Destructive Testing Technician

The independent organization's non-destructive testing technician undertaking non-destructive testing of welds under the Quality Control subsection shall be certified according to CGSB 48.9712 Level 2 or Level 3 for the methods used.

906.07.01.07.12 Welding Corrections and Repairs for Fracture-Critical and Primary Tension Members

906.07.01.07.12.01 General

All repair procedures requiring approval shall be submitted to the Contract Administrator at least 14 Days prior to commencement of the work.

Repair procedures shall be according to CSA-S6, Clause 10.23.6.

906.07.01.07.12.02 Approval for Non-Critical Repairs

Non-critical repairs are those listed in CSA-S6, Clause 10.23.6.

Repair procedures shall be prepared and submitted to the Contract Administrator. Work on the repair shall not commence until the Contract Administrator has given written approval to proceed.

906.07.01.07.12.03 Approval for Critical Repairs

Repair procedures that are beyond those described in CSA-S6, Subclause 10.23.6.4 are considered critical and shall be individually approved by the Contract Administrator before repair welding proceeds.

Critical repairs include those listed in CSA-S6, Clause 10.23.6.

906.07.01.07.13 Non-Destructive Testing of Fracture Critical Members

The fabricator shall maintain documentation of all visual and non-destructive testing for review and verification by the Contract Administrator. Documentation shall be submitted to the Contract Administrator upon completion of the project.

906.07.01.07.14 Repair of Welds

Any section of weld that does not meet the acceptance standards shall be removed, re-welded, and re-examined.

906.07.01.07.15 Bolted Construction

906.07.01.07.15.01 General

Bolted construction shall be according to CSA-S6, Clause A10.1.6.

Once all bolts in a joint are brought to a snug tight condition and all plies in the connection are in firm contact, the nuts and the protruding bolt ends shall be match marked using an indelible paint marker before final tightening to enable the amount of relative rotation to be determined. Match marking does not relieve the bolting inspector's responsibility to ensure the inspection requirements of CSA-S6 are satisfied.

Bolts shall be sufficiently long to exclude threads from the shear plane.

906.07.01.07.15.02 Plasma Arc Cutting of Holes

Plasma arc cutting of holes shall only be permitted in plates up to and including 20 mm in thickness. Plasma arc cut holes shall be produced by mechanically guided means and the diameter of the holes shall be greater than or equal to the thickness of the plate. When plasma arc cutting of holes is permitted, the cutting gas as well as the shielding gas shall be oxygen and the surface roughness shall not exceed 25 microns (1000 micro-inches) as defined in CSA B95 Occasional gouges not more than 1.5 mm in depth are permitted. Thermally cut holes shall be 2 mm larger than the nominal diameter of the bolt and the taper shall not exceed 0.5 degrees.

906.07.01.07.15.03 Holes Drilled Using Numerically Controlled Machines

As an alternative to the shop trial assembly requirements of CSA-S6 when numerically controlled machines have prepared the boltholes, a check assembly consisting of the first components of each type of bolthole pattern to be made shall be undertaken to adequately demonstrate the accuracy of the drilling. If the check assembly is satisfactory, further assemblies of like components are not required. If the check assembly is unsatisfactory, the work shall be redone or repaired in a manner acceptable to the Contract Administrator.

906.07.01.07.15.04 Inspection

Inspection shall be according to CSA-S6 as required.

906.07.01.07.16 Tolerances

906.07.01.07.16.01 Dimensional and Workmanship Tolerances

Dimensional and workmanship tolerances shall be according to CSA W59 and Clause A10.1.7 of CSA-S6.

906.07.02 Delivery

A delivery schedule shall be provided to the Contract Administrator not less than five Days prior to shipping.

Delivery shall include loading of the members, transportation, unloading, storage at the storage site and temporary works for access.

Structural steel shall be loaded for shipping in such a manner that it can be transported and unloaded at its destination without being excessively stressed, deformed, or otherwise damaged.

Plate girders shall be transported with their webs in a vertical plane. When girders cannot be shipped with their webs in the vertical plane, static and dynamic forces during handling, transportation, and storage shall be determined using a dynamic load allowance of 100%. Computed stresses shall be according to CSA-S6, Clause 10.10 and the maximum cyclic stress range shall not exceed the constant amplitude fatigue threshold for the appropriate fatigue categories specified in CSA-S6, Table 10.4. All the calculations and associated sketches, including reasons why the girders cannot be shipped with the webs in the vertical plane, shall be submitted by the Contractor to the Contract Administrator for approval seven Days prior to shipping. The calculations and sketches shall be sealed and signed by an Engineer.

Structural steel, when stored, shall be stored in a manner to avoid excessive stress deformation or other damage.

Advertising by means of removable signing is permitted on elements only while in transit to the specified site. Any permanent markings on a surface that would be visible after installation shall not be permitted.

906.07.03 Erection

906.07.03.01 General

The Contract Administrator shall be notified in writing of the starting erection date at least 14 Days prior to the commencement of field operations.

Erection shall be according to CSA-S6, Clause A10.1.10. Additional permanent material may be provided to ensure that the member capacities are not exceeded during erection, if approved by the Contract Administrator. The additional material shall be shown in the erection diagram.

Repairs to erected material shall only be permitted after the Contract Administrator has approved the repair procedure.

Welding shall not be used to fill misplaced holes.

Hammering that can damage or distort the members is not permitted.

906.07.03.02 Falsework

Falsework shall be according to OPSS 919.

906.07.03.03 Connections

Holes made in the field shall be drilled or sub-drilled and reamed.

Any error that prevents the proper assembly and fitting of parts shall be reported and the proposed method of correction shall be submitted to the Contract Administrator. Corrective measures shall not commence until the submitted proposal is accepted.

Bolt heads shall be located on the outside faces of the exterior girders.

Bolt heads in field splices for box girders shall be located on the exterior surfaces.

906.07.03.04 Maintaining Alignment and Camber

The bridge shall be erected to the alignment and elevations specified in the Contract Documents.

906.07.03.05 Bearings

The installation of bearings shall be according to OPSS 922.

906.07.03.06 Coatings

Coating of new structural steel shall be according to OPSS 911.

906.07.04 Quality Control

906.07.04.01 General

Quality control shall be according to CSA-S6, Clause A10.1.8. The acceptance standards of CSA W59 for dynamically loaded structures shall also apply.

In addition to quality control measures instituted by the Contractor, the Contractor shall be responsible for the quality control procedures specified herein.

906.07.04.02 Control of Material

A record for each component shall be kept identifying the material as to heat number, corresponding mill test certificate, and colour coding or other identification markings.

906.07.04.03 Visual Inspection

The Contractor's inspector shall carry out full visual inspection.

906.07.04.04 Non-Destructive Testing

906.07.04.04.01 General

An independent testing organization shall carry out all non-destructive testing of the welds for bridge structures by using radiographic, ultrasonic, magnetic particle, and liquid penetrant test methods as applicable.

A non-destructive testing technician shall do the testing.

Neither the technician nor the independent testing organization shall be changed without the approval of the Contract Administrator.

906.07.04.04.02 Notification of Testing

The independent testing organization shall be given at least five Days notice of when the work is ready for testing. Such notice shall include the type and quantity of work to be tested.

906.07.04.04.03 Testing of Welds

Radiographic, ultrasonic, or magnetic particle testing shall be carried out using procedures according to CSA W59.

The amount and location of welding to be tested shall not be less than:

- a) Visual inspection of all welds.
- b) Radiographic or ultrasonic inspection of groove welds in flanges and webs of built-up girders:
 - i. Flange splices in tension or stress reversal zones: 100% of all welds.
 - ii. Flange splices in compression zones: 100% of the weld of 1 in 4 splices.
 - iii. Web splices for 1/2 the depth from the tension flange: 100% of the weld length for each weld.
 - iv. Web splices for 1/2 the depth from the compression flange: 100% of the weld length of 1 in 4 splices.

If defects are found during testing of compression zones, two additional zones shall be tested for each zone exhibiting defects.

- c) Magnetic particle inspection of web-to-flange fillet welds:
 - i. Submerged-arc welds - 25% of length of each weld.
 - ii. Semi-automatic welds - 50% of length of each weld.
 - iii. Manual welds - 100% of length of each weld.
- d) Magnetic particle inspection of fillet welds in connection plates and stiffeners to which diaphragms or cross bracing are attached:
 - i. For 1/2 the depth from the tension flange: 100% of weld length of each weld.
 - ii. Transverse welds on tension flanges: 100% of weld length of each weld.
- e) Arc strikes shall be lightly ground and checked for cracks by magnetic particle inspection.

Radiographic and ultrasonic testing shall be performed prior to the assembly of the flanges to the webs.

906.07.05 Repair of Welds

Any section of weld that does not meet the acceptance standards shall be removed, re-welded, and re-examined.

906.07.06 Inspection Reports

Inspection reports shall be sealed and signed by an Engineer.

Inspection reports shall be made available to the Owner's inspector upon request. Copies of all inspection reports shall be submitted to the Contract Administrator within seven Days of inspection.

906.07.07 Erected Girder Elevations

The top of flange elevations and top of splice plate elevations specified in the Contract Documents shall be checked and recorded and shall be submitted to the Contract Administrator within seven Days.

906.07.08 Inspection after Installation of the Structural Steel

A Request to Proceed shall be submitted to the Contract Administrator after the installation of the structural steel.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

906.07.09 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

906.08 QUALITY ASSURANCE

906.08.01 General

Visual inspection, non-destructive testing, and sampling shall be done in the fabrication shop and in the field by an Owner's inspector to confirm the material supplied, fabrication, and erection has been done as specified in the Contract Documents.

Electric power, scaffolding, protection from the weather, and free access for inspection and testing of material, to all aspects of the fabrication, delivery, and erection of the structural steel shall be supplied.

906.10 BASIS OF PAYMENT

906.10.01 Fabrication of Structural Steel - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

Structural steel that is stored at the fabricator's premises or some other location away from the Working Area shall be paid for when the Contractor obtains a lease from the property owner that names the Owner as the tenant. The Owner shall provide the form of lease for this purpose that specifies payment of \$10.00 for the term of the lease. The Contractor shall retain full responsibility for the members.

906.10.02 Delivery of Structural Steel - Item Erection of Structural Steel - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

906.10.03 Shop and Field Inspection and Testing

The supply of electric power, scaffolding, protection from the weather, and access for material testing and inspection shall be the Contractor's responsibility at no extra cost to the Owner.

906.10.04 Bearings

Payment for the supply and installation of bearings shall be according to OPSS 922.

When the Contract does not contain a separate item for bearings and bearings are not paid as part of any concrete tender item according to OPSS 904, the Contract price for the erection of structural steel shall include full compensation for all labour, Equipment, and Material to supply and install the bearings.



CONSTRUCTION SPECIFICATION FOR METAL RAILINGS FOR STRUCTURES

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908.01	SCOPE

This specification covers the requirements for metal railings and inspector guard for structures including posts and anchorage assembly.

908.02	REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 906	Structural Steel for Bridges
OPSS 911	Coating Structural Steel Systems

Ontario Ministry of Transportation Publications

Designated Source for Materials (DSM)

CSA Standards

G40.20/G40.21-04 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels
O80 Series-08 (R2012)	Wood Preservation
W47.1-19	Certification of Companies for Fusion Welding of Steel
W47.2-11 (R2020)	Certification of Companies for Fusion Welding of Aluminum
W59-18	Welded Steel Construction
W59.2-18	Welded Aluminum Construction
S6:19	Canadian Highway Bridge Design Code

ASTM International

A27/A27M-20	Standard Specification for Steel Castings, Carbon, for General Application
A108-18	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
A123/A123M-17	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-16a	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A307-14	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A500/A500M-20	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A563-15	Standard Specification for Carbon and Alloy Steel Nuts
A780/A780M-09(2015)	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B108/B108M-19	Standard Specification for Aluminum-Alloy Pavement Mold Castings
B117-19	Standard Practice for Operating Salt Spray (Fog) Apparatus
B209M-14	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
B221M-13	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
B695-04(2016)	Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
D4541-17	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
F593-17	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F594-09(2020)	Standard Specification for Stainless Steel Nuts
F844-19	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
F880M-16	Standard Specification for Stainless Steel Socket Set Screws (Metric)
F3125/F3125M-19	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

SSPC, American Welding Society (AWS) and NACE Joint Publications

SSPC-CS 23.00 / AWS C2.23M / NACE No.12-2016	Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for Corrosion Protection of Steel.

908.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchorage Assembly means an assembly of metal plates, rods/bolts, nuts and washers installed with posts to anchor metal railing/inspector guard system into concrete.

Barrier Wall Railing means a metal railing that is anchored to the top of a concrete barrier wall and is part of a barrier system that has undergone the barrier appraisal requirements of CSA-S6.

Bicycle Railing means an all-metal barrier system mounted on a structure that is designed to meet the bicycle barrier requirements of CSA-S6.

Combination Railing means a metal railing that is fastened to concrete barrier designed to meet the combination barrier requirements of CSA-S6.

Inspector Guard means metal safety guard anchored to the concrete abutment seat, walls or RSS coping to protect the inspector from a fall during inspection and has been designed to meet the Ontario Building Code requirements.

Metal Railing is a generic term used for metal part of parapet wall, barrier wall, pedestrian, bicycle, or combination railing.

Parapet Wall Railing means a metal railing that is fastened to the top of a concrete parapet wall and is part of a traffic barrier system that has undergone the barrier appraisal requirements of CSA-S6.

Pedestrian Railing means an all-metal railing system mounted on a structure that is designed to meet the pedestrian barrier requirements of CSA-S6.

908.04

DESIGN AND SUBMISSION REQUIREMENTS

908.04.01

Submission Requirements

908.04.01.01

General

Three sets of Working Drawings shall be submitted to the Contract Administrator, prior to commencement of fabrication of the metal railing and/or inspector guard, for information purposes only. Prior to a submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are as specified in the Contract Documents.

When multi-discipline engineering work is depicted on the same Working Drawing and a single Engineer is unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional Engineers as necessary.

The manufacturer shall not commence fabrication of the metal railing or the inspector guard until receiving a sealed and signed copy of the Working Drawings. A copy of these drawings shall be retained at the manufacturing plant during the fabrication.

A sealed and signed copy of the metal railing and/or inspector guard Working Drawings shall be at the site prior to and during installation of the metal railing and/or inspector guard.

908.04.01.02 Inspection after the Fabrication of Metal Railing and Inspector Guard

A Manufacturer's Certificate of Conformance and a Request to Proceed for each individual shipment shall be submitted to the Contract Administrator upon completion of fabrication of the metal railing and inspector guard and prior to shipping from the plant.

The metal railing and inspector guard for each individual shipment shall not be delivered from the plant until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

908.04.01.03 Mill Test Certificates

Mill test certificates shall be submitted according to OPSS 906.

908.04.01.04 Test Reports for Fasteners and Anchorages

Test reports demonstrating that the bolts, anchorages, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as specified in the Contract Documents shall be submitted to the Contract Administrator. Verification of the acceptability of assemblage of zinc-coated bolts, anchors, nuts, and washers delivered to the job site shall be submitted to the Contract Administrator.

For bolts, anchors, nuts, and washers supplied from a manufacturer outside of Canada or the United States of America, the above information shall be verified by testing at a Canadian laboratory according to the Mill Test Certificates clause of OPSS 906.

908.05 MATERIALS

908.05.01 Metal Railings

908.05.01.01 Steel Railing and Steel Posts

Steel shall be according to CSA G40.20/G40.21.

Rails and posts shall be Grade 350W or 350WT as specified in the Contract Documents.

Steel plate shall be Grade 300W or 350W as specified in the Contract Documents.

Galvanized bolts and nuts shall be according to ASTM A307 or ASTM F3125/F3125M, Grade A325 as specified in the Contract Documents.

Studs shall be according to ASTM A108. Lock nuts shall be according to ASTM A563. Washers shall be according to ASTM F844.

Cast steel posts shall be according to ASTM A27, Grade 65-35.

Paint shall be as specified in the Contract Documents.

908.05.01.02 Aluminum Railing and Aluminum Posts

Extruded aluminum tubing shall be 6061-T6 or 6351-T6 alloy according to ASTM B221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B209M.

Cast Posts shall be A444.0-T4 heat-treated according to ASTM B108. Extruded posts shall be 6061-T6 or 6351-T6.

908.05.01.03 Stainless Steel Fasteners

Bolts shall be according to ASTM F593, Type 304 or 316 stainless steel with matching nuts according to ASTM F594 and matching washers. Set screws shall be according to ASTM F880M, Type 304 or 316 stainless steel.

908.05.01.04 Galvanized Hardware

L-bolt assemblies shall be according to ASTM A307 and include hex nuts, flat washers, and lock washers. The assemblies shall be galvanized according to ASTM A153/A153M.

908.05.02 Inspector Guard

Steel railing and posts shall be according to ASTM A500 Grade C, or CSA G40.20/G40.21 Grade 300W.

Steel plate shall be Grade 300W as specified in the Contract Documents.

Galvanized bolts and nuts shall be as specified in the Contract Documents.

Lock nuts shall be according to ASTM A563. Washers shall be according to ASTM F844.

Coating shall be as specified in the Contract Documents.

908.05.03 Anchorage Assembly

Anchorage assemblies shall be as specified in the Contract Documents.

The anchorage assembly shall be supplied with the bolts installed in a template.

908.05.04 Grout

Grout shall be non-staining, non-shrink cement based grout or non-staining, non-shrink epoxy based grout, and as specified in the Contract Documents.

908.05.05 Hot Dip Galvanizing

Purity of the zinc and the galvanizing bath composition for hot dip galvanizing of steel railing and Inspector Guard components shall be according to ASTM A123/A123M.

908.05.06 Zinc-Rich Touch-Up Paint

Zinc-rich touch-up paint shall be according to the ministry's DSM.

908.05.07 Thermal Sprayed Metal Coatings

Thermal sprayed metal coatings shall be according to SSPC-CS 23.00 / AWS C2.23M / NACE No.12. The metallizing wire for thermal metal spray coatings shall be an alloy consisting of 85% zinc and 15% aluminum.

908.05.08 Zinc-Tin-Copper Solder

The zinc-tin-copper solder shall be 50% zinc, 49% tin, and 1% copper used with the manufacturer's recommended flux.

908.07 CONSTRUCTION

908.07.01 Fabrication of Metal Railings and Inspector Guard

908.07.01.01 General

The railing system and inspector guard components shall be fabricated as specified in the Working Drawings. Field modification shall only be done when approved by the Contract Administrator.

The fabricator shall be certified according to CSA W47.1, Division 1 or Division 2 for steel railings or CSA W47.2, Division 1 or Division 2 for aluminum railings.

908.07.01.02 Steel Components

908.07.01.02.01 Fabrication

908.07.01.02.01.01 General

Fabrication and welding shall be according to OPSS 906 and CSA W59. All welding inspection shall be according to CSA W59.

All flame cut edges shall be as smooth and regular as those produced by edge planing and shall be free of slag.

908.07.01.02.02 Surface Preparation for Hot Dip Galvanizing

The metal railing and inspector guard components shall be cleaned according to OPSS 911 prior to galvanizing.

908.07.01.02.03 Hot Dip Galvanizing

Hot dipped galvanizing of steel railing and inspector guard components shall be according to OPSS 911.

908.07.01.02.04 Zinc and Zinc-Nickel Plating

Setscrews shall have zinc-nickel plating applied to a thickness of 10 µm. The plating shall show no red rust after 1,000-hour exposure to salt spray according to ASTM B117.

Lock nuts shall be zinc plated according to ASTM B695.

908.07.01.02.05 Paint Coating of Galvanized Surfaces

When specified, paint coating of galvanized surfaces shall be according to OPSS 911.

908.07.01.02.06 Repair of Damage to Galvanized Coating

When the galvanized surface of a steel railing or inspector guard component is damaged or uncoated, the exposed steel shall be repaired if the cumulative total of the damaged and uncoated areas does not exceed 2% of the total area of each component or 0.02 m², whichever is less. Where the cumulative area exceeds these amounts, the damaged coating shall be stripped and the component re-galvanized according to ASTM A123/A123M.

Damaged and uncoated areas shall be cleaned of all rust and other contaminants and repaired using one of the following methods:

a) Soldering method using zinc-tin-copper solder

The surface preparation and application of flux and zinc-tin-copper solder shall be according to ASTM A780/A780M and the manufacturer's recommendations. The finished thickness of the metal coating in the repaired area shall be a minimum of 90 µm. The repaired surface shall be ground flush with the surrounding galvanized coating.

b) Thermal Metal Spraying

The surface preparation and application of thermal spray metal coating or metallizing shall be done according to SSPC-CS 23.00/AWS C2.23M/NACE No. 12 to provide a minimum thickness of 200 µm, applied in two separate coats.

The metal coating on the repaired areas shall have a minimum adhesion of 2.8 MPa, when tested according to ASTM D4541.

c) Zinc-Rich Touch-Up Paint

This method of repair of galvanized coating is permitted when:

- i. The individual damaged and uncoated area is less than 625 mm², and
- ii. The number of repair spots does not exceed 6 per each 12 m section of galvanized rail bar or inspector guard. The number of repair spots in each galvanized rail post shall be limited to a maximum of 2.

Two coats of one of the approved zinc-rich touch-up paint shall be brush applied after the surface preparation according to ASTM A780/A780M.

908.07.01.03 Aluminum Components

908.07.01.03.01 Fabrication

908.07.01.03.01.01 General

Welding of aluminum shall be permitted only where specified in the Working Drawings.

Fabrication and welding shall be according to CSA W59.2. All welding inspection shall be according to CSA W59.2.

Aluminum railings and posts shall be thoroughly cleaned of all discolorations by approved methods and all marks and scratches shall be removed. The railings, when erected, shall have a clean degreased aluminum surface of uniform appearance and texture.

Railing components shall be joined by riveting, bolting, expanding, or welding as specified in the Working Drawings. Special aluminum alloy fasteners shall only be used with written approval from the Contract Administrator.

When tubular balusters are fastened to the horizontal rails by expanding the tubes, the holes drilled into the rail shall not be more than 1 mm greater than the nominal diameter of the baluster tube. A standard self-feeding tapered roll expander shall be used to expand the balusters to allow for a tight fit in all rails.

Sheet or plate material may be sheared, sawn, or cut with a router; however, sheet or plate materials more than 10 mm thick shall only be sawn or routed. Cut edges shall be true and smooth, free from excessive burrs and ragged edges.

Re-entrant cuts shall only be used when unavoidable and, when they are used, a fillet shall be provided by drilling prior to cutting.

Aluminum alloys shall not be flame cut.

Boltholes in 10 mm or thinner material may be drilled or punched to finished size. In material thicker than 10 mm, the holes shall be drilled to finished size or sub-punched smaller than the nominal diameter of the fastener and reamed to size.

During fit-up, holes shall not be drifted in such a manner as to distort the metal, but holes misaligned less than 2 mm may be reamed to render a reasonable fit.

The shank of bolts shall be long enough to provide full bearing in the connection and, where the shank extends beyond the surface being clamped, washers shall be used under the nuts to ensure proper clamping.

908.07.01.03.02 Contact Surfaces

Where aluminum would otherwise come in contact with other metal surfaces, the contacting surfaces shall be separated from each other by use of a synthetic rubber or neoprene gasket. The single rail and double rail galvanized steel railings mounted on aluminum casting posts on top of a barrier wall or parapet wall are exempt from these requirements.

Where aluminum would otherwise come in contact with concrete, wood, or masonry, the contact surfaces shall be separated by means of a synthetic rubber or neoprene gasket or the aluminum surface shall be given a heavy coat of alkali-resistant bituminous paint prior to installation. The paint shall be applied as it is received from the manufacturer without the addition of thinner.

908.07.02 Anchorages

908.07.02.01 General

Anchorage assemblies shall be installed as specified in the Contract Documents.

908.07.02.02 Anchorages Installed Before Concrete Placement

When specified in the Contract Documents, anchorage components shall be installed prior to placing concrete and shall be securely tied to reinforcing steel. Anchorage assemblies shall be positioned with templates and installed securely in the formwork to maintain the position of the anchors during placement of concrete.

908.07.02.03 Anchorages Installed After Concrete Placement

When specified in the Contract Documents, anchorages shall be installed after concrete placement. Holes shall be core drilled, anchoring grout placed, and anchors properly positioned at locations as specified in the Contract Documents. The placement of the anchoring agent and the anchors shall be according to the manufacturer's recommendations, except as modified in this clause. The holes shall be free of dust and debris immediately prior to placement of the anchoring agent. When the anchoring agent fails to fill the hole after insertion of the anchor, additional anchoring agent shall be immediately added to fill the hole.

When a cement based grout is used as the anchoring agent, the holes shall be pre-dampened for a period of one hour and any free water shall be removed prior to the application of the cement based grout.

When an epoxy grout is specified as the anchoring agent, the inside surface of the holes shall be roughened and dry prior to the application of the epoxy grout.

Where anchors are inserted into horizontal or inclined holes in a vertical face, the anchors shall be maintained in position during the setting of the anchoring agent. Loss of anchoring agent from the holes shall be prevented.

908.07.02.04 Anchorages Installed in Timber

Holes for bolts shall be drilled with a bit 1.5 mm larger in diameter than the bolt. The diameter of the recessed holes for the bolt heads shall be no greater than 10 mm larger than the width of the bolt head.

Where oil treatment has been used on the wooden curbing, the cut surfaces of the wood shall be given three coats of creosote oil. Each coat shall be allowed to dry before the next coat is applied.

Repairs to cuts in material treated with water-borne preservatives shall be according to CSA O80 Series.

908.07.03 Installation of Metal Railings and Inspector Guard

908.07.03.01 General

Metal railing and inspector guard shall be installed according to the Working Drawings.

Metal railing and inspector guard components shall be protected from damage and distortion during hot dip galvanizing, handling, transportation, storage, and installation.

Bedding grout shall not be used. Epoxy grout may be placed under post bases, as necessary, to fill the voids. The epoxy grout shall not have a thickness exceeding 3 mm. The surface preparation, mixing, installation, and curing time for the epoxy grout shall be according to the manufacturer's recommendations.

The work shall include installation of the anchorage assemblies installed after concrete placement or installed in wood.

908.07.03.02 Alignment

The metal railing and inspector guard shall be installed to the elevations and alignments as specified in the Contract Documents within a tolerance of ± 6 mm and with no kinks or other visible breaks in alignment throughout the length of the installation.

908.07.04 Quality Control

908.07.04.01 Inspection After Preparation of the Anchorages

A Request to Proceed shall be submitted to the Contract Administrator upon preparation of the anchorages and prior to the installation of the metal railing or inspector guard.

The installation of the metal railing or inspector guard shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

908.07.04.02 Inspection After Installation of the Metal Railing or Inspector Guard

An inspection after installation shall be performed of the metal railing and/or inspector guard to ensure all the requirements are met as specified in the Working Drawings. The alignment of the metal railing or inspector guard shall remain within the tolerance limits after installation.

908.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

908.08 QUALITY ASSURANCE

908.08.01 General

Access shall be provided to the Owner to do inspection, testing, and sampling in the fabricating shop and field if requested to confirm that the materials supplied, the fabrication, and the installation have been completed as specified in the Contract Documents and Working Drawings.

908.09 MEASUREMENT FOR PAYMENT

908.09.01 Actual Measurement

**908.09.01.01 Barrier Wall Railing
Parapet Wall Railing
Pedestrian Railing
Bicycle Railing
Combination Railing
Inspector Guard**

Measurement of metal railings and inspector guard shall be by length in metres from end to end of the railing/inspector guard.

908.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

908.10 BASIS OF PAYMENT

**908.10.01 Barrier Wall Railing - Item
Parapet Wall Railing - Item
Pedestrian Railing - Item
Bicycle Railing - Item
Combination Railing - Item
Inspector Guard - Item**

Payment at the Contract price for the above tender items shall be full compensation for labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR PRESTRESSED CONCRETE - PRECAST GIRDERS

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APPENDICES

909-A	Commentary

909.01	SCOPE

This specification covers the construction requirements for fabrication, delivery, and installation of precast prestressed concrete girders with steel reinforcement.

909.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

909.01.02 Appendices Significance and Use

Appendices are not for use in provincial Contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner.

Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their Contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

909.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 905	Steel Reinforcement for Concrete
OPSS 910	Stressing Systems for Post Tensioning
OPSS 919	Formwork and Falsework
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1002	Aggregates - Concrete
OPSS 1213	Hot Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual:

LS-407	Method of Test for Compressive Strength of Moulded Cylinders
LS-426	Method of Test for Compressive Strength of High Performance Concrete Cylinders
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
LS-446	Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration – For Precast Girders

Structural Manual

MTO Form:
PH-CC-322 Concrete Construction Report

CSA Standards

A23.2-3C	Making and Curing Concrete Compression and Flexural Test Specimens *
A23.2-1D	Moulds for Forming Concrete Test Cylinders Vertically *
A23.2-9C	Compressive Strength of Cylindrical Concrete Specimens*
A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing*
A23.4-09	Precast Concrete Material and Construction
G40.20/G40.21-04	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
G189-1966 (R2003)	Sprayed Metal Coatings for Atmospheric Corrosion Protection
CAN/CSA S6-14	Canadian Highway Bridge Design Code
W47.1-09	Certification of Companies for Fusion Welding of Steel Structures
W59-03 (R2008)	Welded Steel Construction (Metal Arc Welding)
W186-03 (R2007)	Welding of Reinforcing Bars in Reinforced Concrete Construction

* [Part of A23.1-14/A23.2-14 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

A 153-09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B 633-07	Electrodeposited Coatings of Zinc on Iron and Steel
C 171-07	Sheet Materials for Curing Concrete
C 403-08	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

American Association of State and Highway Transportation Officials (AASHTO)

M182-05 (2009) Burlap Cloth made from Jute or Kenaf and Cotton Mats

909.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bed means the assembly consisting of platform, forms and end blocks in which the girders are cast.

Bughole means a small regular or irregular cavity resulting from entrapment of air bubbles in the surface of formed concrete during placement and consolidation.

Cold Joint means a joint or discontinuity resulting from a delay in placement of sufficient duration to preclude intermingling and bonding of the concrete.

Cold Weather means when the air temperature to which the girder is exposed is at or below 5 °C, or when the air temperature to which the girder is exposed is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Design Proposal means a submission of proposed changes, when engineering design is required.

Laitance means a layer of weak and nondurable material on the surface of the concrete containing cement and fines from aggregates, brought by bleeding water to the top surface concrete.

Lot means all girders produced during a one-week period (seven consecutive days); or, if more than 4 girders are produced in seven consecutive days, a lot means every 4 girders produced consecutively. Girders of the same lot shall be manufactured by the same supplier, made from the same concrete mix design, for the same ministry Contract, and be of the same cross-section and type of precast concrete girder.

Girder Type means a girder differentiated by its cross-section shape such as box girder type (solid or voided), I-girder type (such as Nebraska University (NU) and Canadian Precast Prestressed Concrete Institute (CPCI)), or T-girder type.

Indoor Precast Concrete Plant means a building, which is a permanent structure, providing protection from sun, wind, and rain and which is temperature controlled, such that the temperature does not fall below 15 °C or exceed 30 °C.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Pour Line means a visible delineation between two placements of concrete where the concrete from each placement is well-bonded to the other.

Precaster means the party who produces the girders.

Prestressed Concrete means reinforced concrete in which internal stresses have been initially introduced so that subsequent stresses resulting from dead load and superimposed loads are counteracted to a desired degree. This may be accomplished by pretensioning or post-tensioning.

Pretensioning means a method of prestressing in which strands are tensioned before the concrete is placed.

Repair Proposal means a submission when repairs to the girders are required.

Strand means a group of wires laid helically over a central core-wire.

Sweep means the lateral deviation from straightness of a girder with respect to its design centre line.

Tendon means a high strength steel element consisting of one or more wires, strands or bars; used to impart prestress to the concrete.

909.04 DESIGN AND SUBMISSION REQUIREMENTS

909.04.01 Design Requirements

909.04.01.01 General

The design shall be according to CAN/CSA S6 and the Structural Manual.

909.04.01.02 Permissible Changes from the Contract Drawings

909.04.01.02.01 General

Changes from the Contract Drawings are permitted and may be implemented by the precaster, without prior approval from the Owner, provided they meet the requirements of this specification.

909.04.01.02.02 Prestressing of Girders

The prestressing strand pattern may be adjusted to suit production requirements provided all changes meet the original design strength without adversely affecting other components of the structure. If the centre of gravity of the strands at the interior hold down closest to mid-span is within ± 10 mm of the original design, then one or more of the following adjustments shall be permitted provided that both the serviceability and ultimate limit states capacities are not adversely affected:

- a) Provide additional strands with a lower jacking stress provided the total prestress force is within $\pm 2\%$ of the original design.
- b) Use of imperial strand spacing in lieu of metric, where 25 mm = 1" and 50 mm = 2".
- c) Addition of one hold-down per end is added towards the girder end at the same spacing as the original design.
- d) One less hold-down per end when the hold-down closest to mid-span is deleted.
- e) Increase or decrease the number of strands in each hold-down group.
- f) Increase of vertical strand spacing between hold-down points from 25 mm up to 50 mm.

909.04.01.02.03 Reinforcing of Girders

The stirrup projection may be adjusted from that shown on the original design, based on details such as the predicted camber, provided it meets the deck embedment range indicated elsewhere in the Contract Documents.

Spacing of stirrups around blockouts for diaphragms may be adjusted, provided the minimum spacing requirements of CAN/CSA S6 are satisfied, and up to two stirrups may be added in order to maintain the total reinforcement requirements.

909.04.01.02.04 Other Design Details

Details limited to those below may be adjusted to suit production requirements, provided all changes meet the original design without adversely affecting other components of the structure:

- a) Dowel holes and inserts may be adjusted vertically within ± 75 mm from the location shown on the original design to avoid any conflict with strands.
- b) Undercut dimensions may be adjusted to accommodate the predicted camber.
- c) Additional pockets and hardware for temporary bracing may be added.
- d) Additional temporary post-tensioning or pre-tensioning for shipping and handling may be added provided they do not adversely affect the girders at any stage.

The production length of the girder may be adjusted to account for elastic shortening.

909.04.01.03 Temporary Bracing

Temporary bracing shall be installed at all substructure locations for I-girders at the time of installation to maintain stability.

Temporary bracing for girders shall be designed according to CAN/CSA S6 using a wind load specific for the location and having a return period of 10 years if the girders are to be permanently connected within the same construction season. If the girders are not to be permanently connected within the same construction season, subject to the Owner's approval, the return period to be used in the design shall be 25 years.

In no case shall temporary bracing be less than the minimum requirements specified in the Contract Documents.

909.04.02 Submission Requirements

909.04.02.01 Working Drawings

Three sets of fabrication Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator at least 7 Days prior to commencement of fabrication of the girders, for information purposes only. Prior to making a submission, the design Engineer and the design-checking Engineer shall affix their seals and signatures on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

When other authorities are involved in the approval of the design or construction of a highway structure, the fabrication Working Drawings submission shall be at least 5 weeks prior to commencement of the work and one additional copy of the submission shall be provided for each authority. The requirements of each authority and the requirements of the Owner as specified in the Contract Documents shall be satisfied prior to commencement of the work.

The Working Drawings shall include the following information:

- a) Girder details.
- b) Prestressing reinforcing steel size, grade, location, and jacking force as required by the design.
- c) Hold-down locations and forces.
- d) Reinforcing steel schedules.
- e) Lifting point locations.
- f) Details and location of all temporary supports.
- g) Strand release sequence.
- h) Any changes to the Contract Drawings made according to the Permissible Changes from the Contract Drawings clause.
- i) All other applicable details.

The supporting documents shall include the following information:

- j) A letter signed and sealed by an Engineer listing all permitted changes made along with supporting calculations. The letter shall state that the changes have not adversely affected the girder capacities.

- k) Handling and installation procedures, including calculations and lifting point locations.
- l) Details of bracing installed to provide adequate support and stability to the girder during construction.

909.04.02.02 Concrete Mix Design

The Contractor shall be responsible for the concrete mix design and shall submit the concrete mix design to the Contract Administrator according to the Mix Design clause of OPSS 1350.

909.04.02.03 Concrete Plant Certification

The certificate verifying compliance of the plant with the certification requirements of the Canadian Standards Association (CSA) or CPCI, under the category Group B, Bridges as either subcategory B4 (Prestressed Deflected Strand Bridge Members) or subcategory B3 (Prestressed Straight Strand Bridge Members), as required for the work, shall be submitted to the Contract Administrator with the concrete mix design submission.

Copies of precast plant certification audit reports of CPCI or CSA, or both as applicable, and related documentation shall be submitted to the Owner upon request.

Documentation verifying certification of the concrete production facility by the Ready Mixed Concrete Association of Ontario shall be submitted when concrete is supplied by a ready-mixed concrete supplier.

909.04.02.04 Control of Concrete Temperature

One week prior to the commencement of fabricating the girders, a description of the method for monitoring and effectively controlling the temperature of the concrete shall be submitted to the Contract Administrator, for information purposes only. The description shall include the method of controlling the concrete temperature during the curing and protection period.

909.04.02.05 Precast Report

A precast report shall be submitted to the Contract Administrator for each shipment of girders, prior to shipping the girders. The report shall contain the following information:

- a) List of girders in the shipment, including their ID number, lot number, and description.
- b) The mill certificates for the strands, along with the elongation calculations based on the actual material properties specified in the mill certificate of the strands used in the work.
- c) Record of the jacking force, elongations, and corrections.
- d) Temperature records for formwork and steel at the time of concrete placement.
- e) Temperature control records, including location of thermocouple wires.
- f) Record of inspection of moist curing.
- g) Summary of material test results for plastic concrete: air content, slump, and concrete temperature.
- h) Summary of material test results for hardened concrete: transfer strength, confirmation of the projected 28-Day compressive strength. If test results are not available at the time of shipping, they may be submitted within 4 Business Days following completion of testing.
- i) Summary of all measurements and inspections required by this specification, including the concrete cover, crack measurement summary, tolerances, and surveys for geometric control.

- j) Documentation confirming that all repairable defects have been identified, evaluated, and repaired as detailed in the Repair of Defects and Deficiencies Repairable by Standard Methods clause.
- k) A letter from the Quality Verification Engineer (QVE), giving the Contractor permission to proceed with the work. The letter shall state that the QVE has conducted an interim inspection and verified that the fabrication of girders and required testing have been carried out in general conformance with the sealed and signed Working Drawings, supporting documents, and Contract Documents.
- l) When steam curing is used, test results indicating that time of initial set was determined, unless standard delay periods are used, according to the Steam Curing and Other Application of Heat clause.

909.04.02.06 Design Proposals

Five copies of the design proposal shall be submitted to the Contract Administrator for acceptance. The design proposals shall bear the seal and signature of the design Engineer and the design checking Engineer. The Contractor shall not proceed with the proposed changes until the design proposal has been accepted by the Contract Administrator.

The Contract Administrator shall provide a response within 10 Business Days of receiving the proposal.

909.05 MATERIALS

909.05.01 Bearing Plate

The bearing plate shall be according to CSA G40.20/G40.21, Grade 300W or greater.

Anchor studs shall be a headed type and be according to CSA W59 and shall be welded to the bearing plates prior to galvanizing.

All surfaces shall be hot dipped galvanized according to ASTM A153 or shall be zinc metallized according to CSA G189.

909.05.02 Burlap

Burlap shall be according to AASHTO M182, Class 4, and shall be free from substances that are deleterious to concrete. The burlap shall have no tears or holes.

909.05.03 Concrete

Concrete materials shall be according to the Materials section of OPSS 1350 with the following additions and amendments:

- a) Compressive strength shall be as specified in the Contract Documents.
- b) The air void system in hardened concrete when tested according to LS-432 shall be:
 - i. Air Content: 3.0% minimum
 - ii. Spacing Factor: 0.200 mm maximum
- c) Rapid chloride permeability of concrete containing silica fume at 28 to 32 Days shall be equal to or less than 1,000 coulombs and rapid chloride permeability of all other concrete at 28 Days shall be equal to or less than 2,500 coulombs.

- d) Aggregates shall be according to OPSS 1002. The nominal maximum size of coarse aggregate shall be 19.0 mm, except when a smaller nominal size is required in order to meet the requirements of CAN/CSA S6.
- e) Slag aggregate shall not be used.
- f) Superplasticizer may be added to the mix at time of batching for all types of concrete.

When self-consolidating concrete (SCC) is proposed to be used, it shall be subject to Owner approval prior to use. Where accepted for use, SCC shall be according to the Owner's requirements for self-consolidating concrete. A copy of the non-standard Special Provision can be obtained from the Materials Engineering and Research Office, Concrete Section.

909.05.04 Concrete Sealers

Concrete sealers shall be from the Owner's list of acceptable sealers.

909.05.05 Elastomeric Coating

Elastomeric coating shall be according to OPSS 1213.

909.05.06 Formwork

Formwork shall be fabricated steel, except for box girders of non-standard width for which wood forms may be used. All formwork shall be according to OPSS 919 and CAN/CSA A23.4. Forms shall be fabricated to meet the dimensional tolerances and finishes specified in the Contract Documents.

909.05.07 Hardware

All hardware shall be non-corroding or be galvanized according to ASTM A153.

The hold down device may be black steel; however, the surfaces of the hold down device located within 40 mm of the concrete surface shall be chromate coated over an electrodeposited coating of zinc according to ASTM B 633.

909.05.08 Moisture Vapour Barrier

The moisture vapour barrier shall be a white opaque polyethylene film according to ASTM C171 and shall not be less than 100 µm thick.

909.05.09 Post-Tensioning Material

Post-tensioning material, including grout, shall be according to OPSS 910.

909.05.10 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's List of Concrete Patching Materials. The list of proprietary patching materials shall be obtained from the Contract Administrator.

909.05.11 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

909.05.12 Water

Water used for curing, fog-misting, and steam curing of concrete, including presoaking of material for moist curing, shall be according to OPSS 1302.

909.06 EQUIPMENT

909.06.01 Chipping Hammers

Chipping hammers shall have a maximum weight of 9.0 kg and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and model number engraved on them by the manufacturer. All information must be legible.

909.06.02 Pretensioning and Post-Tensioning

Pretensioning equipment shall be according to CSA A23.4. Post-tensioning equipment shall be according to OPSS 910.

909.06.03 Thermocouples and Dataloggers

Thermocouples and associated instrumentation shall have an accuracy of ± 1.5 °C, shall record temperatures at time intervals not exceeding 15 minutes and shall display the temperature.

909.07 CONSTRUCTION

909.07.01 General

The Contract Administrator shall be notified in writing at least 7 Days prior to commencement of fabrication.

Each girder shall be identified with a unique number and the date of casting within 24 hours of stripping forms. The information shall be marked on the girders and shall remain exposed and visible throughout the duration of construction. When the information is stencilled, indelible ink or paint shall be used.

909.07.02 Precast Plant Certification

Girders shall be fabricated by a plant certified by CSA or by CPCI under the category Group B, Bridges, as either subcategory B4 (Prestressed Deflected Strand Bridge Members) or subcategory B3 (Prestressed Straight Strand Bridge Members), as required for the work.

909.07.03 Pretensioning

Strands shall not be tensioned in the deflected position, unless the hold-down device used permits free movement of the strand and the use of the device has been tested by its manufacturer to ensure that the final stress along the full length of the strand is uniform.

909.07.03.01 Strand Splicing

Strands shall not be spliced within the concrete girder.

909.07.04 Welding

Welding of steel hardware, including shear studs, shall be according to CSA W59 and shall be performed by a qualified welder working for a company certified by the Canadian Welding Bureau according to CSA W47.1.

Welding of reinforcing steel bars shall be according to CSA W186 and performed by a qualified welder working for a company certified by the Canadian Welding Bureau according to CSA W186.

Welding within 3 m of the prestressing steel is not permitted unless the prestressing steel is fully encased in concrete that has reached the transfer strength specified in the Contract Documents. Welding equipment shall not use any components of the prestressing system or any component in contact with the prestressing system as an electrical ground.

909.07.05 Steel Reinforcement

The placement of steel reinforcement shall be according to OPSS 905, with the exception and/or addition of the placing tolerances listed below:

- a) Vertical position of prestressing strands: + 5/-10 mm
- b) Length of debond on prestressing strands: ± 50 mm
- c) Projection of positive moment connection reinforcing steel at girder ends: ± 25 mm
- d) Stirrup spacing: ± 15 mm when spacing is 100 mm or less
 ± 25 mm when spacing is greater than 100 mm
 ± 30 mm when spacing is 300 mm or greater

Under no circumstances shall reinforcement be inserted into plastic concrete.

909.07.06 Placing of Sheaths and Anchorages

When girders are to be post-tensioned, the sheaths and anchorages shall be placed according to OPSS 905 except that the placing tolerances shall be ± 5 mm at splice points and ± 10 mm elsewhere.

909.07.07 Production of Concrete

Production of concrete shall be according to the General, Temperature Control, Mixing Time and Mixing Rate, and Delivery sub-sections in OPSS 1350.

When there are multiple batches of concrete in a single ready-mix truck, hopper or other container, discharge times shall be measured from the time of introduction of water to cement for the first batch of concrete in the truck. Discharge of all concrete in the truck shall be completed within 1.5 hours, except when the air temperature exceeds 28 °C and the concrete temperature exceeds 25 °C, the discharge shall be completed within 1 hour.

909.07.08 Placing of Concrete

909.07.08.01 General

The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation.

Devices for placing and transporting concrete shall not be supported by the steel reinforcement.

Concrete shall be deposited within 0.5 m of the top of the reinforcement and 2.5 m horizontally of its final position.

Concrete shall be placed at a steady rate, such that a monolithic concrete is obtained without the formation of cold joints or pour lines.

When there is an interruption in placing concrete greater than 20 minutes, the top of the formwork shall be covered with wet burlap to maintain 100% relative humidity above the concrete. The Contract Administrator shall be notified of any interruption resulting in a cold joint. A proposal for remedial action shall be submitted to the Contract Administrator for approval by the Owner.

909.07.08.02 Concrete Placing Restrictions

All surfaces against which concrete is to be placed shall be free of standing water. Fresh concrete shall be protected from contact with rain or snow.

All debris shall be removed from the area where concrete is to be placed.

Ice and snow shall be removed from the area where concrete is to be placed. Deicing chemicals shall not be used. Any surface against which concrete is placed, including any existing concrete, steel reinforcement, structural steel, forms, or other surfaces shall be at a minimum temperature of 5 °C immediately prior to commencement of placing concrete.

The average temperature of the formwork, steel reinforcement or any other material against which concrete is to be placed shall not exceed 30.0°C, with no individual temperature exceeding 35.0 °C, and the maximum difference between the highest and lowest temperature measurement shall not exceed 10.0 °C. Average temperature shall be based on the average of a set of 10 temperature measurements, evenly spaced, along the formwork, steel reinforcement or other material against which concrete is to be placed. For formwork, five temperature measurements shall be made on each side of the formwork.

Temperature measurements shall be taken no more than 10 minutes prior to concrete placement, for each girder. Temperature measurements shall be made with a contact thermometer with an accuracy of ± 1 °C. Temperature measurements shall be recorded and included in the precast report.

909.07.09 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate concrete, within 15 minutes of placing.

Concrete shall be thoroughly consolidated around all steel reinforcement.

Each layer of concrete shall be vibrated. Vibrators shall extend into the previous layer to produce a homogenous mixture at the layer interface and prevent the formation of pour lines or cold joints.

Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.

909.07.10 Concrete Finishing

The top surface of the girders, against which new concrete is to be placed, shall be intentionally roughened while the concrete is sufficiently plastic so that the depth of the indentations is at least 5 mm and the spacing is not greater than 15 mm.

All concrete surfaces against which new concrete is to be placed shall be clean, sound, and free from any loose particles and laitance.

The following surfaces shall be abrasive blast cleaned according to OPSS 929, prior to shipping the girders:

- a) Top portion of girders containing laitance.
- b) The portion of the sides and end of the girder against which new concrete is to be placed.

909.07.11 Control of Temperature

909.07.11.01 General

All necessary actions shall be taken to maintain temperatures within the specified limits. During the moist curing, moisture retention, and protection periods, the following temperature requirements shall be met:

- a) The concrete temperature shall not exceed 70.0 °C.
- b) The concrete temperature shall not fall below 10.0 °C before the concrete has reached 75% of the specified 28-Day compressive strength.
- c) The temperature difference, as measured between thermocouples at the following locations, shall not exceed 20 °C:
 - i) Internal concrete temperature and the corresponding surface concrete temperature.
 - ii) Internal concrete temperatures at different locations within the girder.
- d) The maximum cooling rate of concrete shall not exceed 15.0 °C per hour until the concrete is not more than 20.0 °C above the air temperature. Air temperature is temperature next to the concrete, within the curing enclosure.

909.07.11.02 Temperature Monitoring and Records

The concrete and air temperatures during the curing period and, if applicable, cold weather protection period shall be monitored and recorded. Thermocouples and dataloggers shall be used to measure and record temperatures for each girder produced.

Thermocouple wires shall be installed prior to placing concrete according to Table 3. Thermocouples for monitoring air temperature shall measure air temperature adjacent to the girder. Thermocouples used to monitor the surface concrete temperature shall be imbedded in the concrete within 5 mm of the surface. Thermocouples to monitor maximum internal temperature shall be placed at the locations where the concrete is expected to reach the highest temperature, according to Table 3.

Recording of concrete and air temperatures shall begin at the start of placement. The temperatures shall be recorded automatically at time intervals not exceeding 15 minutes until the end of the curing period and, if applicable, the end of the cold weather protection period. The dataloggers shall be left in place until the end of the monitoring period.

The Contract Administrator and any other Owner's representatives shall be provided access to verify temperature readings. If the datalogger does not have a digital display that allows the Contract Administrator to verify temperature, the Contractor shall provide the Contract Administrator with the necessary instruments to allow the Contract Administrator to verify thermocouple function and readings.

The temperature monitoring and recording system shall provide unalterable records of temperature during the recording period. Prior to use on the Contract, the temperature monitoring and recording system shall be confirmed, in writing, to be acceptable to the Owner.

A record of temperatures shall be prepared for each Day during the temperature monitoring period.

The record of temperatures, including a graphical plot of temperature versus time, shall be submitted to the Contract Administrator in the precast report. The format of the temperature plot shall be acceptable to the Owner.

909.07.12 Curing

909.07.12.01 General

Moist curing shall continue throughout the duration of the moist curing period. The moist curing period shall be 48 hours followed by a 48-hour moisture retention period, except for concrete containing silica fume which shall have a moist curing period of 7 Days.

Moist curing of exposed surfaces shall be applied within 2 to 4 m of concrete placement, except for girders produced in an indoor precast concrete plant and not containing silica fume; for such girders, exposed surfaces may be covered with moisture vapour barrier between concrete placement and concrete finishing, for the shortest practical time period and in no cases exceeding 40 minutes.

For all girders, after formwork is removed, formed surfaces shall be moist cured for the remainder of the 48-hour moist curing period, and no less than 24 hours.

909.07.12.02 Moist Curing

Moist curing shall be sufficient to keep all surfaces of the precast girder in a continuously wet condition, with no dry areas, by applying one or a combination of the following methods:

- a) Curing with Burlap and Water
- b) Curing with Water Mist
- c) Steam Curing
- d) Immersion

Records of moist curing shall be maintained and submitted according to the Precast Report clause.

Girders whose surfaces have not been kept in a continuously wet condition shall be rejected and replaced; the Contractor may submit a proposal for remediation subject to the approval of the Owner.

909.07.12.02.01 Curing with Burlap and Water

Burlap shall be pre-soaked by immersing it in water for a period of at least 24 hours immediately prior to placing. Two layers of burlap shall be applied to the surface of the concrete. Burlap strips shall overlap 150 mm.

The burlap shall be maintained in a continuously wet condition throughout the curing period by means of a soaker hose. The soaker hose shall be turned on as soon as possible, when running water will not cause damage to the concrete surface. The burlap shall be covered with a layer of moisture vapour barrier within 3 hours of placing of the concrete, in a manner that shall prevent deformation of the surface of the concrete.

Air flow in the space between the burlap and the girder shall be prevented.

Water shall not be allowed to drip, flow or puddle on the concrete surface until the concrete has hardened sufficiently to resist damage.

909.07.12.02.02 Steam Curing and Other Application of Heat

Application of steam may be used.

The girder shall be heated evenly. Steam, heat or forced air shall not be directed on the concrete, forms or reinforcing steel. There shall be free circulation of steam, heat and forced air around the top, sides, and ends of the girder. Concrete surfaces shall not be exposed to combustion gases during the curing cycle.

There shall be a delay period prior to application of steam or heat above 30 °C, as follows:

- a) Delay period of four hours after completion of concrete placement if the mix does not contain a retarder.
- b) Delay period of six hours after completion of concrete placement if the mix contains a retarder.

A shorter delay period may be used if it has been demonstrated to the satisfaction of the Owner that initial set occurs earlier. Time of initial set shall be demonstrated by testing according to ASTM C403, using the same mix design, mixing equipment, concrete temperature, and ambient temperature as when producing the girders. Time of initial set testing shall be done in the presence of the Contract Administrator or the Owner's representative. Time of initial set testing shall be done before production. Demonstration of the time of initial set according to ASTM C403 may be required up to two times per year, upon request by the Contract Administrator.

909.07.12.03 Moisture Retention

After completion of the moist curing period, girder surfaces shall be completely covered by moisture vapour barrier to protect girders from moisture loss for a period of 48 hours.

Alternatively, moist curing methods may be continued during this period.

909.07.13 Cold Weather Protection Period

If cold weather conditions are present at the end of the curing period and moisture retention period, the girders shall be provided with protection from cold weather and moisture loss for an additional 24 hours, prior to exposure to cold weather conditions. Protection shall be extended beyond 24 hours if required to meet the requirements in the Control of Temperature subsection.

909.07.14 Exposure

During moist curing, moisture retention and cold weather protection periods, the girder may be exposed for a maximum total period of 1 hour per day for the purposes of formwork removal, release of strands at transfer strength, removal from the bed, filling of bug holes, inspection or relocation within the plant, except for indoor precast concrete plants, where the exposure period shall not exceed 2 hours per day.

During the exposure period:

- a) The requirements in the Control of Temperature subsection do not apply.
- b) There shall be no more than 3 consecutive thermocouple measurements of surface temperature below 10 °C, and none below 5 °C, when measured at 15 minute intervals at locations according to Table 3.

On the first day only of the moist curing period, the moist curing requirements do not apply during the 1-hour exposure period, or 2-hour exposure period for indoor plants, except for concrete containing silica fume, where continuous moist curing shall be applied throughout the exposure period.

909.07.15 Transfer of Prestressing Force

The prestressing force shall not be transferred to the girders until the transfer strength specified in the Contract Documents has been reached. The prestressing force shall be transferred according to the strand release sequence specified on the Working Drawings.

909.07.16 Treatment at Ends of Girders

The prestressing strands at ends of girders that are to be encased in concrete shall be cut off 25 mm beyond the ends of the beams. The prestressing strands at the end of girders that are not to be encased in concrete shall be cut back to recess the cable 25 mm from the end of girder. The recess shall be cleaned, filled with a proprietary patching material, and the ends of the girders coated with elastomeric coating.

909.07.17 Surface Finish

909.07.17.01 General

Concrete surfaces shall not be treated with cement slurry or paste.

Bugholes with a depth less than or equal to 5 mm and a maximum dimension at the surface of 50 mm do not require repair.

Surface defects and deficiencies with dimensions according to Table 2 are repairable by standard methods according to Table 2.

A repair proposal shall be submitted to the Contract Administrator to repair surface defects and deficiencies with dimensions greater than those listed in Table 2.

909.07.17.02 Exposed Surfaces

The appearance of the concrete and repairs shall be uniform in colour, pattern, and texture when viewed from a distance of 15 m. Care shall be taken to select material, including proprietary patching materials, to achieve uniformity of colour and appearance.

All projections, such as fins and bulges, and all blemishes, such as stains and rust marks, shall be removed.

909.07.18 Sampling and Testing of Plastic Concrete

Sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350. The results of these tests shall be recorded. The minimum frequency of testing shall be as follows:

- a) For concrete supplied by an external concrete supplier and delivered by a ready-mix truck, once for each of the first three trucks, until satisfactory control is established, and then once every third truck.
- b) For batches of concrete produced at the precast plant and transported by a ready-mix truck, once for each of the first three trucks, until satisfactory control is established, and then once every third truck
- c) For batches of concrete produced at the precast plant, and not delivered by a truck, once for each of the first five batches of concrete, until satisfactory control is established, and then once every fifth batch.

Satisfactory control is established when three or five consecutive tests of concrete, as specified above, are within the specified requirements, without adjustments. If any adjustments are required or conducted, testing shall continue until three or five consecutive tests, as specified above, meet the requirements with no adjustments. Satisfactory control shall be established each Day.

Testing of plastic concrete shall be carried out as close as possible to the location of discharge of concrete into the formwork.

Sampling and testing of slump, air content, and temperature of plastic concrete, and casting of cylinders for determination of compressive strength shall be carried out by a person holding either of the following certifications:

- a) CCIL Certified Concrete Testing Technician, or
- b) ACI Concrete Field Testing Technician, Grade 1.

The person shall have a valid original card issued by the certifying agency in his or her possession at all times.

909.07.19 Transfer Strength

Prior to transfer of the prestressing force, it shall be demonstrated that the transfer strength specified in the Contract Documents has been achieved. The Contractor, when requested by the Owner, shall participate in standard cylinder correlation strength testing programs conducted by the Owner.

909.07.20 Concrete Cover Measurement

The Contractor shall carry out, at the precaster's facility, a cover meter survey on all girders until satisfactory control is established. For each type, design and size of girder, satisfactory control shall be established when three consecutive girders of the same design are within the specified tolerances. After satisfactory control has been established, testing shall be carried out on every fifth girder. If testing indicates that cover measurements for a girder do not meet the tolerances specified in Table 1, testing shall resume on each girder until satisfactory control is re-established.

Readings shall be taken at locations 600 mm from both ends, at mid-span, and at intervals not exceeding 5 metres along the length of the girder.

For I-girders, readings shall be taken at each location, as detailed below:

- a) Top of web, both sides.
- b) Bottom of web, both sides.
- c) Mid-height of each side of bottom flange for CPCI-Girders, and on top of each side of bottom flange, 150 mm from the edge of the flange for NU girders.
- d) Underside of girder, located at 150 mm from both edges of flange.

For box girders, readings shall be taken at each location, as detailed below:

- a) Top of web, exterior sides.
- b) Bottom of web, exterior sides.
- c) Underside of girder, located at 400 mm from both edges of flange.

909.07.21 Dimensional Measurements

The Contractor shall carry out measurements on each girder to determine compliance with tolerance requirements. Girders shall meet the tolerances specified in Table 1.

909.07.22 Access for Quality Assurance

Electrical power, scaffolding, protection from the weather, and unhindered access for inspection and testing of all fabrication, delivery, and installation of girders shall be provided to the Contract Administrator or Owner's representative.

For the purposes of cover meter and dimensional measurements, all debris and obstructions shall be removed.

909.07.23 Delivery

The Contract Administrator shall be notified in writing 3 Business Days prior to delivery of the girders.

Delivery shall include transportation and storage of the girders. Transportation and storage of the girders shall be according to CAN/CSA A23.4. The delivery shall include loading of the girders, transportation, unloading, and storage at the storage site.

Girders shall be loaded for shipping in such a manner that they can be transported and unloaded at their destination without being damaged or exposed to stresses for which they were not designed.

Girders shall be handled and transported with their webs in a vertical plane, and the points of support during loading and unloading, lifting, storing, and transporting shall be according to the Working Drawings.

Girders, when stored, shall be stored in such a manner to avoid excessive stress or other damage.

Advertising by means of removable signing shall be permitted on girders only while in transit to the storage site. Any permanent markings on a surface that would be visible after installation shall not be permitted.

909.07.24 Installation

The Contract Administrator shall be notified in writing of the installation date at least 3 Business Days prior to the commencement of field installation operations. Installation shall be according to the Working Drawings.

The work shall consist of installation and stabilization of the girders during construction. Girders shall be lifted and placed in a manner to ensure they are not overstressed, unstable, or unsafe at any time.

A copy of the Working Drawings shall be kept on the site during installation of the girders.

The installation tolerance of girders shall be ± 15 mm on the bearing in both the longitudinal and transverse directions.

For box girders placed side-by-side, accumulated tolerance differences shall be distributed equally along the width of the structure. The maximum accumulated increase or decrease in total width of the girders shall not exceed 70 mm with 35 mm maximum on either side.

The forces resulting from the lifting devices acting on the girders shall not be inclined to the vertical at an angle greater than 30 degrees. All lifting devices for girders shall be removed or cut off to maintain the specified cover prior to placement of concrete in the deck.

I-girders and other girders that may experience stability problems during construction shall be braced individually by attaching each end to the substructure, as a minimum, immediately upon installation and according to the Working Drawings.

909.07.25 Repair of Defects and Deficiencies Repairable by Standard Methods

Any individual girder having one or more of the defects and deficiencies identified in Table 2 shall be repaired according to the repair method specified. Such repairs do not require proposals or Owner approval. Where more than one of the defects or deficiencies listed in Table 2, excluding bugholes, are located in the same area in the girder, a repair proposal shall be submitted. All causes, preventative actions, and corrective actions, including repair methods and materials used, shall be documented and submitted in the precast report.

909.07.25.01 Assessment of Repair

When defects or deficiencies occur, at the discretion of the design Engineer, a visual inspection may be conducted or other measures required, such as cores to be taken to assess the effectiveness of the repairs.

The filling of core holes shall be according to OPSS 1350.

909.07.26 Certificate of Conformance

Within 5 Business Days of installing all the girders within a stage, a Certificate of Conformance sealed and signed by a Quality Verification Engineer shall be submitted to the Contract Administrator. The Certificate shall identify the girders and state that the work has been carried out in general conformance with the signed and sealed documents, which include the Working Drawings, supporting documents, and Contract Documents.

909.07.27 Material Sampling for Acceptance Testing

909.07.27.01 Sampling of Steel Reinforcement

Samples of steel reinforcement shall be provided to the Owner according to OPSS 905 when requested.

If required, samples shall be delivered to:

Head, Concrete Section
Ontario Ministry of Transportation
145 Sir William Hearst Avenue, Room 15
Downsview, Ontario, M3M 0B6

909.07.27.02 Sampling of Water, Admixtures, and Cementing Materials

When requested by the Owner, samples of all cementing materials, admixtures, and water shall be obtained and delivered for testing by the Owner. If required, samples of admixtures and water shall be delivered to the Regional Quality Assurance laboratory and samples of cementing materials shall be delivered to:

Head, Concrete Section
Ontario Ministry of Transportation
145 Sir William Hearst Avenue, Room 15
Downsview, Ontario, M3M 0B6

909.07.27.03 Sampling of Hardened Concrete for Acceptance Testing

909.07.27.03.01 General

Test specimens shall consist of cylinders cast from plastic concrete for determination of compressive strength and cores removed from completed girders for determination of air void system parameters of hardened concrete and rapid chloride permeability. Test specimens shall be delivered to the designated laboratory for testing by the Owner.

Girders shall be sampled on a lot basis according to Table 4 of this specification.

909.07.27.03.02 Cylinders for 28-Day Compressive Strength Testing

Sets of cylinders, as defined in Table 4, shall be cast for 28-Day compressive strength testing by the Owner.

All concrete test cylinders shall be cast in new, single-use moulds conforming to the requirements of CSA A23.2-1D and made of plastic, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide watertight closure for the moulds.

Concrete test cylinders shall be cast, cured, and transported to the designated laboratory according to CSA A23.2-3C with the exception that cylinders shall be cured with the girder prior to delivery to the laboratory. Cylinders shall be delivered to the laboratory for demoulding.

Test information shall be recorded on MTO form PH-CC 322. A copy of the form shall be submitted with each set of the concrete cylinders along with a transmittal form and the Form A of the concrete mix design for the girder.

909.07.27.03.03 Coring

The number of cores removed from a girder shall be according to Table 4.

Cores shall be removed at the plant or on site when the girder is between 7 to 10 Days of age. Cores shall be removed in the presence of the Contract Administrator or Owner's representative. The girder from which core samples shall be taken shall be randomly selected from the lot by the Contract Administrator.

Coring shall be carried out according to CSA A23.2-14C. Cores shall not contain reinforcement or other embedded material. A covermeter capable of detecting the type(s) of reinforcing materials in the girder shall be used to establish the location of reinforcement and other embedded material prior to coring.

Cores shall be taken from locations selected by the Contract Administrator as follows:

- a) For I-girders, cores shall be from the middle quarter of the girder length, in the upper half of the web, outside of the flange area.
- b) For box girders, cores shall be taken at random locations of the top slab.

The Contract number, lot number, and girder identification number shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag, sealed to prevent loss of moisture, fitted with a security tag by the Contract Administrator. Cores shall be transported to the designated laboratory within 24 hours of coring with a transmittal form and the Form A of the concrete mix design for the girder. Cores shall be transported in a manner to avoid damage.

The core holes shall be filled, within 3 Days, according to the Filling of Core Holes subsection of OPSS 1350, with concrete or a proprietary patching material from the Owner's pre-qualified products list.

Concrete used to patch core holes shall have comparable properties to that of the concrete used in the girder.

909.07.28 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

909.08 QUALITY ASSURANCE

909.08.01 General

The acceptance of girders shall be according to the requirements of this specification, including satisfactory completion of all repairs, if applicable. Girders not meeting the requirements of the Contract Documents shall be deemed unacceptable and shall not be included in the Work.

Acceptance for compressive strength, air void system parameters, and rapid chloride permeability shall be on a lot basis. Lot size, of the lesser of either 7 consecutive Days' production or 4 consecutively produced girders, shall be confirmed with the Contract Administrator prior to commencing production.

For Contracts requiring high-volume production, the use of a larger lot size may be proposed, up to a maximum of 20 girders per lot produced over no more than 7 consecutive Days, and shall be subject to the approval of the Owner. The established lot size shall remain consistent for the duration of the Contract

909.08.02 Lot Size and Samples for Compressive Strength, Air Void System, and Rapid Chloride Permeability

Acceptance of 28-Day compressive strength shall be based on testing of cylinders.

Acceptance testing of air void system and rapid chloride permeability shall be performed on cores removed from the girders. Testing of cores for air void system shall commence when the sample is delivered to the designated laboratory.

The sample type and size, and number of samples per lot shall be according to Table 4.

909.08.03 Acceptance of Concrete Compressive Strength

Compressive strength of cylinders, for acceptance, shall be determined according to LS-426 for concrete with silica fume and high strength concrete, and according to LS-407 for all other concrete.

909.08.03.01 Basis of Acceptance

28-Day compressive strength of a lot shall be considered acceptable when it meets all of the following:

- a) The average of the set of three cylinder compressive strengths shall be equal to or greater than the specified 28-Day compressive strength.
- b) No individual cylinder test shall be more than 4.0 MPa below the specified 28-Day compressive strength.

Unacceptable lots shall be rejected and replaced.

Test results shall be forwarded to the Contractor as they become available.

909.08.03.02**Referee Testing of Compressive Strength**

Referee testing of compressive strength may only be invoked by the Contractor within 5 Business Days of receipt of the acceptance test result.

Referee testing of compressive strength shall be carried out on a set of three cores taken by the Contractor from the girder which the acceptance cylinders represent. The Contractor shall remove the cores in the presence of the Contract Administrator. The cores shall be 100 mm in diameter and 220 mm long or full depth, whichever is less. The core extraction shall be according to the Coring subsection of this specification, with the exception that if the girders have not been delivered to the construction site, coring shall take place at the precast plant in the presence of the Contract Administrator. Referee cores shall be obtained and transported to the referee laboratory designated by the Owner within 3 Business Days of invoking referee testing.

The referee laboratory shall be designated by the Owner based on the applicable roster and cores shall be tested according to CSA A 23.2-9C on moisture conditioned cores.

Referee test results shall be forwarded to the Contractor as they become available.

If the difference between the referee test result and the acceptance test result is less than the confirmation value, the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of acceptance of the lot. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification. The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cores, expressed to one decimal place.

The cost of referee testing of compressive strength shall be according to OPSS 1350.

909.08.04**Acceptance of Air Void System in Hardened Concrete**

Testing of air void system shall be according to LS-432. One half of the sample shall be tested to determine the acceptability of the lot. The other half of the sample shall be retained by the Owner for audit purposes.

Test results shall be forwarded to the Contractor as they become available.

For a lot to be considered acceptable, the sample shall have a minimum air content of 3.0% and a spacing factor of 0.200 mm or less. Acceptable lots shall be subject to full payment.

Lots with samples with a spacing factor greater than 0.200 mm and less than or equal to 0.250 mm shall be considered unacceptable and shall be repaired according to Table 2.

Lots with samples with a spacing factor more than 0.250 mm or air content less than 3.0 % shall be rejected and replaced.

909.08.04.01**Referee Testing of Air Void System in Hardened Concrete**

Referee testing of air void system parameters shall be according to OPSS 1350.

909.08.05**Acceptance of Rapid Chloride Permeability**

Cores shall be tested for rapid chloride permeability according to LS-446. Three 50-mm long test specimens shall be prepared for each core:

- a) One specimen shall be tested immediately after the core is delivered to the laboratory. Results shall be provided to the Contractor for information purposes as they become available.
- b) Two specimens shall be tested between 28 and 32 Days of age to determine acceptance of the lot. The acceptance test result for the lot shall be the average of the two 50-mm long samples tested between 28 and 32 Days of age. The test result shall be used to determine the acceptance of the lot.

Lots with rapid chloride permeability less than 2,500 coulombs are considered acceptable. Lots with a rapid chloride permeability result greater than 2,500 coulombs and less than or equal to 3,500 coulombs shall be considered unacceptable but with the agreement of the Owner may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated according to the Basis of Payment section.

Lots with rapid chloride permeability results exceeding 3,500 coulombs shall be rejected and replaced.

For concrete lots containing silica fume, rapid chloride permeability less than 1,000 coulombs are considered acceptable. Lots containing silica fume with a rapid chloride permeability result greater than 1,000 coulombs and less than or equal to 2,000 coulombs shall be considered unacceptable but, with the agreement of the Owner, may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated according to the Basis of Payment section.

Lots containing silica fume with rapid chloride permeability results exceeding 2,000 coulombs shall be rejected and replaced.

Test results shall be forwarded to the Contractor as they become available.

909.08.05.01 Referee Testing of Rapid Chloride Permeability

Referee testing of rapid chloride permeability may only be invoked by the Contractor within 5 Business Days of receipt of the acceptance test result.

Referee testing for rapid chloride permeability shall be carried out on a new core taken by the Contractor from the same girder from which the acceptance sample was obtained. A core for referee testing shall be removed in the presence of the Contract Administrator, for each disputed lot, at a location no more than 1 meter from the location from which the disputed acceptance core was removed. The core shall be 100 mm in diameter and 220 mm long or full depth, whichever is less. The core extraction shall be according to the Coring subsection of this specification. Referee cores shall be obtained and transported to the referee laboratory designated by the Owner within 3 Business Days of invoking referee testing.

The referee laboratory shall be designated by the Owner based on the applicable roster and cores shall be tested by that laboratory.

Referee test results shall be forwarded to the Contractor as they become available.

When the referee result is greater than the acceptance test result or no more than 200 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the lot is more than 200 coulombs below the acceptance test result, the acceptance test result is then not confirmed, and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

The cost of referee testing of rapid chloride permeability for all concrete shall be according to OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete.

909.08.06 Acceptance of Water, Admixtures, and Cementing Materials

Acceptance of water, admixtures and cementing materials shall be according to OPSS 1350.

909.08.07 Acceptance of Concrete Temperature

Girders that meet the temperature requirements of this specification during production, the curing period, and, if applicable, the cold weather protection period, are considered acceptable. Girders that do not meet one or more of the temperature requirements of this specification are considered unacceptable and shall be rejected and replaced.

Each girder for which the highest temperature has been maintained below 65.0 °C during the moist curing, moisture retention, and protection periods and which meets all other requirements of the Contract Documents shall be eligible for a payment bonus. The bonus shall be \$1,000 for each girder, up to a maximum of \$10,000 in total for all of the girders in a single structure. A girder which is rejectable or fails to fully meet the requirements of the Contract Documents shall not be eligible for a bonus.

909.08.08 Acceptance of Surface Finish

All girders meeting the surface finish requirements of this specification shall be considered acceptable. A proposal may be submitted by the Contractor for unacceptable surface finish, according to the All Other Defects and Deficiencies section of this specification, subject to the approval of the Owner.

909.08.09 Dimensional Verification and Concrete Cover Measurements

The Contract Administrator shall carry out measurements to confirm compliance with the requirements of Table 1.

If a girder fails to meet the requirements specified in Table 1,

- a) It shall be rejected and replaced, and
- b) A consultant shall be retained by the Owner, at the Contractor's expense, to verify all other girders are within the tolerances of Table 1.

If a girder fails to meet the dimensional tolerances in Table 1, it shall be rejected and replaced; the Contractor may submit a proposal for remediation or for use of the girder, subject to the approval of the Owner.

909.08.10 Defects and Deficiencies

909.08.10.01 General

Defects and deficiencies are classified as follows:

- a) Defects and deficiencies repairable by standard methods.
- b) Defects and deficiencies causing rejection.
- c) All other defects and deficiencies.

909.08.10.02 Defects and Deficiencies Repairable by Standard Methods

Any individual girder having one or more of the defects and deficiencies listed in Table 2 shall be deemed unacceptable and the girder shall be repaired according to Table 2. When more than one of the defects or

deficiencies listed in Table 2 is located in the same area in the girder, the Contractor shall be required to submit a repair proposal for acceptance according to the All Other Defects and Deficiencies clause.

909.08.10.03 Defects and Deficiencies Causing Rejection

A girder having any one of the following defects and deficiencies shall be rejected and replaced:

- a) If concrete temperature exceeds 70 °C at any time during the curing period.
- b) For I-girders, if there is honeycombing, voids, cavities, spalls, delaminations, or cracks in the concrete within a bearing surface area defined by the contact area of the bearing plus 30 mm on all sides, except when the bearing area of the girder is fully encased in concrete.
- c) For box girders, if there is honeycombing, voids, cavities, spalls, or delaminations in the concrete within a bearing surface area defined by the contact area of the bearing plus 30 mm on all sides, except when the bearing area of the girder is fully encased in concrete.
- d) If there is a crack in the bottom flange that extends through to the opposite face, unless the entire crack is located at the end of the girder and will be fully encased in concrete.
- e) If breakage of strand wires exceeds the limit permitted in CAN/CSA A23.4.
- f) If the sweep of the girder on site and in position without any intermediate bracing is in excess of 1.5 mm/m length of girder.
- g) If cover does not meet specified requirements except as indicated in the All Other Defects and Deficiencies section of this specification.

909.08.10.04 All Other Defects and Deficiencies

The Contractor shall submit a proposal for repair or remediation to the Contract Administrator for acceptance, when,

- a) A girder has defects or deficiencies that are not identified as rejectable or included in Table 2 in the list of defects and deficiencies repairable by standard methods; or
- b) More than one of the defects or deficiencies listed in Table 2, except for bugholes, are located in the same area in the girder; or
- c) Three occurrences of the same defect are present in the girder; or
- d) There is the presence of pour lines or cold joints; or
- e) Unacceptable surface finish; or
- f) The compressive strength of the lot is lower than specified, but not lower than 4 MPa below the specified strength; or
- g) Dimensional tolerances of the girder do not meet the requirements of this specification; or
- h) Failure to maintain moist curing has occurred.

The repair proposal, signed and sealed by an Engineer, shall include, as a minimum,

- a) Description of the girder and identification of the defects or deficiencies.

- b) Detailed sketches, width, length, depths, location, and nature and frequency of any defects.
- c) Assessment of any impact of the repaired defects on durability, structural adequacy, and integrity of the girder or on the structure.
- d) A detailed repair plan, including material, method, and equipment to be used.
- e) Verification that the repair plan complies with the applicable standards for the type of work.
- f) All relevant supporting information, including material test results, field measurements and observations, production records, photographs, and structural analysis calculations used for determining that the performance and function originally expected from the girder shall be met.
- g) Causes of the defect and corrective action to be taken to prevent recurrence of the defect in future production, delivery, or installation.

If the repair proposal is deemed acceptable, the girder shall be repaired according to the proposal. The Contractor shall not carry out any repairs without the prior acceptance of the proposal by the Contract Administrator. If the repair proposal is deemed unacceptable, the girders shall be rejected and replaced.

In addition, the repair proposal shall be signed and stamped by an Engineer, including, as a minimum, assessment of any impact on the durability, structural adequacy, and integrity of the girder or on the structure, of either low or high cover, and submitted to the Contract Administrator for acceptance, when,

- a) Low cover at soffit of girders at locations other than bearing cutouts: any cover readings less than 40 mm and greater than 35 mm.
- b) High cover at soffit of girders at locations other than bearing cutouts: any cover readings less than 70 mm and greater than 60 mm.
- c) High cover at all locations other than between bearing cutouts on soffit of girders: any cover readings less than 55 mm and greater than 45 mm.

For low cover at all locations except girder soffits between bearing cutouts, the girder may be sealed for cover readings between -5 mm and -10 mm of the specified cover, according to Table 2 of this specification.

If the Engineer's assessment is deemed acceptable by the Contract Administrator, the girders shall be accepted according to the Engineer's assessment. If deemed unacceptable, the girders shall be rejected and replaced.

909.10 BASIS OF PAYMENT

909.10.01 Prestressed Concrete Girders (Type) Fabrication - Item Prestressed Concrete Girders Containing Silica Fume (Type) Fabrication - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Rejected girders shall be replaced at no additional cost to the Owner.

Girders stored at the precaster's premises or at some other location away from the Working Area shall be paid for when the Contractor obtains a lease from the property owner that names the Owner as the

tenant. The Owner shall provide the form of lease for this purpose that specifies a payment of \$10.00 for the term of the lease. The Contractor shall retain full responsibility for the girders.

909.10.02 Payment Adjustment for Rapid Chloride Permeability

The payment adjustment shall be calculated based on individual lots and applied as follows:

$$\text{Payment adjustment} = \text{lot quantity} \times (C-2500)/5$$

Where:

Payment adjustment	=	payment adjustment of a lot (\$)
C	=	rapid chloride permeability of a lot (coulombs)
Lot quantity	=	volume of concrete in a lot (m ³) (calculated based on plan dimension)

The payment adjustment for concrete containing silica fume shall be calculated based on individual lots and applied as follows:

$$\text{Payment adjustment} = \text{lot quantity} \times (C-1000)/5$$

Where:

Payment adjustment	=	payment adjustment of a lot (\$)
C	=	rapid chloride permeability of a lot (coulombs)
Lot quantity	=	volume of concrete in a lot (m ³) (calculated based on plan dimension)

**909.10.03 Prestressed Concrete Girders (Type) Delivery - Item
Prestressed Concrete Girders Containing Silica Fume (Type) Delivery
- Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

**909.10.04 Prestressed Concrete Girders (Type) Installation - Item
Prestressed Concrete Girders Containing Silica Fume (Type) Installation
- Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Tolerances

Item	Tolerances
Length: Straight-line measurement taken horizontally at the mid-height of girder	± 1.0 mm/m; not to exceed ± 25 mm maximum
Overall Depth	± 8 mm for depths up to 600 mm ± 12 mm for depths over 600 mm
Flange Depth and Web Width for Girders Without Voids	Flange depth ± 5 mm Web width -5/+10 mm
Flange Depth and Web Width for Girders With Voids	Flange depth ± 10 mm Web width ± 10 mm
Width: Flanges and Box Girders	± 10 mm
Sweep: I-girders, spaced box girders, and spaced hollow slab girders	1 mm/m length of girder.
Abutting box and hollow slab girders	± 10 mm
Squareness and Plumbness	1 in 200 maximum
Camber Difference: Between adjacent girders spaced apart	25 mm
Between adjacent girders placed side-by-side	15 mm
Hold-Down Position Along Length	± 300 mm
Void and Diaphragm Position Along Length	± 25 mm
Concrete Cover Over Steel Reinforcement	Unless otherwise specified in the Contract Documents, the tolerance for concrete cover over steel reinforcement shall be -5/+15 mm
Stirrup Projection	-10/+15 mm

TABLE 2
Defects and Deficiencies Repairable by Standard Methods

Repairable Defects and Deficiencies	Condition	Repair Method
Bugholes	Bugholes with depth greater than 5 mm and all dimensions at the surface not exceeding 25 mm, or depth less than or equal to 5 mm and any dimension at the surface greater than 50 mm and not exceeding 100 mm.	a) Prior to filling bugholes, surfaces shall be blasted with high pressure water to remove any weak or loose material. b) Bugholes shall be filled with a proprietary patching material placed and cured according to the manufacturer's instructions.
Honeycombing, Voids, Cavities, Spalls, and Delaminations	Any area less than an equivalent area of 300 x 300 mm with no reinforcing steel or strand exposed. Cumulative total area of this type of repair shall not exceed 10 % of each face of the girder.	a) Square all sides of the repair area. b) Saw cut perimeter of removal area to a depth of 10 mm or to the depth of reinforcing steel or strands, whichever is less. c) Remove all loose concrete using a chipping hammer or hand tools. d) Insert corrosion resistant wire mesh and anchors. e) Abrasive blast-clean all concrete surfaces to be patched according to OPSS 929. f) Remove all dust and loose material from the prepared surface by using compressed air. g) Moisten area to be repaired. h) Fill repair area with concrete or a proprietary patching material. i) Cure concrete according to moist curing requirements of this specification. Cure proprietary patching material according to the manufacturer's recommendations.
Low Cover (all girder surfaces except girder soffits between bearing cutouts)	Low cover readings between -5 mm and -10 mm of the specified cover.	The entire surface of the girder shall be sealed, with an acceptable sealer, except areas against which new concrete is to be placed or in contact with bearings. Where sealing of an exterior girder is required all exterior girders in the same line of girders shall be sealed for consistency of appearance.
Air Void System Parameters	Any lot with spacing factor greater than 0.200 mm, but less than or equal to 0.250 mm.	The entire surface of all the girders of the lot shall be sealed, with an acceptable sealer, except areas against which new concrete is to be placed or in contact with bearings. Where sealing of an exterior girder is required, all exterior girders in the same line of girders shall be sealed for consistency of appearance.
Sweep	Sweep greater than 1.0 mm /m length but less than or equal to 1.5 mm/m length.	Push or pull the girders to within tolerance. Girders that can be brought into tolerance and maintained at that position without visible signs of distress shall be accepted. Girders greater than or equal to 1,900 mm in depth shall be pulled or pushed at both the top and bottom flange.

TABLE 3
Concrete and Air Temperature Measurements

Temperature	Location of Thermocouple for Concrete and Ambient Temperature
Internal	• I-Girders: - o Centroid of bottom flange at mid-span (1), for maximum temperature - o Middle of web, 1 m from each end of the girder (2) • Box Girders: - o Mid-depth at the centroid of solid section at each end of the girder (2), for maximum temperature - o Middle of bottom slab at mid-span (1)
Surface	• For each internal thermocouple above, a corresponding thermocouple shall be installed at the closest adjacent concrete surface. This thermocouple shall be imbedded in the concrete within 5 mm of the surface of the concrete (3)
Air Temperature	• Air temperature next to the concrete within the enclosure at each end of the girder (2)
Note: Number of thermocouples shown above in parentheses, total for each girders = 8	

TABLE 4
Sampling for Acceptance Testing

Element Type	Sample Type and Size	Number of Samples per Lot
Prestressed Precast Girders	Cylinders 100 mm diameter and 200 mm long	One set of 3 cylinders for 28-Day compressive strength. The girder for which the cylinders shall be cast shall be randomly selected from the Lot. (for acceptance testing)
	Cores* 100 mm diameter 220 mm long or full depth, whichever is less	One set of 2 cores, for acceptance testing of air void system parameters (1) and rapid chloride permeability (1).

* Cores to be taken from a single girder in the Lot

Appendix 909-A, November 2016
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STRESSING SYSTEMS FOR POST-TENSIONING

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910.01 SCOPE

This specification covers the construction requirements for internal bonded post-tensioning and grouting of tendons in prestressed concrete. This specification does not cover requirements for post-tensioning in concrete segmental construction nor requirements for post-tensioning with external tendons.

910.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

Ontario Provincial Standard Specification, Material

OPSS 1302	Water
OPSS 1440	Steel Reinforcement for Concrete

Structural Manual:

Division 1 - Exceptions to the Canadian Highway Bridge Design Code CAN/CSA S6 for Ontario

MTO Forms:

PH-CC-701	Request to Proceed
PH-CC-702	Notice to Proceed
PH-CC-822	Certificate of Conformance

Canadian Standards Association

A283-19	Qualification Code for Concrete Testing Laboratories
A3004-2C	Test Method for Determination of Compressive Strengths*
	*[Part of CSA A3000-18, Cementitious Materials Compendium]
S6:19	Canadian Highway Bridge Design Code

ASTM International

A123/A123M-17	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A370-22	Test Methods and Definitions for Mechanical Testing of Steel Products
C1152/C1152M-20	Test Method for Acid-Soluble Chloride in Mortar and Concrete
D2239-22	Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D3350-21	Specification for Polyethylene Plastics Pipe and Fitting Materials
D4285-83(2018)	Test Method Indicating Oil or Water in Compressed Air
E328-21	Test Methods for Stress Relaxation for Materials and Structures

Post Tensioning Institute

PTI/ASBI M50.3-19	Multistrand and Grouted Post-Tensioning
PTI M55.1-19	Grouting of Post-Tensioned Structures

International Federation for Structural Concrete (fib)

FIBBUL 75	Polymer-duct systems for internal bonded post-tensioning

910.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchorage Zone means the end portion of the post-tensioning element consisting of local zone and general zone.

Calibration means the process of determining experimentally the absolute values corresponding to the gradation on a scale subject to error.

Coupler means a device for the joining of two post-tensioning tendons or prestressing steel bars by means of a mechanical connector.

General Zone means the anchorage zone region of post-tensioned component which extends from anchorage device along the axis of the component according to CSA S6.

Local zone means the zone behind the anchorage device where the prestressing force is transferred to the post-tensioned structural component.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Prestressing Steel means as defined in OPSS 905.

Prestressing Steel Bar means as defined in OPSS 1440.

Primary Tendon Anchorages means the anchorage on longitudinal tendons.

Tendon means a high-strength steel element used to impart prestress to concrete.

Tensile Strength means the breaking load of the tendon per unit area established by tensile testing.

Vent means an inlet to permit the injection of grout into the duct or an outlet to provide for the escape of air, grout, and to bleed or drain water.

Yield Strength means the stress at which the tendon exhibits a specified deviation of proportionality of stress and strain.

910.04 DESIGN AND SUBMISSION REQUIREMENTS

910.04.01 Design Requirements

910.04.01.01 General

All proposed post-tensioning systems shall meet the design slip requirements specified in the Contract Documents.

910.04.01.02 Design of Anchorage Zone

Design shall be according to the CSA S6 and the Structural Manual, Division 1. The supplier of the post-tensioning system shall be responsible for the design of the local zone according to CSA S6. Design of the general zone shall be as specified in the Contract Documents.

910.04.02 Submission Requirements

910.04.02.01 General

All Working Drawings, post-tensioning details, and calculations shall bear the seal and signature of an Engineer.

All submissions shall be according to the appropriate clause; however, when other authorities are involved in the approval of the design or construction of a Highway structure, submissions shall be made at least 5 weeks prior to commencement of work and one additional copy of the submission shall be provided for each authority.

910.04.02.02 Post-Tensioning Working Drawings

At least 3 weeks prior to commencement of post-tensioning work, one electronic copy of all Working Drawings in pdf format shall be submitted to the Contract Administrator. The drawings shall include the following:

- a) Design details.
- b) Slip.
- c) Calculation data, including wobble and friction coefficients for the duct material used.
- d) Post-tensioning sequence.

e) Details of the:

- i. Ducts.
- ii. Supports.
- iii. Vents.
- iv. Anchorages.

Details of anchorages for post-tensioning tendons shall be according to the requirements of the manufacturer of post-tensioning system.

910.04.02.03 Post-tensioning Details

At least 2 weeks prior to commencement of the post-tensioning operations, one electronic copy in pdf format of the following information shall be submitted to the Contract Administrator:

- a) Elongation calculations that take into account all relevant losses.
- b) The type of jacks.
- c) Friction of jacks.
- d) Jacking pressure.
- e) Method of attaining the required slip (e.g. wedge or nut seating procedure).
- f) Two copies of the prestressing steel manufacturer's stress-strain curves test reports.

910.04.02.04 Couplers

910.04.02.04.01 General

At least 3 weeks prior to the commencement of the work, a copy of the post-tensioning system manufacturer's catalogue giving complete data on the coupler material, installation procedures, and test reports from the manufacturer certifying that the strength and fatigue requirements have been satisfied shall be submitted to the Contract Administrator.

910.04.02.04.02 Testing

Dynamic tests are not required on bonded tendons, unless specified in the Contract Documents.

A dynamic test for bonded tendons shall be performed on a representative anchorage and coupler specimen and the results submitted to the Contract Administrator. The tendon shall withstand, without failure, 500,000 cycles from 60 to 66% of its minimum specified ultimate strength and also 50 cycles from 40 to 80% of its minimum specified ultimate strength. The period of each cycle shall be the change from the lower stress level to the upper stress level and back to the lower. The specimen used for the second dynamic test may be the same one used for the first dynamic test. Systems using multiple strands, wires, or prestressing steel bars may be tested using a test tendon of smaller capacity than the full-sized tendon. The test tendon shall duplicate the behaviour of the full-sized tendon and generally shall not have less than 10% of the capacity of the full-sized tendon.

910.04.02.05 Prestressing Steel Mill Test Certificates and Stress-Strain Curves for Prestressing Steel

Submission of mill test certificates and stress strain curves shall be according to Mill Certificates and Stress-Strain Curves for Prestressing Steel subsection in OPSS 1440

One copy of mill test certificates for all material to be used in the fabrication of the prestressing steel shall be available for review at the fabricating plant during fabrication. The mill test certificates shall show that the material is according to the Contract Documents.

Mill test certificates for prestressing steel bars shall demonstrate that tensile testing has been carried out on full-section specimens according to ASTM A370.

Test results shall be provided for relaxation testing of prestressing steel bars for the same heat number as the material supplied for the work. The testing shall be carried out according to the test procedure described in the Material section.

910.04.02.06 Prestressing Personnel

At least 12 weeks prior to commencing the post-tensioning operation, experience records shall be submitted to the Contract Administrator for prestressing personnel employed or licensed by the manufacturer of the post-tensioning system as described herein.

910.04.02.07 Grouting Plan

At least 4 weeks prior to the work, written procedures for grouting operations shall be submitted to the Contract Administrator. The grouting plan shall include the following:

- a) Pre-packaged grout product name, manufacturer, and quantity to be used in grouting.
- b) Manufacturer's specified limits for efflux time measurement for the fluidity of the grout.
- c) 28-Day compressive strength test results for the grout from the manufacturer within the last 12 months.
- d) Type of grouting equipment including provision for spare parts and details of a backup mixer.
- e) Mixing and pumping procedures.
- f) Direction of grouting and sequence of use of the inlets and outlets.
- g) Procedures for handling blockages, and procedures for possible regrouting.
- h) Temperature control measures for grouting operation.
- i) Details of vacuum-assisted grouting procedures, if applicable.

910.04.02.08 Corrosion Inhibitor

At least 3 weeks prior to the commencement of the work, the name of the corrosion inhibitor applied to the prefabricated cables and written approval by the post-tensioning system supplier shall be submitted to the Contract Administrator.

910.05 MATERIALS

910.05.01 Anchorages and Couplers

910.05.01.01 General

When anchorages and couplers for post-tensioning are tested in an unbonded state, they shall develop at least 95% of the ultimate tensile strength of the tendons. After tensioning and the initial slip required to seat the strands has occurred, anchorages shall be capable of sustaining the applied loads without additional slippage, distortion, or other changes that could result in unaccounted loss of prestress.

910.05.01.02 Anchorages

The manufacturer of the post-tensioning system shall establish the dimensions and details of anchorages within the local zone, which are dependent on the jacking force and the concrete strength at transfer specified in the Contract Documents. Additional steel reinforcement required to resist tensile, bursting, spalling, or longitudinal edge tension forces within the general zone shall be as specified in the Contract Documents.

Primary tendon anchorages of multi-strand tendons shall be multi-plane bearing type. Primary and transverse tendon anchorages shall be provided with end caps that cover the strand ends and wedges according to PTI/ASBI M50.3. Steel and plastic end caps are permitted. The end caps shall have a 3 mm minimum wall thickness and shall have attachments and gaskets that allow the cap to withstand full grouting pressures. End caps shall be vented to ensure that they are completely filled with grout. Steel end caps shall be galvanized according to ASTM A123 or equivalent.

910.05.01.03 Couplers

Couplers shall be according to the submitted manufacturer's data accepted by the Contract Administrator.

910.05.02 Ducts

910.05.02.01 General

Ducts for internal post-tensioning shall be corrugated plastic. The ducts, including joints, shall be watertight, vapour-tight and nonreactive with concrete, tendons, or grout. The ducts and components shall meet the requirements of Post-Tensioning System Tendon Protection Level 2 (PL-2) according to PTI/ASBI M50.3.

Ducts provided for future external post-tensioning shall be made from smooth, and rigid polyethylene.

All ducts shall be provided with suitable devices for the injection and discharge of grout after prestressing. Air vents shall be provided at all high points on the ducts that are continuous over more than one span. Air and drainage vents shall be provided at other locations as specified in the Contract Documents.

Ducts shall be capable of withstanding concrete pressures without excessive deformations and shall not permit the entrance of cement paste during the placement of concrete. The ducts shall have sufficient rigidity to maintain the required profile between points of support.

For single strand of prestressing steel tendons, the inside diameter of the ducts shall be at least 6 mm larger than the nominal diameter of the strand or prestressing steel bar. For multiple strand tendons, the inside cross-sectional area of the duct shall be at least twice the cross-sectional area of the tendon.

910.05.02.02 Plastic Ducts

Plastic ducts, including their splices, shall be made of polyethylene or polypropylene according to PTI/ASBI M50.3 and shall be vapour-tight and remain so after tendon installation and stressing.

Plastic for the external post tensioning ducts shall be code letter D or E for colour and ultraviolet (UV) stabilizer according to ASTM D3350. The plastic duct shall be manufactured according to ASTM D2239 from virgin material.

The ducts shall be capable of being curved to the specified radius without damage. The duct wall thickness shall not be less than 1 mm for the specified minimum radius of curvature, after a tendon movement of 750 mm under a tendon stress of 80% of the specified strength. For curved ducts, the radial force, as exerted on the duct wall by a single strand, shall not exceed 40 kN/m.

The plastic ducts shall meet the following requirements:

- a) For ducts with an inside diameter of 50 mm or less, a 3 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20 °C.

- b) For ducts with an inside diameter of more than 50 mm, a 6 m length supported at the ends shall not deflect under its own weight by more than 75 mm at a temperature of not less than 20 °C.
- c) The duct shall not deform more than 3 mm under a point load of 445 N applied through a No. 10 reinforcing steel bar located between the corrugation ribs at a temperature of not less than 20 °C.
- d) Material thickness shall be as follows:
 - i. Corrugated, internal duct shall have a minimum of 2.0 mm wall thickness or meet the requirements of FIBBUL 75 Table 8.1.
 - ii. External ducts shall have an external diameter to wall thickness ratio of 17 or less.

910.05.02.03 Vents and Drains

Vents and drains shall be a 19 mm minimum diameter flexible tubing material capable of withstanding the applied grouting pressures. Vents shall be temporarily equipped with an airtight shut-off valve to isolate the duct system from the environment.

910.05.03 Grout

910.05.03.01 Pre-Packaged Grout

The grout used shall be one of the pre-packaged grout products listed in Table 1 and shall meet the requirements of a Class C grout according to PTI M55.1.

The pre-packaged dry grout mixture shall be supplied on skids and covered with polyethylene sheeting. The pre-packaged dry grout mixture shall be stored in a dry condition up to the time of its use and suitably protected against the weather during delivery and storage on site. The pre-packaged dry grout mixtures shall be used within 6 months of packaging and shall be stored on site for a maximum of 1 month.

The dry ingredients of the grout shall be thoroughly mixed and packaged in bags, with a maximum bag size of 30 kg. The bag shall be of sufficient strength and waterproof to withstand handling and to protect the grout from moisture and contamination. The bags shall have the following information printed on the outside: Name of manufacturer, maximum amount of water to be used per bag of dry grout mixture, date packaged, and expiry date.

910.05.03.02 Grout Properties

The grout shall have the following physical properties:

- a) The minimum 28-Day compressive strength shall be 55 MPa, when tested according to CSA A3004-2C.
- b) No bleeding or segregation when allowed to stand for 3 hours according to clause 4.4.8.1, wick-induced bleed test of PTI M55.1
- c) The efflux time measurement for the fluidity of the grout shall be within the limits specified by the manufacturer.
- d) The chloride content shall be according to PTI M55.1 when tested according to ASTM C1152

910.05.04 Hardware

Only hardware, including spacers and support devices for the ducts, that are capable of withstanding the loads placed on it and that is approved by the Owner shall be used. All embedded hardware within 100 mm of exposed faces shall be coated with an acceptable material or be of an acceptable non-metallic material.

910.05.05 Prestressing Steel

910.05.05.01 General

Prestressing steel shall be low alloy prestressing steel bar or uncoated, low relaxation 7-wire strand according to OPSS 1440.

Prestressing steel bar shall be low relaxation and shall meet the requirements of relaxation testing as specified herein when furnished in its final condition after all processing. Relaxation loss shall be less than 3.0% when tested at an initial stress of 70% of minimum specified ultimate tensile strength of the bar for 1000 hours according to ASTM E328 Method A, except a gauged bar is not required if the specimen length is at least 60 bar diameters. Relaxation testing shall be completed at a temperature of 20 °C ± 2 °C. Quenched and tempered bars are not permitted.

910.05.05.02 Corrosion Inhibiting Coating

A corrosion inhibitor, approved by the post-tensioning system supplier, shall be applied to the prefabricated cables to prevent the pitting of the prestressing steel as described herein. Vapour phase corrosion inhibitors shall not be used.

910.05.06 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

910.05.07 Water

Water shall be according to OPSS 1302.

910.06 EQUIPMENT

910.06.01 Air Compressor

The air compressor used for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free of oil according to ASTM D4285.

910.06.02 Grouting Equipment

The grouting equipment shall consist of a mixer, a separate holding tank, and a pump.

The mixer shall be:

- a) A high-shear mechanical or colloidal type with a speed of 1200 to 2000 rpm.
- b) Equipped with a calibrated measuring device for determining the quantity of mixing water. The total quantity of water used in each batch of grout shall be measured to an accuracy of ± 2%.
- c) Equipped with a visible timing device suitable for controlling the mixing time.
- d) Any pressure measuring devices shall be calibrated within a 6 month period preceding the work. The device shall be accompanied by a certified calibration curve.

The holding tank shall be capable of keeping the mixed grout continuously in motion until it is used. The outlet to the pump shall have a 5 mm screen.

The grout pump shall be capable of grouting to a pressure of at least 1 MPa and shall be equipped with a pressure gauge and a pressure valve set to release at a pressure of 1 MPa, except for vertical tendons with approval from the Contract Administrator. The pressure gauge shall have an accuracy of ± 2%, shall be accompanied by a certified calibration curve and shall be calibrated at least once a year.

The grouting equipment shall be of sufficient capacity to ensure that the grouting of the longest duct can be completed within 30 minutes after mixing. The velocity of grout in the duct shall be between 5 and 12 m/min and the pressure shall be compatible with the length and size of the duct.

The grout hoses and their rated pressure capacity shall be compatible with the pump output and the maximum grouting pressure. All connections from the grout pump to the duct shall be airtight so that air cannot be drawn into the duct.

The configuration of the equipment shall be such that the grout can be recirculated to the holding tank, if stoppage occurs in the grouting.

A backup mixer in good working condition shall be available at the site before commencement of grouting in case of breakdown of the grouting equipment during grouting.

910.06.03 Malfunction of Gauges

Malfunctioning gauges shall be replaced immediately upon discovery of the malfunction.

910.06.04 Measuring Devices for Post-tensioning

Pressure gauges, dynamometers, tension meters, load cells, or other suitable devices shall be used for controlling and measuring the tendon forces and shall be according to the following:

- a) The device shall be capable of measuring the forces to an accuracy of $\pm 2\%$.
- b) Each gauge shall be capable of indicating forces directly in Newtons or be accompanied by a conversion chart so that the imperial readings can be converted into Newtons.
- c) The indicating dials of the gauges shall be at least 150 mm in diameter or a digital pressure gauge shall be used.
- d) Each gauge shall be accompanied by a certified calibration curve.
- e) The graduated capacity of the gauge shall be such that the forces to be measured fall within 25 and 75% of the minimum and maximum measurement levels respectively, unless calibration data clearly establishes that the gauge is accurate over a wider range.
- f) Pressure gauge readings shall be taken in a static configuration.
- g) Gauges shall be mounted near eye level and within 2 m of the operator and positioned so readings can be obtained without parallax.
- h) Two gauges shall be used at each jack and pump combination.
- i) The gauges shall be recalibrated any time a gauging system indicates erratic results and at intervals not greater than 6 months.

910.07 CONSTRUCTION

910.07.01 Prestressing Personnel

Personnel employed or licensed by the manufacturer of the post-tensioning system shall carry out the work.

Personnel employed to supervise the work of installation, tensioning and grouting shall:

- a) Have a working knowledge of the post-tensioning system used;

- b) Be capable of evaluating the forces, gauge pressures, elongations, and method by which the post-tensioning system transfers the forces to the structure;
- c) Have a minimum of 5 years experience in carrying out this type of work within the last 10 years or shall have PTI Level 2 Multistrand & Grouted Field Specialist Certification;
- d) Be present during the post-tensioning and grouting; and
- e) Also be present during concreting operations to ensure that the post-tensioning components of the work are not adversely affected.

910.07.02 Welding

Shop welding of the prestressing tendons shall only be permitted to facilitate pulling the tendon through the duct. Where the ends of strands are welded together to facilitate pulling the tendon through the duct, the length of the tendon used as an electrical ground or 1 m, whichever is greater, shall be cut off from the welded end prior to stressing. Care shall be exercised at all times to prevent the possibility of heat destroying the tensile properties of the steel. No other welding of post-tensioning tendons and ducts is permitted.

Field welding within 3 m of the post-tensioning steel is not permitted on site. Field welding equipment shall not use any components of the post-tensioning system as an electrical ground.

910.07.03 Surface Condition of Post-Tensioning System Components and Temporary Corrosion Protection of Prestressing Steel

All material shall be clean and free of oil, dirt, scale, and pitting. A light rust coating on steel hardware is acceptable.

Prestressing steel shall be free of rust or pitting prior to grouting. Strand condition shall be evaluated according to Figure 11.1 of PTI/ASBI M50.3 and the condition shall be similar to Photo 2 or better. A quality process shall be established to maintain the corrosion inhibitor on the prestressing steel until the time of grouting. Dry hot air, with a maximum relative humidity of 40%, shall be blown into the ducts and sealed to maintain the prestressing steel condition if the time between stressing and grouting is to exceed 14 Days.

910.07.04 Installation

910.07.04.01 Post-Tensioning System

The post-tensioning system shall meet a protection level of PL-2, according to PTI/ASBI M50.3 and as described herein.

Prestressing steel, ducts, anchorages, couplers, and local steel reinforcement at anchorages shall be placed in the position specified in the Contract Documents and shall be held in the correct location during the operations of placing and consolidating of concrete. The ducts shall be supported and secured at intervals not exceeding 0.6 m and a smooth profile shall be maintained. Flat ducts that are not preloaded with strands, shall be supported and secured at intervals not exceeding 0.6 m. Flat ducts that are preloaded with strands shall be supported and secured at intervals not exceeding 0.5 m. All joints between ducts and other associated hardware shall be protected against the ingress of laitance during concreting and against the entry of any deleterious material before, during, and after placement of concrete. Ducts and anchorages shall be installed at the locations specified in the Contract Documents and within the following tolerances:

- a) Longitudinal sheath ± 15 mm.
- b) Transverse sheath ± 10 mm.
- c) Anchorage ± 10 mm.

Couplers for strand or prestressing steel bar are not permitted in the work unless specified in the Contract Documents. When couplers are specified in the Contract Documents, installation of couplers shall be according to the recommendations of the manufacturer of the post-tensioning system used.

Bearing plates at anchorage components shall be within 2 degrees of their design orientation and trumpets shall be perpendicular to the faces of the bearing plates and securely fastened in place.

Ducts shall be fully sealed against the elements prior to installation of prestressing steel. Duct alignment and transition to anchorage components shall be free of kinks and shall provide smooth continuous transitions between elements. Slitting of ducts to facilitate bending is not permitted. Pushing or pulling of strands through ducts shall be done with methods that will not snag or cut ducts.

Joints in ducts shall be by means of proprietary couplers. Fusion welding of ducts is not permitted. Heat shrink sleeves, if applicable, shall be as per PTI/ASBI M50.3. Proprietary couplers shall be according to the PL-2 leak-tightness requirements of FIBBUL 75. Joint tape is not permitted in lieu of couplers.

Half-shell duct supports shall be used to support the inside radius of curvature for bonded rounded ducts when the radius of curvature is less than 20 m.

Monostrand jacks are only permitted for flat tendons.

MTO form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator after the installation of the post-tensioning system is complete and prior to placing the concrete.

The next operation shall not proceed until MTO form PH-CC-702, Notice to Proceed, has been received from the Contract Administrator.

910.07.04.02 Vents and Drains

Vents shall be installed as follows:

- a) At the anchorages of the tendon.
- b) At the high points of the duct.
- c) At the lowest point of a tendon having a small radius such as a vertical loop.
- d) At major changes in the cross-section of the duct such as trumpets of couplers and anchorages.
- e) For all tendons other than top slab transverse tendons, place drains at low points of all duct profiles, or as close as practical to the geometric low points of all duct profiles, except where an inlet, outlet, or anchorage that can service as a drain is located at the low point.

Vents at anchorages and high points shall extend at least 500 mm above the highest point on the profile of the duct in which the vent is placed. Duct holes at vent locations shall be of the same size as the inside diameter of the vent tube. Direct inlets, outlets or drains existing on vertical or predominantly vertical surfaces of box girders towards the interior of the box.

Drain tubes shall be routed for positive drainage when required. Vents shall be sealed when not in use for grouting operations.

910.07.04.03 Placing of Steel Reinforcement

The placing of steel reinforcement as duct support spirals, tensioning rings, and reinforcing grids at anchorages shall be according to OPSS 905.

910.07.04.04 Duct Proving

When strands are installed after concreting, a torpedo shall be passed through the longitudinal ducts to confirm the ducts are free of any obstructions according to PTI/ASBI M50.3.

910.07.05 Post-Tensioning

910.07.05.01 Material Sampling

The Contract Administrator shall be notified when the post-tensioning steel is available for sampling at least 1 week in advance of stressing.

Prestressing steel samples selected by the Contract Administrator for testing and inspection shall be labelled by the Contractor with the following information:

- a) Manufacturers identification number.
- b) Reel number.
- c) Heat number.
- d) Location of sampled area.

Samples of post-tensioning materials and the dry grout mixture shall be submitted to the Contract Administrator as follows:

- a) For strand, 1 sample 1.0 m long from each reel.
- b) For prestressing steel bar, 1 sample 1.0 m long from each heat number.
- c) For anchorages and couplers, samples shall be selected by the Contract Administrator on a random basis.
- d) For dry grout mixture, representative samples of the packaged material shall be submitted to the Contract Administrator when requested.

910.07.05.02 Post-tensioning of Prestressing Steel

Post-tensioning shall not commence until the concrete has reached the strength specified in the Contract Documents.

Post-tensioning shall be carried out according to the Contract Documents.

Jacking pressures shall be read with the gauge in a static configuration and shall remain steady until the jacks are released, otherwise subsequent readings shall be recorded.

After post-tensioning, all openings and vents along the post-tensioning system shall be temporarily plugged or sealed until grouting commences.

MTO form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator upon completion of the post-tensioning and prior to cutting of tendons and grouting.

Cutting of tendons and grouting shall not proceed until MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

910.07.05.03**Measurement of Tensioning and Variation in the Post-Tensioning Force**

Friction losses in jacks, hoses, and connections shall be determined and recorded. The force in the tendons shall be determined by means of the pressure gauge and shall be continually verified by measuring the tendon elongation. The pressure gauge readings and the elongations shall be recorded at intervals of 25% of the maximum force and shall include the final reading.

The measured elongations of individual tendons, at the specified jacking force and based on the gauge pressures, shall be within - 3 to + 9% of the calculated values. If the actual elongation is outside this tolerance, jacking of that tendon shall stop and the Contractor shall prepare and submit a report rationalizing the observed difference.

The variation from the specified total post-tensioning force over the entire component cross-section, including any broken strands, shall not exceed $\pm 5\%$. The distribution of the variation of the total post-tensioning force across the component cross-section shall be subject to the approval of the Contract Administrator.

910.07.05.04**Maximum Tension**

In no case shall the low relaxation steel be tensioned above 85% of its tensile strength and in no case shall any steel be tensioned above 94% of its yield strength.

910.07.05.05**Post-Tensioning Records**

Upon completion of all post-tensioning operations, the Contractor shall submit to the Contract Administrator, records of elongation, calibrated jacking pressure readings, slippages, and strand breakages.

910.07.05.06**Cutting of Tendons**

Care shall be exercised at all times in the cutting of tendons to avoid the possibility of adversely affecting the pre-stressing steel.

Cutting of the tendons shall be by mechanical means.

910.07.06**Grouting****910.07.06.01****General**

Grouting shall be carried out as soon as possible, but in no case shall any post-tensioning ducts be left un-grouted for more than 7 Days from the date of the Contract Administrator's completed MTO form PH-CC-702, Notice to Proceed, or more than 21 Days from the time of first installation of prestressing within ducts.

The temperature of the concrete and the ducts shall not be less than 5 °C or higher than 30 °C before grouting commences and for at least 72 hours after grouting has been completed.

Grouting shall not proceed when the ambient air temperature is expected to exceed 28 °C or fall below 2 °C at the time of grouting or within the 48 hour period following the grouting operation.

The preparation, mixing and grouting procedures shall follow manufacturer's instructions unless otherwise specified in this specification.

910.07.06.02**Preparation for Grouting****910.07.06.02.01****General**

Dry, oil free compressed air shall be blown through each duct. Each vent shall be tested in turn to ensure that the ducts, vents, inlets, and outlets are capable of accepting the injection of grout.

All ducts shall be free of all deleterious material that may impair bonding of the grout to the ducts and tendons. The use of steam or flushing with water is not permitted.

910.07.06.02.02 Duct Air Test

An air test shall be carried out on all ducts prior to grouting according to PTI/ASBI M50.3.

910.07.06.03 Grout Mixing

Grout mixture showing evidence of dampness, lumps, hardened pieces, or contamination shall not be incorporated in the work.

A standard batch size shall be established and the size of the batch to be used shall be reported to the Contract Administrator prior to commencement of grouting. The standard batch size shall be used throughout the grouting operation.

The time interval between the addition of the water to the dry grout in the mixer and pumping of the grout shall not exceed 30 minutes. Water shall not be added to the grout after initial mixing.

The holding tank shall be kept partially full at all times during the pumping operation to prevent air from being drawn into the duct.

910.07.06.04 Temperature of Grout

When the ambient air temperature exceeds 15 °C, the grout shall be stored and protected in a shaded area.

The temperature of the grout in the holding tank at the time of injection shall meet the manufacturer's instructions, but shall not exceed 35 °C. Temperature shall be measured hourly.

910.07.06.05 Grouting Procedures

All grout vents of each duct shall be open when grouting starts. The elevation of the end of the injection vent, at the free end, shall be higher than the high point vents along the duct.

Grouting shall commence as soon as possible after mixing is complete. The grout shall be continuously pumped from the lowest grout inlet without any interruptions. The one-way flow of grout shall be maintained throughout the grouting operation. The pumping pressure at the injection vent shall not exceed 1 MPa.

The method of injection shall ensure that the ducts are completely filled with grout and the tendons or prestressing steel bars encapsulated with grout.

The consistency of grout flowing from a vent shall be examined to determine whether or not the grout is of the same consistency as that being pumped into the injection vent. When the grout is of the same consistency, an additional 5 litres of grout shall be allowed to flow out prior to closing that vent. An additional 20 litres of grout, minimum, shall be pumped out the final outlet until consistency is achieved and no visible signs of air is being ejected. The outlet at the end of the tendon shall not be permanently closed until the wet density consistently meets the established acceptable range.

As grout of original consistency flows from the vents, the vents shall be successively closed as the filling of the duct progresses. When grout of original consistency flows from the ejection vent at the free end, that vent shall be closed. The injection tubes shall be sealed off under pressure when the duct is completely filled with grout. A pressure of approximately 500 kPa shall be maintained for at least 1 minute after sealing. Grout vents shall not be reinjected to burp the ducts.

The grout tubes shall be topped up with grout if subsidence of grout occurs when disconnecting the pump or pressure apparatus so that grout completely fills the ducts and openings. After the grout has hardened, the grout tubes shall be cut off flush with the surface of the deck and any tubes not completely full of grout shall be topped up with grout flush with the surface of the concrete.

After grouting is completed, any residue of grout remaining on concrete surfaces adjacent to the vents shall be removed.

After grouting, loads shall not be applied to or removed from the structure until the grout has reached a minimum compressive strength of 20 MPa. For the purposes of this clause, removal of falsework and formwork shall not constitute a load on the structure.

910.07.07 Material Sampling and Testing

910.07.07.01 Grout Mixture

910.07.07.01.01 General

Field trial batch testing shall be carried out on site using the same equipment, materials, and personnel to be used in grouting production.

Production testing shall be carried out at the time of grouting.

Field sampling and testing shall be performed by a person certified according to the Testing of Plastic Concrete clause of OPSS 1350. Additionally, test cubes for compressive strength testing shall be prepared by personnel from a testing laboratory certified by an organization accredited by the Standards Council of Canada according to CSA A283 for Additional Tests according to CSA A3004-2C.

910.07.07.01.02 Field Trial Batch Testing

At least 7 Days prior to the grouting operation, a trial batch shall be carried out to ensure that the grout meets the specified requirements. The Contractor shall notify the Contract Administrator of the date and location of the trial batch at least 7 Days prior.

The trial batch shall consist of the following tests, at minimum:

- a) Pumpability and fluidity test according to clause 4.4.7 of PTI M55.1.
- b) Wick-induced bleed test according to clause 4.4.8.1 of PTI M55.1 or, alternatively, Schupack pressure bleed test according to clause 4.4.8.2 of PTI M55.1.
- c) Chloride ion content according to clause 3.3.4 of PTI M55.1 from a sample of the grout with the same water source to be used for the operation. Testing shall be completed by an independent testing laboratory.

910.07.07.01.03 Production Testing of Plastic Grout

Prior to grouting, the fluid grout shall be sampled from the mixer or holding tank of the mixer immediately following completion of mixing in the presence of the Contract Administrator. The sample batch of grout shall be tested for the following:

- a) A pumpability and fluidity test shall be carried out according to clause 4.4.7 of PTI M55.1. The efflux time shall be within 5 seconds of the previously measured trial batch values and not less than 5 seconds in total. Measurements shall be performed immediately after the grout is removed from the mixer and 30 minutes after mixing. After 30 minutes has elapsed since mixing, the grout shall be remixed for 30 seconds before testing again for efflux time. Subsequent fluidity tests shall be carried out at the mixer and the end outlet every 2 hours during grouting operations.

The grout used for the first set of fluidity measurements shall be discarded after testing and shall not be used for the 30 minute measurement. The grout used for the 30 minute measurement shall be left undisturbed in a clean container covered with a lid until the measurement is performed.

- b) One wick-induced bleed test shall be initiated prior to the start of grouting according to clause 4.4.8.1 of PTI M55.1.

- c) A wet density (mud balance) test shall be performed for the initial batch of grout and every 2 hours at the mixer and the outlet to establish batch consistency, according to PTI M55.1. The permitted density range shall be specified by the grout manufacturer. The density at the outlet shall be equal to or greater than the value measured at the mixer. If the density at the outlet is lower, then additional grout shall be pumped until consistency is achieved.

The results of the fluidity, wick-bleed, and wet density tests shall be submitted to the Contract Administrator. Any test result that indicates the grout is not meeting the requirements specified herein shall be immediately reported to the Contract Administrator with proposed corrective measures.

910.07.07.01.04 Sampling for 28-day Compressive Strength Acceptance Testing

Cubes for determination of the compressive strength of the grout shall be cast and cured according to CSA A3004-C2 for testing of 28-Day compressive strength by the Owner. Two sets of six cubes shall be cast per lot, one set for acceptance testing and one set for referee testing, if invoked. The Contract Administrator shall randomly select the batch from the Day's production from which the acceptance and referee samples are taken.

Stainless steel moulds provided by the Contract Administrator shall be used for preparing cubes for compressive strength tests.

The specimens shall be stored at a temperature between 15 °C and 25 °C and shall not be moved prior to demoulding. The specimens shall be demoulded and transported to the designated laboratory within 24 hours ± 4 hours. The samples shall be transported in a sealed white opaque plastic bag containing at least 250 ml of water and maintained at a temperature between 15 °C and 25 °C.

910.07.07.01.05 Early Compressive Strength Tests

Prior to early loading, it shall be demonstrated that the grout has attained a compressive strength of 20 MPa. Grout cubes for compressive strength testing shall be prepared, stored, demoulded and tested according to CSA A3004-2C.

The laboratory conducting the early compressive strength tests shall be CSA certified as specified herein.

910.07.07.01.06 Access for Quality Assurance

Unhindered access for inspection and testing of all the work shall be provided to the Contract Administrator or the Owner's representative. Any debris and obstructions shall be removed to allow access for the purposes of dimensional measurements and/or inspection.

910.07.08 Post Grout Inspection

A post-grout inspection shall be carried out 24 hours after grouting by the prestressing personnel. The prestressing personnel shall be according to the Prestressing Personnel subsection. An inspection report shall be submitted to the Contract Administrator within 7 Days of grouting. The report shall describe, with photos, any leaks, cracks, voids or other deficiencies found and shall note locations of deficiencies, if present.

910.07.09 Inspection after Cutting Tendons and after Grouting

Placement, stressing, and grouting of the post-tensioning system shall be carried out as specified in the Contract Documents.

A MTO form PH-CC-822, Certificate of Conformance shall be submitted to the Contract Administrator upon completion of cutting tendons and after grouting.

910.07.10 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

910.08 QUALITY ASSURANCE

910.08.01 General

The acceptance of post-tensioning system shall be according to the requirements of this specification, including satisfactory completion of any repairs. Repairs shall not be carried out without the prior written acceptance by the Contract Administrator.

910.08.02 Acceptance of Post-tensioning System

Acceptance shall be based on:

- a) Acceptable 28-Day Compressive strength of the grout.
- b) The post-tensioning system being free of voids, contamination, or defects.
- c) No damage to prestressing steel, anchorages, ducts, vents, and other system components.
- d) No visible damage to prestressing steel including but not limited to yielding, pitting, nicks, heat damage or excessive corrosion. Any damage to the prestressing steel listed here shall be cause for rejection.
- e) No damaged or blocked ducts or incompletely filled tendons. Any one of the defects/deficiencies listed here shall be rejectable and shall be repaired to the satisfaction of the Contract Administrator.

910.08.03 Acceptance 28-Day Compressive Strength of Grout

910.08.03.01 Lot Size

A lot shall consist of all the grout from one Day's placement of grout.

910.08.03.02 Acceptance Testing

One set of six cubes shall be tested for 28-Day compressive strength per lot to determine the acceptance of the lot. The compressive strength of a lot shall be the average of the set of the six cubes.

Compressive strength shall be determined according to CSA A3004-C2.

Compressive strength shall be considered acceptable when the lot strength is greater than or equal to the specified 28-Day compressive strength.

Unacceptable grout shall be subject to removal and replacement.

910.08.03.03 Referee Testing

910.08.03.03.01 General

The referee testing process for 28-Day compressive strength of grout is based on duplicate cubes cast at the same time as the acceptance cubes.

Referee testing of compressive strength for a lot may only be invoked by the Contractor within 3 Business Days of receiving the test results for that lot.

The referee laboratory shall be designated by the Owner. Referee test results shall be forwarded to the Contractor as they become available.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of acceptance for the grout. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded, and the referee results shall be used in the determination of acceptance. The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cubes, expressed to one decimal place.

910.08.03.02 Referee Testing Cost

The cost of compressive strength referee testing shall be as specified in the Contract Documents.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of compressive strength referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

910.08.04 Acceptance of Prestressing Steel

Acceptance of prestressing steel shall be according to OPSS 1440.

910.10 BASIS OF PAYMENT

**910.10.01 Longitudinal Stressing System - Item
Transverse Stressing System - Item
Vertical Stressing System - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Materials to do the work.

TABLE 1
Pre-Packaged Grouts

Manufacturer	Product Name
Target Products Ltd.	Target® 1121 Cable Duct Grout
BASF Master Builders Solutions	MasterFlow® 1205
Sika Canada Inc.	SikaGrout®-300 PT



CONSTRUCTION SPECIFICATION FOR COATING STRUCTURAL STEEL AND RAILING SYSTEMS

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911.01 SCOPE

This specification covers the requirements for the surface preparation and coating of structural steel and railing systems.

911.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 919 Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1704 Paint Coating Systems for Structural Steel

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

Structural Manual

MTO Forms:

PH-CC-701 Request to Proceed

PH-CC-702 Notice to Proceed

CSA Standards

S6-19 Canadian Highway Bridge Design Code

ASTM International

A123/A123M-17	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A143/A143M-07(2020)	Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
A153/A153M-16a	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A780/A780M-20	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
B833-20	Specification for Zinc and Zinc Alloy Wire for Thermal Spraying (Metallizing) for the Corrosion Protection of Steel
C566-19	Test Method for Total Evaporable Moisture Content of Aggregate by Drying
D4285-83(2018)	Test Method for Indicating Oil or Water in Compressed Air
D4417-21	Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
D4541-22	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
D4940-15(2020)	Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
D6386-22	Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
D7091-22	Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

The Society for Protective Coatings (SSPC)

Good Painting Practice, SSPC Painting Manual Volume 1, Fifth Edition, 2016

AB 1, May 2019	Mineral and Slag Abrasives
PA 1, June 2016	Shop, Field, and Maintenance Painting of Steel
PA 2, November 2018	Procedure for Determining Conformance to Dry Coating Thickness Requirements
PA 11, August 2008	Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
SP 1, August 2016	Solvent Cleaning
SP 8, November 2004	Pickling
SP 11, November 2013	Power Tool Cleaning to Bare Metal
VIS 1-2002	Visual Standard for Abrasive Blast Cleaned Steel
VIS 3-2004	Visual Standard for Power-and Hand-Tool Cleaned Steel

SSPC and National Association of Corrosion Engineers (NACE) Joint Publications

SP 5/NACE No. 1, January 2007	White Metal Blast Cleaning
SP 6/NACE No. 3, January 2007	Commercial Blast Cleaning
SP 10/NACE No. 2, January 2007	Near-White Blast Cleaning

SSPC, American Welding Society (AWS), and NACE Joint Publications

SSPC-CS 23.00 / AWS C2.23M/NACE No.12-2016 Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for Corrosion Protection of Steel

Others

Federal Standard 595C Colors, 2017 - Published by U. S. General Services Administration

911.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Coating means a liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer.

Coating System means a number of coats of metallic or paint coating, or both, separately applied in a predetermined order at suitable intervals to allow for setting, drying, or curing.

Dry Film Thickness means the thickness of a coating after it has dried throughout, after all the solvent has evaporated, and the coating has cured.

Escape means any visible emission or settlement of dust or debris, including abrasive media, paint chips, and coating material, outside the limits of the enclosure resulting from surface preparation or coating application.

Faying Surface means the mating surface of a member that is in contact with the mating surface of another member when joined together.

Final Surface Preparation means surface preparation as specified in the Contract Documents.

Interim Surface Preparation means an incomplete surface preparation that does not meet the requirements for the final surface preparation.

Metallic Coating means hot dip galvanizing or thermal sprayed metal coating.

Metallizing means application of thermal sprayed metal coating.

Paint Coating means a liquid or mastic composition that upon drying or curing is converted to a solid protective, decorative, or functional adherent film after application as a thin layer.

Paint Coating System means a number of coats of paint coating separately applied in a predetermined order at suitable intervals to allow for setting, drying, or curing.

Power Washing means the use of low-pressure water to remove contaminants from the surface without damaging the coating. The water pressure shall be within the range of 7 to 10 MPa.

Railing System means steel tube rails, steel panels, steel posts, steel caps, steel panel anchorages, and steel splash guards, including all steel connections.

Recoat Time means the time recommended by the manufacturer for drying, curing, or setting of paint coating prior to application of subsequent coat.

Seal Coat means a paint coating used to seal thermal sprayed metal coating.

Slip Critical Connection means a connection where slippage cannot be tolerated, including those subject to fatigue or to frequent load reversal, or where the resultant deflections are unacceptable.

Spent Material means the spent abrasive, removed coating material, rust, or other debris or a mixture thereof generated during surface preparation.

Spot Measurement means the average of the three gauge readings taken per spot.

Structural Steel means the steel components of a structure, including lighting poles, traffic signal poles, bearing assemblies, deck drains, piles, and all other steel appurtenances and connections, excluding railing systems.

Surface Profile means the surface contour of a blast or power tool cleaned substrate, when viewed from the edges of the surface.

Sweep Blasting means a process of rapid movement of abrasive blast nozzle over a surface to remove deleterious substances and to roughen its surface profile.

911.04 DESIGN AND SUBMISSION REQUIREMENTS

911.04.01 Design Requirements

Design of enclosures and temporary supports shall be according to CSA-S6, Structural Manual, and OPSS 919.

911.04.02 Submission Requirements

911.04.02.01 General

Except for the material certification for the coating material, five sets of each of the following submissions shall be submitted to the Contract Administrator at least 3 weeks prior to commencement of the coating operations, for information purposes only.

911.04.02.02 Written Notices

Written notice submissions shall include:

- a) Details of the methods, procedures, and sequence of operations to be employed to complete the work, including Working Drawings and schedules.
- b) Details of surface preparation and coating of areas that are difficult to access. This shall include an identification of all areas that are difficult to access, methods of surface preparation and level of surface preparation achievable if different than specified in the Contract Documents, and method of coating application.
- c) Details of the proposed method for management of excess materials including collection, containment, and disposal of all solid and liquid wastes.

911.04.02.03 Working Drawings

911.04.02.03.01 Environmental Protection

When the Contract contains a tender item for environmental protection, the Working Drawings shall include a detailed description of the environmental protection to be employed, including details of the enclosure, erection of the enclosure, and relocation procedure for the enclosure and equipment.

911.04.02.03.02 Restriction on Construction Loads

911.04.02.03.02.01 General

Working Drawings shall show the location and magnitude of all applied construction loads.
The Working Drawings shall:

- a) State that the bridge, including all components that the Contractor requires to support the enclosure system, can safely support all loads, including construction loads according to CSA-S6 and the Structural Manual; and,
- b) Shall bear the seals and signatures of two Engineers who shall also verify the actual field condition of the structure prior to certifying the Working Drawings.

Where the applied construction loads exceed the limits specified in the Construction Load Limits clause, two Engineers shall be retained who shall act as an evaluation Engineer and a design-checking Engineer to carry out a structural evaluation. Such evaluation shall ensure that the bridge can safely support all loads according to CSA-S6 and the Structural Manual, including construction loads imposed on the bridge based on the Contractor's method of construction. A synopsis of the evaluation, including detailed calculations and notes, shall be prepared and, when requested, be made available to the Contract Administrator. The documents shall bear the seals and signatures of both the evaluation Engineer and the design-checking Engineer. Documentation of such evaluation shall be retained for a period of six years after the Contract Administrator has issued a Certificate of Completion.

911.04.02.03.02.02 Construction Load Limits

- a) Slab on Girder Structures
 - i. 400 kg per support point with a maximum of two support points loaded per girder per span, or
 - ii. The specified uniformly distributed load per linear metre of the girder.
- b) Truss or Arch Structures
 - i. 400 kg per panel point with a maximum of two panel points loaded on a truss or arch, or
 - ii. The specified load per panel point.

911.04.02.04 Paint Coating Product Data Sheets

Product data sheet submissions shall include the manufacturer's product data sheets showing the following:

- a) Recommended maximum dry film thickness.
- b) The mixing and thinning directions.
- c) The recommended spray nozzles and pressures.
- d) The recommended temperature range and acceptable humidity levels for application.
- e) The minimum acceptable recoat time period for temperatures in the intervals of 5 °C from 0 to 30 °C.

911.04.02.05 Material Certification

911.04.02.05.01 Coating Manufacturer's Certification

Prior to commencement of the coating application, the Contract Administrator shall be supplied with written certification from the coating manufacturer stating that all materials supplied are as specified in the Contract Documents and the manufacturer's current product data sheets.

911.04.02.05.02 Certification of Abrasive Media

Prior to abrasive blasting, the Contract Administrator shall be supplied with written certification from a laboratory certified by an organization accredited by the Standards Council of Canada stating that the abrasive media meets the material requirements specified in this specification.

911.05 MATERIALS

911.05.01 Abrasive Media

911.05.01.01 General

Abrasive media shall have a conductivity not exceeding 1,000 micro Siemens (μ S)/cm, when tested according to ASTM D4940.

Except for abrasive blast cleaning of galvanized surfaces, the abrasive media shall have a hardness of 6 or greater on the Mohs scale. There shall be no presence of oil.

The testing for hardness and presence of oil shall be according to SSPC-AB 1.

The maximum moisture shall be 0.5% by weight, when tested according to ASTM C566.

911.05.01.02 Paint Coating on Galvanized Surfaces

The abrasive media used for surface preparation of galvanized surfaces prior to receiving paint coating shall be of such hardness that the galvanized coating is not damaged.

911.05.01.03 Thermal Sprayed Metal Coatings

Abrasive media used for the surface preparation for thermal spray metal coating application shall be sufficiently hard and sharp to produce an angular surface profile on to the steel substrate such that the subsequent metal coating shall meet the bond strength requirements specified. Shot or other abrasives producing a rounded or peened profile shall not be used.

911.05.02 Compressed Air

Compressed air used during all work operations shall be clean, dry, and free from oil residues, when tested according to ASTM D4285.

911.05.03 Metal Coatings

911.05.03.01 Hot Dip Galvanizing

Purity of the zinc and the galvanizing bath composition for hot dip galvanizing of structural steel shall be according to ASTM A123/A123M.

Material for repair of galvanized surfaces shall be either zinc-tin-copper solder for repair by soldering or metallizing wire for repair by metallizing.

In addition to the above materials, the use of the following paint coatings is permitted for repair of galvanized surfaces on new structural steel sign support structures and sectional steel high mast lighting poles:

- a) For the repair of overhead trusses by paint coating, all three coats of the epoxy zinc/epoxy/polyurethane system shall be included on the ministry's DSM. The colour of the finish coat shall be equivalent to 17178 aluminum according to Federal Standard 595C colors.
- b) For the repair of sign support columns and sectional steel high mast lighting poles that are specified to receive a subsequent paint coating, epoxy zinc primer shall be included on the ministry's DSM.

911.05.03.02 Thermal Sprayed Metal Coatings

Thermal sprayed metal coatings shall be according to SSPC-CS 23.00/AWS C2.23M/NACE No.12. The metallizing wire shall be an alloy consisting of 85% zinc and 15% aluminum that is according to the requirements of ASTM B833.

911.05.03.03 Zinc-Tin-Copper Solder

The zinc-tin-copper solder shall be 50% zinc, 49% tin, and 1% copper used with the manufacturer's recommended flux.

911.05.04 Paint Coatings

911.05.04.01 General

Paint coating shall be according to OPSS 1704 and as specified in the Contract Documents.

Only paint coatings contained in the original containers sealed by the manufacturer shall be used.

911.05.04.02 Paint Coating Systems for Coating Galvanized Surfaces

Where specified in the Contract Documents, one of the approved paint systems for coating galvanized surfaces from the ministry's DSM shall be applied to hot dipped galvanized components that require subsequent paint coating.

The colour of the finish coat shall be equivalent to 16307 grey according to Federal Standard 595C, unless otherwise specified in the Contract Documents.

911.05.04.03 Rapid Deployment Coating Systems for Structural Steel

Where specified in the Contract Documents, one of the approved paint systems for rapid deployment coating systems from the ministry's DSM shall be applied to structural steel.

911.05.04.04 Seal Coat

The seal coat shall be as specified in the Contract Documents.

911.06 EQUIPMENT

911.06.01 Scaffolds

The coated areas of the structure, coming into contact with rollers, clamps, and other parts of the scaffolding and access facilities shall be protected using rubber or other material to prevent damage to the coating.

911.06.02 Spray Pot

The agitators in the spray pot shall extend to within 25 mm of the bottom of the pot to ensure proper mixing of paint components prior to spray application.

911.07 CONSTRUCTION

911.07.01 General

The extent of work, cleaning requirements, surface preparation, environmental protection requirements, and type of coating system shall be as specified in the Contract Documents.

Where there is a conflict between the manufacturer's recommendations and the Contract Documents, the more stringent requirements shall apply as determined by the Contract Administrator.

All components coated off-site shall be protected from handling or shipping damage by using padded slings, separators, and tie downs or other similar devices. Loading procedures shall be designed to protect coated surfaces from any possible damage to the coating.

Components of structural steel sign support structures and sectional steel high mast lighting poles that are to be hot dip galvanized shall be according to the Contract Drawings. Components of structural steel sign support structures and sectional steel high mast lighting poles that are to be hot dip galvanized and subsequently paint coated shall be according to the Contract Drawings.

The Contract Administrator shall be granted access to the galvanizing and painting shops where components are being cleaned and coated, during all hours of work.

Galvanized steel components, when stored, shall be stored in a manner to avoid wet storage stain. Components shall be stored above ground on skids or other supports. Careful consideration shall be given to how galvanized steel components are stacked and bundled to ensure adequate air flow.

911.07.02 Operational Constraints

A MTO form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator when the surface preparation and each subsequent phase of work of coating application are completed and ready for inspection.

Subsequent work shall not commence until the Contract Administrator has completed the inspection of the work completed and issued a MTO form PH-CC-702, Notice to Proceed.

Welding, cutting, or drilling of existing structural steel shall not be permitted unless approved by the Contract Administrator.

All structural rehabilitation work shall be completed prior to commencing the coating operations.

Surfaces adjacent to areas to be cleaned and coated shall be protected from damage during surface preparation and coating application.

When there is partially completed coating work at seasonal shutdown, the following operations shall be carried out immediately prior to commencement of coating application in the next construction season:

- a) Areas that have been coated but have not received the finish coat shall be power washed using potable water and allowed to dry thoroughly.
- b) Partially completed coating exhibiting rust or rust stains shall be removed, and the surface shall be cleaned to the original surface preparation standard as specified in the Contract Documents and re-coated with the specified coating system or an alternative coating system acceptable to the Contract Administrator.

911.07.03 Surface Preparation and Surface Profile

911.07.03.01 General

Fins, slivers, burred, or sharp edges weld spatter; or slag shall be removed by power grinding prior to the surface preparation and coating application. Edges of all structural steel specified to be cleaned and coated shall be ground to a smooth radius of at least 3 mm by hand or power tools prior to abrasive blast cleaning.

Final surface preparation for coating application shall only be carried out when the temperature, moisture, and humidity satisfy the criteria specified in SSPC-PA 1 for coating application.

The temperature, moisture, and humidity limitations do not apply to interim surface preparation. The Contract Administrator shall be notified of interim surface preparation work prior to commencement of the work.

911.07.03.02 New Structural Steel

New structural steel specified to be cleaned and paint coated shall be abrasive blast cleaned to the requirements of SSPC-SP 10/NACE No. 2. The abrasive blast cleaning shall provide a surface profile height of a minimum of 40 µm and a maximum of 75 µm.

911.07.03.03 Existing Structural Steel

Existing structural steel that has been specified to be cleaned and paint coated in the Contract Documents, shall be abrasive blast cleaned to the requirements of SSPC-SP 10/NACE No. 2. The abrasive blast cleaning shall provide a surface profile height of a minimum 40 µm and a maximum of 90 µm for paint coating application.

911.07.03.04 Existing Steel Railing Systems

The steel components in the handrail panels shall be cleaned to the requirements of SSPC-SP 8. The steel components in the posts, caps, and panel anchorages on steel posts shall be abrasive blast cleaned to the requirements of SSPC-SP 5/NACE No.1. The abrasive blast cleaning shall provide a surface profile height of a minimum of 50 µm and a maximum of 100 µm for thermal sprayed metal coating application.

The steel panel anchorages on the concrete posts shall be abrasive blast cleaned to the requirements of SSPC-SP 10/NACE No.2.

911.07.03.05 Paint Coating on Galvanized Surfaces

Galvanized surfaces to be paint coated shall be prepared according to ASTM D6386.

Thick edges due to excess liquid zinc run-off during the galvanizing process; high spots; and rough edges, such as metal drip line, shall be removed by clean hand or power tools to ensure smooth surface. The excess zinc shall be removed until it is flush with the surrounding area. Any oil or grease on the surface shall be removed by solvent cleaning according to SSPC-SP 1. Surface preparation shall be performed by sweep blasting to roughen the surface using an abrasive of such hardness that the galvanized coating is not damaged.

After sweep blasting and prior to the application of the paint coating, the galvanized surface shall be examined and repaired, as required. The dry film thickness of the zinc coating after sweep blasting shall be according to ASTM A123/A123M.

911.07.03.06 Thermal Sprayed Metal Coating

Structural steel surfaces specified to receive a thermal sprayed metal coating shall be abrasive blast cleaned to the requirements of SSPC-SP 5/NACE No.1. The abrasive blast cleaning shall provide a surface profile height of a minimum of 50 µm and a maximum of 100 µm.

911.07.03.07 Hot Dip Galvanizing

Existing structural steel specified to be hot dip galvanized shall be first abrasive blast cleaned to SSPC SP 6/NACE No.3 to remove the existing paint coatings and rust and then the components shall be cleaned to the requirements of SSPC-SP 8 prior to being galvanized.

New structural steel shall be cleaned to the requirements of SSPC-SP 8 prior to galvanizing.

The length of time that all steel components are immersed in the pickling solution shall be kept to an absolute minimum to achieve the specified surface preparation condition prior to hot dip galvanizing. The galvanizer shall employ proper pickling and galvanizing procedures as precautionary measures to safeguard against embrittlement, as specified in ASTM A143/A143M.

911.07.03.08 Faying Surfaces

Faying surfaces of existing and new structural steel components to be connected by bolts shall be cleaned to the surface preparation standard required for the coating system specified.

Faying surfaces of slip critical connections designed to receive Class A or Class B coatings shall have the same blast cleaning as was used in the tests to determine the mean slip coefficient.

911.07.03.09 Surface Preparation of Areas Difficult to Access

Surface preparation of areas specified in the Contract Documents as difficult to access shall be carried out to the extent practical from the access opening as detailed on the Contractor's submission for methods, procedures, and sequence of work. The surface preparation standard for these areas shall be based on reasonable effort demonstrated in the field acceptable to the Contract Administrator.

911.07.04 Application of Coating

911.07.04.01 General

The Contract Administrator shall be notified 48 hours in advance of mixing and applying a paint coating or coating system.

New atmospheric corrosion resistant steel shall be coated with a low Volatile Organic Compound (VOC) epoxy zinc/epoxy/polyurethane system. All other steel shall be cleaned and coated with the coating system as specified in the Contract Documents.

All new A325 bolts and accompanying nuts and washers used with steel specified in the Contract Documents to receive a paint coating or galvanizing shall be Type 1 and shall be galvanized.

Prepared surfaces shall have no dust prior to the application of coating.

Paint coating shall be smooth, continuous, and free of runs and sags. No pinholes or holidays of the paint coating on galvanized components shall be allowed.

911.07.04.02 Paint Coating Systems

911.07.04.02.01 General

All paint coating systems shall be stored, thinned, handled, mixed, and applied according to SSPC-PA 1 and the recommendations on the manufacturer's product data sheets.

When there is a drop in temperature after the coating has been applied, the recoat time period shall be according to the manufacturer's product data sheets for the lower temperature.

All rivets, bolts, nuts, washers, and pitted areas shall be stripe coated with the primer and with the top coat material by brush, in addition to spray application. Stripe coating with the primer shall be carried out after the spray application of the primer. For projects where the inorganic zinc primer is specified, an epoxy-zinc primer from the same manufacturer shall be used for stripe coating. Stripe coating with the top coat material shall be carried out prior to the spray application of the finish coat. Stripe coating shall be according to SSPC-PA 11.

Bearing shoe plates or bevelled plates or both at girder locations where coating of the girders has been specified in the Contract documents shall also be coated using the specified coating system.

For each coat of paint, the initial pass of the spray gun shall be directed at the outside edges of the steelwork prior to completely coating all surfaces.

All runs and sags shall be brushed out as the application progresses.

Application related failures in coatings, as described in the Coating Failures chapter of the SSPC Painting Manual Volume 1, shall be corrected prior to the application of a subsequent coat and, in the case of the top coat, after the application of the top coat.

Where excessive coating thickness produces "mud cracking" in zinc rich coating materials, the coating shall be scraped back and sanded to a soundly bonded coating and the area recoated to the required thickness.

All dry spray shall be removed by sanding and the coating reapplied as specified in the Contract Documents.

911.07.04.02.02 New Structural Steel

All new structural steel including diaphragms, excluding surfaces in contact with concrete and the faying surfaces of bolted joints, shall be coated to the extent as specified in the Contract Documents.

The maximum time between final surface preparation and prime coat application inside the shop shall be 24 hours. Structural steel subjected to outdoor exposure after final surface preparation shall be prime coated within 10 hours.

All coats of the specified paint coating system shall be shop applied.

Prior to assembly, surfaces not in contact with other steel surfaces, but that are inaccessible after assembly shall have all coats applied.

Surfaces inaccessible for coating after erection shall be coated prior to erection.

At least 100 mm of bare metal and 100 mm of each coat of the new system shall be left exposed for lapping of subsequent coats, where the continuous application of paint or final surface preparation is interrupted in a section.

911.07.04.02.03 Existing Structural Steel

Except for metallizing and hot dip galvanizing, the maximum time between final surface preparation and the prime coat application shall be 10 hours.

When work operations require bolt connections of structural steel components, faying surfaces of existing structural steel shall have only the prime coat applied, prior to assembly.

When tying into existing coatings, that portion of the existing coating within 300 mm of the edge of the new coating shall be power washed using potable water to remove all contaminants. The edges of the existing coating shall be feathered into areas cleaned to bare steel so that at least 4 mm of each coat of the existing coating is exposed.

911.07.04.02.04 Paint Coating on Galvanized Surfaces

All coats of the paint system shall be shop applied.

When surface preparation is done indoors and the galvanized steel component remains indoors at all times until coating is completed, the maximum time allowable between surface preparation by sweep blasting and prime coat application shall be 24 hours provided that the relative humidity within the shop is maintained at 50% or below 50% for the entire 24-hour period. If the prepared galvanized steel component is exposed outdoors or if it is kept indoors and the relative humidity is above 50%, the maximum time between final surface preparation by sweep blasting and prime coat application shall be 4 hours.

911.07.04.02.05 Faying Surfaces

911.07.04.02.05.01 General

Faying surfaces of bolted connections shall have only the prime coat applied.

Exterior surfaces of the bolted connections within a distance of 25 mm around the edge of the bolt holes and against which the bolt head or washer is going to be bearing shall receive only the prime coat. Any exposed areas of primer not covered by the bolt head or washer after the installation of the bolts shall be touched up with the second and third coats of the specified coating system.

Faying surfaces left exposed to UV radiation for extended periods of time may begin to chalk. All necessary precautions shall be taken to prevent chalking if bolted connections will not be assembled within 3 months. If chalking is present at the time of assembly, it shall be removed by washing the surface with an appropriate cleaner and rinsing with potable water, or as recommended by the coating manufacturer.

911.07.04.02.05.02 Slip Critical Connections

Faying surfaces of slip critical connections designed to receive Class A or Class B coatings shall have the same coating application as was used in the tests to determine the mean slip coefficient. Slip critical connections shall not be assembled before the coating has cured for the minimum time that was used in the qualifying tests and identified in the coating manufacturer's written instructions.

At slip critical connections on paint coated components, the surface within the bolt pattern, and for a distance of 50 mm beyond the splice plates shall receive only the prime coat of paint, prior to assembly.

Prime coated surfaces that are exposed after assembly shall receive the second and third coats of the paint system after cleaning of the surfaces according to manufacturer's recommendations.

Faying surfaces of galvanized components of slip critical connections shall be hot dip galvanized according to the requirements of ASTM A123/A123M. Power or hand wire brushing is not permitted. These faying surfaces shall not be subsequently paint coated.

911.07.04.02.06 Dry Film Thickness

Dry film thickness shall be as listed on the ministry's DSM. If not listed on the ministry's DSM, dry film thickness shall be according to the following:

- a) An epoxy-zinc, water-based acrylic, water-based acrylic coating system shall consist of three coats with dry film thickness according to Table 1.
- b) An epoxy-zinc, epoxy, polyurethane coating system shall consist of three coats with dry film thickness according to Table 2.
- c) An inorganic-zinc, water-based acrylic, water-based acrylic coating system shall consist of three coats with dry film thickness according to Table 3.
- d) An inorganic-zinc, epoxy, polyurethane coating system shall consist of three coats with dry film thickness according to Table 4.
- e) Three-coat moisture-cured polyurethane (MCU) coating system with zinc-rich primer shall consist of three coats with dry film thickness according to Table 5.
- f) A coal tar epoxy coating system shall consist of two coats with dry film thickness according to Table 6.
- g) High build epoxy prime coat, aliphatic polyurethane topcoat coating system for coating galvanized surfaces shall consist of two coats with dry film thickness according to Table 7.
- h) Modified aluminum epoxy mastic prime coat, aliphatic polyurethane topcoat coating system for coating galvanized surfaces shall consist of two coats with dry film thickness according to Table 7.

911.07.04.02.07 Repair of Paint Coatings on New and Existing Structural Steel

Damaged areas of paint coated surfaces shall be prepared to the original surface preparation standard specified and by feathering the edges of sound coatings. For damaged areas of less than 100 cm², power tool cleaning according to SSPC SP 11 may be used for surface preparation. The prepared surfaces shall be recoated with the originally applied materials, except for inorganic zinc primer, which shall be recoated with an epoxy zinc primer from the same manufacturer. The dry film thickness of all the three coats in the repair area shall be as specified for the initial application.

911.07.04.02.08 Repair of Paint Coatings on Galvanized Surfaces

Painted galvanized surfaces where the paint coating has been damaged shall be carefully prepared by hand or power tool cleaning and the edges, including at the interface of the uncoated areas of the faying surfaces, shall be feathered. The prepared surfaces shall be recoated with the specified materials according to the manufacturer's product data sheets.

In areas where the galvanized coating beneath the paint coating is also damaged, the repair of paint coating shall be performed upon completion of the repair of galvanized coating.

911.07.04.03 Metal Coatings

911.07.04.03.01 Hot Dip Galvanizing

At least 72 hours prior to the commencement of galvanizing, the Contract Administrator shall be given written notice of the intent to hot dip galvanize including a schedule for hot dip galvanizing of various components. Hot dip galvanizing done without this prior notification may be rejected.

Galvanized surfaces that are to receive a subsequent paint coating shall be identified when delivered to the hot dip galvanizer. These surfaces shall be air cooled. Passivation treatment or water quenching shall not be permitted.

Hot dip galvanizing shall be according to ASTM A123/A123M. Hot dip galvanizing of structural bolts and steel hardware that are to be centrifuged or otherwise handled to remove excess zinc shall be according to ASTM A153/A153M.

Girders, diaphragms, and all other structural steel components shall be handled in such a manner to ensure that the components do not get warped or distorted during or immediately after hot dip galvanizing. The lifting system during handling of girders shall consist of a spreader beam providing support to the girder being galvanized at spacing not greater than 6 m.

Web of girders shall be kept vertical during the galvanizing process and supports at spacing not greater than 6 m shall be provided for placing of the components during cooling after galvanizing.

Two copies of the galvanizer's coating thickness readings shall be submitted to the Contract Administrator after galvanizing and prior to the installation of the component in the structure.

911.07.04.03.02 Thermal Sprayed Metal Coatings

A written notice shall be submitted to the Contract Administrator 48 hours in advance of surface preparation and thermal metal spray coating application.

The application of thermal sprayed metal coating shall be according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a minimum of 200 µm coating thickness. Coating thickness shall not exceed 400 µm. Thermal sprayed metal coating shall have a minimum of 4.8 MPa bond strength to the steel substrate when tested according to ASTM D4541 using either Type III or Type V self-alignment tester.

Immediately prior to metallizing, all prepared surfaces shall be cleaned by vacuuming to remove dust, debris, and other surface contaminants. At least one layer of thermal sprayed metal coating shall be applied within 4 hours of blast cleaning or before flash rusting occurs, whichever is sooner. This layer shall cover the peaks of the surface profile. Prior to applying additional sprayed metal to the specified thickness, the first layer of coating shall be visually inspected to verify that the coating surface has not become contaminated. Any contamination between coats shall be removed according to the manufacturer's instructions before any additional material is applied. The coating shall be sprayed to obtain the specified thickness, as soon as possible.

Before starting the work, a 300 x 300 mm steel sample plate similar in composition and thickness to the steel to be coated shall be submitted to the Contract Administrator. This plate shall be cleaned and sprayed on site according to the Contract Documents. The metal coating on the sample plate shall be checked by the Contract Administrator for compliance with the Contract Documents. This plate, when accepted by the Contract Administrator, shall be used as the visual standard to determine the acceptability of the thermal spray metal coating for the entire work.

All thermal metal spray applicators shall demonstrate proficiency in applying the thermal sprayed metal coating on a test patch to the satisfaction of the Contract Administrator prior to commencing full-scale application. The first 600 mm square block pattern application shall be used for this evaluation by the Contract Administrator.

The equipment shall be operated according to the manufacturer's latest written instructions, including air pressure, gun distance to work surface, and gun angle relative to the work surface.

Thermal metal spraying shall be done in a block pattern, typically 600 mm square. The sprayed metal shall overlap 50% on each pass to ensure uniform coverage. The required coating thickness shall be obtained in multiple layers. Each layer shall be applied at right angles to the previous layer. The semi-molten or molten particles of metallizing wire shall be firmly adhered to the substrate; free from lumps, chips, blisters, or loosely adhering particles; and have a fine-sprayed texture.

911.07.04.03.03 Seal Coating of Thermal Sprayed Metal Coatings

All thermal sprayed metal coated surfaces shall be seal coated within 6 hours after application of thermal sprayed metal coating according to SSPC-PA 1.

Contamination on thermal sprayed metal coated surfaces, including dust and moisture, shall be removed to the satisfaction of the Contract Administrator prior to the application of the seal coat. The seal coat materials shall be mixed and applied according to the manufacturer's instructions. Thinning shall not be done, unless approved in writing by the manufacturer and by the Contract Administrator.

The minimum dry film thickness shall be 100 µm.

911.07.04.03.04 Repair of Hot Dip Galvanizing

The Contract Administrator shall be notified 24 hours in advance of their intention to carry out the repair of damaged coatings.

Damaged and uncoated areas in galvanized coating shall be repaired, only if the cumulative total of the damaged and uncoated areas does not exceed 2% of the total area of a fabricated assembly or 0.02 m², whichever is smaller. If the cumulative total of the damaged or uncoated area exceeds the above, then the damaged coating shall be stripped and the component re-dipped in a galvanizing bath according to ASTM A123/A123M.

Damaged and uncoated areas shall be cleaned of all rust and other contaminants and repaired using one of the following methods:

a) Soldering Method Using Zinc-Tin-Copper Solder

The surface preparation of damaged and uncoated areas and the application of the flux and zinc-tin-copper solder shall be according to ASTM A780 and the manufacturer's recommendations. The finished thickness of the metal coating in the repaired area shall be a minimum of 90 µm. The repaired surface shall be ground flush with the surrounding galvanized coating.

For components that are to be subsequently paint coated, repair by soldering shall be performed prior to surface preparation for paint coating application.

b) Thermal Metal Spraying

The surface preparation and application of thermal spray metal coating shall be done according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a cumulative thickness of 200-400 µm, applied in two separate coats.

The metal coating on the repaired areas shall have a minimum of 2.8 MPa adhesion when tested according to ASTM D4541 using either Type III or Type V self alignment tester.

When metallizing is to be used for repair of damaged galvanized coating of structural components that are to be subsequently painted, it shall be performed immediately after the surface preparation of the repair area to the specified surface preparation standards and sweep blasting of the entire component, prior to the application of the prime coat of the paint coating system. The prime coat of the paint coating system shall be applied within 6 hours of repair by metallizing.

c) Epoxy Zinc/Epoxy/Polyurethane Paint System

This method of repair of metal coating is permitted on sign support structures and sectional steel high mast lighting poles when:

- a) The individual damaged and uncoated area with exposed steel is less than 625 mm²;
- b) The dry film thickness of the galvanized coating of a structural member in localized areas does not meet the specification requirements but exceeds 60 µm; and
- c) The number of repair spots does not exceed 6 per galvanized overhead truss or a column or a section of sectional steel high mast lighting pole.

All three coats given for the system listed on the ministry's DSM shall be used for repair of galvanized coating defects on overhead trusses.

Only the epoxy zinc primer listed on the ministry's DSM shall be used for repair of galvanized coating defects in sign support columns and sectional steel high mast lighting poles. Defects shall then be top coated with the same paint coating system used for top coating of the structural component.

Surface preparation of the damaged or uncoated areas shall be by hand or power tool cleaning using clean equipment, scraping of the edges of galvanized coating to remove loose edges, feathering of the edges of intact coatings, and abrading of surface followed by solvent cleaning according to SSPC-SP 1. Where coating damage has exposed the base metal and the width is larger than 6 mm, the damaged area shall be cleaned according to SSPC-SP 11 prior to the application of the epoxy zinc primer.

All paint coating materials shall be brush applied according to manufacturer's product data sheets.

When paint coated galvanized surfaces are damaged, the paint coating on and around the galvanized surfaces that are to be repaired shall be removed by sanding to a sufficient distance from the repair area to prevent heat damage to the paint during metal coating repair process, followed by repair of damaged metal coating. The specified paint coating system shall then be applied over the repaired area according to manufacturer's product data sheets.

911.07.04.03.05 Repair of Thermal Sprayed Metal Coatings and Seal Coat

The Contract Administrator shall be notified 24 hours in advance of the intention to carry out the repair of damaged coatings.

Damaged metal coating and uncoated areas of structural steel surfaces shall be cleaned of all rust and other contaminants and repaired by thermal metal spraying according to SSPC-CS 23.00/AWS C2.23M/NACE No.12 to provide a minimum of 200 µm cumulative thickness, applied in two separate coats. The surfaces shall be brought to the original surface preparation standard specified prior to thermal metal spraying.

For repair of seal coated metallized surfaces, the seal coating on and around the metallized surfaces that are to be repaired shall be removed by sanding to a sufficient distance from the repair area to prevent damage to seal coating during the metal coating repair process. The repaired area shall then be coated with the specified seal coating system according to the Seal Coating of Thermal Sprayed Metal Coatings clause.

911.07.04.04 Coating of Areas Difficult to Access

Coating of areas specified in the Contract Documents as difficult to access shall be done from the access opening, as detailed in the Contractor's submission for methods, procedures, and sequence of work. Quality of the coating application for these areas shall be based on a reasonable effort demonstrated in the field acceptable to the Contract Administrator.

911.07.04.05 Existing Steel Railing Systems

Steel handrail panels shall be removed from the structure, delivered to the galvanizer, cleaned, prepared, galvanized, delivered to the site, and reinstalled.

Steel posts, steel post caps, and steel panel anchors shall be metallized after removal of and prior to reinstallation of the handrail panels.

The structural steel in the steel panel anchorages on concrete posts shall be coated with the low VOC epoxy-zinc/epoxy/polyurethane system.

911.07.05 Field Sampling and Testing of Coating Materials

911.07.05.01 Paint Coating Materials

Field samples of 250 ml of each batch of each component of all paint coating materials used shall be obtained for testing. Complete Owner Standard Form, PH-CC-430, Structural Coating Sample Data, for each component sample. Submit the samples and the completed forms to the Contract Administrator for delivery to the laboratory designated by the ministry.

For multicomponent paint coat, there shall be enough samples of each paint component so that different batches could be combined to form the complete coat for testing.

The coating supplier shall be consulted for the sampling procedure prior to obtaining samples of moisture sensitive materials. Solvent shall not be added to the field samples.

911.07.05.02 Metallic Coating Materials

When the application of thermal sprayed metal coating is specified in the Contract Documents, a 1.0 m long metallizing wire from the same batch used in the work shall be submitted to the Contract Administrator.

911.07.06 Access for Inspection

Access for inspection to all portions of the work shall be provided and maintained.

911.07.07 Quality Control

Ongoing quality control of the cleaning and coating application operations, including measurements of temperature, humidity, dew point, surface profile, and coating thickness shall be performed. Quality control measurements shall also include monitoring of the air change and the existence of negative pressure within the enclosure for projects that require surface preparation by abrasive blast cleaning or other high dust generating methods. The existence of negative pressure within the enclosure by instrument measurements or by visual assessment shall be demonstrated as often as requested by the Contract Administrator. Written documentation of measurements taken, including dry film thickness (DFT) measurements taken using Type 2 constant pressure probe magnetic gauges, shall be provided to the Contract Administrator on a weekly basis, minimally, or more often as requested by the Contract Administrator. Dry film thickness readings for quality control shall be measured according to ASTM D7091 using a Type 2 magnetic gauge.

The magnetic gauge shall be calibrated according to the procedures in SSPC-PA 2. To facilitate the calibration procedure, a 75 x 75 mm area of the prepared steel at a location selected by the Contract Administrator shall be masked off. After all tests are completed, this area shall be coated as specified in the Contract Documents. As an alternative to calibrating the Type 2 magnetic gauge on the prepared surface, an uncoated 300 x 300 mm reference plate sample of steel of similar composition; thickness, $\pm$ 10%; and surface preparation for gauge calibration may be provided.

911.07.08 Environmental Protection During Surface Preparation and Coating of Structural Steel and Steel Railing Systems

911.07.08.01 General

During the work of surface preparation and coating of structural steel and steel railing systems, the total cumulative time of random escapes to the environment shall not exceed 15 minutes over an 8 hour work shift. For shorter or longer work shifts, the allowable cumulative time of escape shall be prorated by proportioning, based on the duration of the work shift to 8 hours.

Operation shall cease immediately in the event that the random escapes exceed the specified limits or any escape extends beyond the right-of-way.

Operation shall not resume until remedial action and cleanup has been completed.

911.07.08.02 Application of Coating Material Without Spray Equipment

When coating material is applied without spray equipment, an enclosure is not required, provided escape of coating material is prevented. A method of containment shall be provided to protect the surrounding areas from unwanted spills and drips of paint coating materials.

911.07.08.03 Application of Coating Material with Spray Equipment

When coating material is applied with spray equipment, a full enclosure that prevents the escape of coating material shall be installed and maintained.

911.07.08.04 Low Dust Generating Surface Preparation

Partial enclosures may be used to prevent escape of material, including substrate material, paint chips, and localized dust, from low dust generating surface preparation methods such as cleaning with hand or power tools.

911.07.08.05 Abrasive Blasting or Other High Dust Generating Surface Preparation

911.07.08.05.01 General

Except as specified below for the vacuum abrasive blasting and filtration or similar vacuum and filtration systems, a full enclosure with a negative pressure system shall be installed and maintained around all surface preparation activities when abrasive blasting is carried out.

911.07.08.05.02 Vacuum Abrasive Blasting

At work areas where vacuum abrasive blasting is used, a full enclosure with negative pressure system is not required, provided the vacuum blasting equipment can satisfy the random escape limits stipulated in this specification. A partial enclosure with ground covers and skimmers on waterways shall be installed as a minimum to prevent incidental escape.

911.07.08.06 Enclosures

911.07.08.06.01 General

Enclosures shall be installed, operated, and maintained to limit the random escape of material.

When openings or tears occur in the enclosure, surface preparation operations shall cease until repairs have been made.

The enclosures shall be removed from the right-of-way at the completion of the work.

Work platforms and the ground surface, where work is being conducted from the ground, shall be covered with tarps with overlapping sealed edges or other means to protect the ground from contamination and to permit recovery of the spent material.

Deck drains shall be fully sealed when the deck surface forms the floor of the enclosure. Where the enclosure extends below the deck, deck drains shall be temporarily extended or redirected to avoid road run off discharging into the enclosure.

There shall be no escape of dust or materials while dismantling or moving the enclosure. Walls, floors, and joints of the enclosure shall be cleaned by vacuuming prior to moving or dismantling it. All dust and material not previously accessible or found in cracks and joints during dismantling shall be immediately vacuumed.

911.07.08.06.02 Partial Enclosures

Partial enclosures shall be installed to prevent the escape of all materials, including localized dust.

A partial enclosure is not an appropriate containment system for high dust generating surface preparation operations such as abrasive blast cleaning. Partial enclosures may consist of vertical and floor tarps, provided the tarps are overlapped and securely fixed together at the seams.

911.07.08.06.03 Full Enclosure

Full enclosures shall be impervious to dust and wind and prevent the escape of all materials, including dust. A full enclosure on its own is not an appropriate containment system for high dust generating surface preparation operations such as abrasive blast cleaning. Full enclosures shall be free of any openings and shall have joints, seams, and overlaps fully sealed.

911.07.08.06.04 Full Enclosure with Negative Pressure

A full enclosure with negative pressure shall consist of the full enclosure, as described in the Full Enclosures clause, equipped with a mechanical ventilation system capable of effecting complete air change for the enclosure in less than one minute. The mechanical ventilation system shall be in operation during abrasive blast cleaning, clean up activities, and surface blow down or other high dust generating surface preparation operations to ensure effective removal of dust and other materials from the air inside the enclosure.

911.07.08.07 Dust Collector

Air evacuated from an enclosure shall be conveyed in fully sealed conduits to a dust collector appropriately sized for the material and airflow. There shall be no escape of materials from conduits and dust collectors.

911.07.08.08 Recycling Equipment

When spent abrasive material is recycled, there shall be no escape of dust or material during the mobilization, operation, clean-up, or demobilization of abrasive recyclers, conduits, dust collectors, and associated equipment. The collectors and filters should arrive on site undamaged, empty, and free of all dust and debris.

911.07.08.09 Handling and Storage of Spent Material

Spent materials and dust in the immediate vicinity of the area where structural steel is to be coated shall be removed prior to paint coat application. Spent materials from an enclosure shall be collected daily. Spent material from recycling equipment and dust collectors shall be collected on a regular basis to maintain the effective performance of the equipment. All spent material shall be stored in rigid containers with tight sealing lids. The containers shall be made of steel, rigid plastic, or similar material and shall be in sound condition. The containers shall keep the material dry at all times and prevent its escape. There shall be no escape of material during transfers to and from containers, enclosures, recycling equipment, or dust collectors.

Measures shall be taken to prevent vandalism of stored spent material.

911.07.08.10 Containment around Equipment and Materials

If any equipment or materials is parked or stored on the bridge deck, approaches, or adjacent surfaces, the surfaces under such equipment shall be covered with tarps to contain any spills or leaks from the equipment or operations involving the equipment.

Tarps shall be sufficiently overlapped, impervious to water, and free of holes and openings.

All spills accumulated on the tarps shall be prevented from escaping onto the surrounding surface and be cleaned up immediately.

911.07.08.11 Remedial Work

Remedial work related to the environmental protection shall be carried out to rectify work that does not meet the requirements as specified in the Contract Documents. A remedial work scheme shall be submitted to the Contract Administrator and work shall not proceed until written permission to do so is received from the Contract Administrator.

911.07.09 Management of Excess Materials

Management of excess materials shall be as specified in the Contract Documents.

911.08 QUALITY ASSURANCE

911.08.01 Inspection

Each phase of the work shall be inspected by the Contract Administrator and approved before work is to commence on to the next phase.

911.08.02 Surface Preparation

Acceptability of the surface preparation by the Contract Administrator shall be based on the applicable SSPC surface preparation specifications and pictorial standards given in SSPC-VIS 1 and SSPC-VIS 3.

911.08.03 Measurement of Surface Profile

Surface profile measurements shall be made by the Contract Administrator on a random basis using a surface profile gauge according to ASTM D4417, Method B or a spring micrometer and an extra coarse pressure sensitive replica tape according to ASTM D4417, Method C.

911.08.04 Testing for Cleanliness

The work shall be randomly tested by the Contract Administrator for cleanliness to determine contamination of surfaces by the presence of visible dust, oils, grease, or other foreign matter.

911.08.05 Measurement of Temperature, Humidity, and Dew Point

Random testing of ambient and surface temperature, relative humidity, and dew point by the Contract Administrator shall be done by means of a thermometer, surface thermometer, or recording hygro-thermograph and digital or sling psychrometer with recognized psychometric tables.

911.08.06 Measurement of Coating Thickness

Measurement of the coating thickness shall be made by the Contract Administrator. The dry film thickness shall be measured according to ASTM D7091 using a Type 2 magnetic gauge.

Determination of the acceptability of the dry film thickness of each coat shall be made according to SSPC-PA 2, Coating Thickness Restriction Level 3

The specified maximum dry film thickness used to determine acceptability of coating thickness according to SSPC-PA 2 shall be the manufacturer's recommended maximum, as shown in the submitted product data sheets.

The Contractor shall be present when the Owner's magnetic gauges are being calibrated by the Contract Administrator.

911.08.06.01 Measurement of Coating Thickness on New Structural Steel Sign Support Structures and Sectional Steel High Mast Lighting Poles

The dry film thickness shall be measured by Type 2 constant probe magnetic gauges according to ASTM D7091 and SSPC-PA 2, except that 5 separate spot measurements at representative locations of each galvanized sign support columns or legs and each sectional steel high mast lighting pole, as determined by the Contract Administrator, shall be taken after the application of individual coats of the paint coating system.

The Contractor shall note defects on sectional steel high mast lighting poles prior to installation. All defects shall be repaired according to the Repair of Paint Coatings on Galvanized Surfaces and Repair of Hot Dip Galvanizing clauses as applicable. The coating of sectional steel high mast lighting poles is subject to inspection by the Contract Administrator.

911.08.07 Testing Adhesion of Paint Coatings

Paint coatings may be tested for adhesion at the discretion of the Contract Administrator.

911.08.08 Testing Adhesion of Thermal Sprayed Metal Coatings

During thermal metal spraying, the Contract Administrator shall perform random adhesion tests according to ASTM D4541 using either Type III or Type V self alignment tester. The minimum acceptable adhesion strength shall be 4.8 MPa. All non-conforming areas and areas damaged by the test shall be re-blasted and re-sprayed to conform to the requirements as specified in the Contract Documents.

Adhesion measurements on repaired areas may be made on a random basis according to the above method.

911.08.09 Testing of Coating Materials

Field samples shall be delivered within one week from the date of sampling for testing to:

Head, Concrete Section
Ontario Ministry of Transportation
95 Arrow Road
Toronto, Ontario, M9M 2L4

The submitted field samples of paint coatings shall be tested according to OPSS 1704 and as specified in the Contract Documents. Samples of metallic coating materials shall be tested as specified in the Contract Documents.

911.08.10 Frequency of Tests and Inspection

Except as specified above, the frequency of tests shall vary as conditions require.

911.08.11 Performance Warranty for Coating of Existing Structural Steel

When the area of existing structural steel to be cleaned and coated is more than 200 m², the coating system shall be unconditionally warranted for a period of 24 months from the date of the Contract Completion Certificate that it has been applied as specified in the Contract Documents, and will be free from defects, as specified below.

The coating system shall be considered defective if any of the following conditions exist:

- a) Visible corrosion products, except at locations defined in the Contract Documents as difficult to access, blistering, bubbling, checking, cracking, wrinkling, delaminations, dry spray, pinholes, sagging, flaking, mud cracking, peeling, scaling, or undercutting.
- b) Coating applied over dirt, debris, blasting debris, corrosion products not removed during surface preparation, or steel projections.
- c) Incomplete coating.
- d) Damage to the coating caused by the Contractor's operations or excessive blast dust on the finish coat.

In the 2 months immediately preceding the last month of the warranty period, the Owner shall inspect the coatings for the defects listed above. The Contractor shall be given a minimum of 72 hours' notice prior to the inspection and may be present during this inspection. The Owner at their expense shall arrange for traffic control and access for the inspection.

All defective areas identified by the inspection shall be repaired as specified in the Contract Documents. All repair work shall be completed within 8 weeks of the Contractor receiving notification of the results of the inspection, unless prevented by seasonal shutdown, in which case the repairs shall be completed in the first 5 weeks of the following construction season.

911.10 BASIS OF PAYMENT

911.10.01 Coating Existing Structural Steel - Item Coating New Structural Steel - Item Coating Steel Railing System - Item Environmental Protection During Coating of Structural Steel and Steel Railing Systems - Item Coating New Structural Steel Sign Support Structures - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Remedial work on environmental protection shall be completed by the Contractor at no additional cost to the Owner.

911.10.02 Progress Payments

911.10.02.01 Coating Items

Progress payments for the coating items shall be made on the following basis:

a) Coating Existing and New Structural Steel

i. Paint Coatings:

Surface preparation and prime coat	80% for 2 coat systems 70% for 3 coat systems
2 nd coat	15% for 2 coat systems 10% for 3 coat systems
3 rd coat	15% for 3 coat systems
Cleanup and final coating repair	5%

ii. Hot Dip Galvanizing and Hot Dip Galvanizing with Paint Coatings:

Surface preparation and hot dip galvanizing	90% for hot dip galvanizing only application 55% for hot dip galvanizing with paint coatings
Sweep blasting and all coats of paint coating	35%
Cleanup and final coating repair after erection	10%

iii. Thermal Sprayed Metal Coating with Seal Coat:

Surface preparation, metallizing, and seal coat 90%

Cleanup and final coating repair 10%

b) Coating Steel Railing System:

Dismantling, delivery to galvanizer,
surface preparation, galvanizing, and
coating of posts and anchors 80%

Delivery to site and erection 15%

Cleanup and final coating repair after erection 5%

911.10.02.02 Environmental Protection Items

Progress payments for environmental protection shall be made on the same percentage basis as the coating items for which the environmental protection is required.

TABLE 1
Epoxy-Zinc, Water-Based Acrylic, Water-Based Acrylic Coating System

Coat	Dry Film Minimum Thickness µm
Prime	90
Second	90
Third	90

TABLE 2
Epoxy-Zinc, Epoxy, Polyurethane Coating System

Coat	Dry Film Minimum Thickness µm
Prime	90
Second	100
Third	50

TABLE 3
Inorganic-Zinc, Water-Based Acrylic, Water-Based Acrylic Coating System

Coat	Dry Film Minimum Thickness µm
Prime	75
Second	90
Third	90

TABLE 4
Inorganic-Zinc, Epoxy, Polyurethane Coating System

Coat	Dry Film Minimum Thickness µm
Prime	75
Second	100
Third	50

TABLE 5
Three-Coat Moisture-Cured Polyurethane Coating System with Zinc-Rich Primer

Coat	Dry Film Minimum Thickness µm
Prime	90
Second	100
Third	50

TABLE 6
Coal Tar Epoxy Coating System

Coat	Dry Film Minimum Thickness µm
Prime	200
Second	200

TABLE 7
Paint Coating Systems for Coating Galvanized Surfaces

Coat	Dry Film Minimum Thickness µm
High Build Epoxy Prime Coat	100
Aliphatic Polyurethane Topcoat	75
Modified Aluminum Epoxy Mastic Prime Coat	125
Aliphatic Polyurethane Topcoat	50



CONSTRUCTION SPECIFICATION FOR PRECAST CONCRETE CULVERTS WITH SPANS GREATER THAN 3.0 M

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912.01 SCOPE

This specification covers the material and construction requirements of single and adjacent side-by-side (multi-cell) precast concrete box culverts with spans greater than 3.0 m, and associated precast concrete appurtenances, in open cut, for both new culverts and replacement of existing culverts. This specification includes requirements for excavation, bedding, backfilling, and cover material.

912.02 REFERENCES

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 209	Embankments Over Swamps
OPSS 404	Support Systems
OPSS 501	Compacting
OPSS 517	Dewatering
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 902	Excavating and Backfilling – Structures
OPSS 905	Steel Reinforcement for Concrete

OPSS 909	Prestressed Concrete – Precast Girders
OPSS 919	Formwork and Falsework
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation – Concrete Patches, Refacing, and Overlays
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standards Specifications, Material

OPSS 1002	Aggregates – Concrete
OPSS 1004	Aggregates – Miscellaneous
OPSS 1010	Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1205	Clay Seal
OPSS 1302	Water
OPSS 1306	Burlap
OPSS 1350	Concrete – Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1860	Geotextiles

MTO Publications

MTO Laboratory Testing Manual:

LS-410	Method of Test for Compressive Strength of Concrete Cores
LS-432	Method of Test for Microscopical Determination of Air Void System Parameters in Hardened Concrete
LS-433	Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
LS-706	Moisture - Density Relationship of Soils Using 2.5 kg Rammer and a 305 mm Drop Structural Manual

MTO Forms:

PH-CC-322	Concrete Construction Report
PH-CC-433A	Concrete Mix Design Form A
PH-CC-701	Request to Proceed
PH-CC-702	Notice to Proceed

ASTM International

A153-16a	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B633-15	Electrodeposited Coatings of Zinc on Iron and Steel
C171-16	Sheet Materials for Curing Concrete
C990-09 (R2014)	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
D6938-17a	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

CSA Standards

A23.4-16	Precast Concrete Materials and Construction
S6-19	Canadian Highway Bridge Design Code
W47.1-09 (R2019)	Certification of Companies for Fusion Welding of Steel
W59-13	Welded Steel Construction (metal arc welding)
W186	Welding of Reinforcing Bars in Reinforced Concrete Construction
A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing*
	* [Part of A23.1-19/A23.2-19 – Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

For the purpose of this specification, the following definitions apply:

Backfill means earth, rock, or granular material used as fill within the excavation placed beyond the limits of bedding and cover below the subgrade elevation, including frost tapers.

Bedding means the material used to support the bottom of the culvert.

Bughole means a small regular or irregular cavity resulting from entrapment of air bubbles in the surface of formed concrete during placement or consolidation.

Cold Joint means a joint or discontinuity resulting from a delay in placement of sufficient duration to preclude intermingling and bonding of the concrete.

Cold Weather means when the air temperature to which the element is exposed is at or below 5 °C, or when the air temperature to which the element is exposed is at or is likely to fall below 5 °C within 96 hours after completion of concrete placement. Temperature refers to shade temperature.

Culvert means a structure with a span greater than 3.0 m that is typically embedded in fill, and is used to convey water, pedestrians, vehicles, cyclists, or animals.

Concrete Appurtenances means head walls, cut-off walls, aprons, collars and any other concrete fixtures associated with the culvert, excluding concrete bedding or concrete structures covered elsewhere in the Contract Documents.

Distribution Slab means a reinforced concrete slab on top of the culvert that may be specified when the earth cover is less than 600mm to improve load distribution on a culvert.

Element means an individual precast concrete culvert unit.

Excavation, Earth and Rock means the excavation of material classified as earth and rock according to OPSS 902.

Granular Cover means the material placed as a protective layer above the culvert to prevent damage to the culvert.

Honeycombing means rough and stony concrete surface with voids where the mortar did not fill the spaces between the coarse aggregate particles.

Indoor Precast Concrete Plant means a building, which is a permanent structure, providing protection from sun, wind, and rain and which is temperature controlled, such that the temperature does not fall below 15 °C or exceed 30 °C.

Length of the culvert means the distance measured between the ends of the assembled elements, measured along the longitudinal axis.

Lot consists of all elements of the same span and concrete mix design, produced over seven consecutive Days.

Native Material means the original material removed to form an excavation and which is acceptable to the Contract Administrator for return to the same or other excavation as backfill beyond the structure.

Pour Line means a visible delineation between two placements of concrete where the concrete from each placement is well-bonded to the other.

Protection Slab means a concrete slab that may be placed on the top of the culvert in an area exposed to chlorides. See also Distribution Slab.

Segregation means visible separation of the mortar and coarse aggregate particles in the plastic concrete resulting in concrete that is not uniform in appearance or proportions.

Soil means all loose or moderately cohesive organic or inorganic deposits of the earth's crust such as silt, sand, gravel, or clay or any of their mixtures.

Span means the horizontal distance measured perpendicular to the inside faces of the walls of the culvert.

912.04 DESIGN AND SUBMISSION REQUIREMENTS

912.04.01 Design Requirements

The design shall be according to CSA S6, the Structural Manual, and as specified in the Contract Documents.

Culverts shall be waterproofed as specified in the Contract Documents.

912.04.02 Submission Requirements

912.04.02.01 Working Drawings

Three sets of Working Drawings, including supporting documentation, shall be submitted to the Contract Administrator at least seven Days prior to commencement of fabrication of the elements, for information purposes. The Working Drawings shall be:

- a) signed and sealed by an Engineer, where Working Drawings show the same reinforcement sizes, spacing, and layouts from Contract Drawings, or,
- b) signed and sealed by a design Engineer and a design-checking Engineer, where Working Drawings have been modified from Contract Drawings.

When other authorities are involved in the approval of the design or construction of the culvert, the submission of Working Drawings shall be made at least 35 Days prior to commencement of fabrication of the elements and one additional copy of the submission shall be provided for each authority. The requirements of each authority and the requirements of the Owner as specified in the Contract Documents shall be satisfied prior to commencement of the Work.

The Working Drawings shall include as a minimum the following information:

- a) Element details.
- b) Steel reinforcement details.
- c) Lifting point locations.
- d) Details and location of any temporary supports.
- e) Stripping strength and requirements for handling of components immediately after stripping.
- f) Design calculations, of any components not specified on, or altered from, the Contract Drawings.
- g) Waterproofing details, provided by Owner.

- h) Connection details.
- i) Details for invert, obvert, depth of embedment and substrate materials.
- j) Details for inlet and outlet control structures and any associated retaining structures.
- k) Details of any openings required in the walls or slabs for connection of storm drainage.
- l) Details of any features required to facilitate fish passage, up-welling or any other environmental requirements.
- m) Any other applicable details.

The supporting documents shall include, as a minimum, the following information:

- a) Handling and installation procedures including calculations.
- b) Details of any bracing required to provide stability to the elements during transportation and construction.

912.04.02.02 Concrete Mix Designs

The concrete mix shall be designed to provide adequate strength and durability for the intended use and to meet the requirements as specified in the Contract Documents. The concrete mix design shall be submitted according to the Mix Design clause of OPSS 1350.

912.04.02.03 Precast Plant Certification Submissions

The certificate, verifying the precast plant is certified according to the Precast Plant Certification clause, shall be submitted with the concrete mix design submission.

Copies of precast plant certification audit reports of Canadian Precast Concrete Quality Assurance Program (CPCQA), Canadian Standards Association (CSA), or both as applicable, and related documentation, shall be submitted to the Owner upon request.

If concrete is supplied by a ready-mix concrete supplier, a currently valid Certificate of Ready Mixed Concrete Production Facilities as issued by the Ready Mixed Concrete Association of Ontario (RMCAO), shall be submitted with the concrete mix design submission.

For multi-year contracts, for all plants supplying the work, documentation verifying that the precast plant, and ready-mix plant(s) if used, continue to hold valid certification shall be submitted annually.

912.04.02.04 Control of Concrete Temperature

Seven Days prior to the commencement of fabrication of the elements, a description of the method for monitoring and effectively controlling the temperature of the concrete shall be submitted to the Contract Administrator, for information purposes. The description shall include the method of controlling and recording the concrete temperature during the curing and protection period.

912.04.02.05 Notification of Placement

The Contract Administrator shall be notified in writing at least seven Days prior to commencement of fabrication. Any changes in the fabrication schedule shall be provided to the Contract Administrator in writing.

912.04.02.06**Mill Certificates**

Mill certificates shall be submitted according to OPSS 1440. The mill certificates shall be submitted as part of the precast report.

912.04.02.07**Manufacturer's Certificate of Conformance and Precast Report**

A manufacturer's Certificate of Conformance and precast report shall be submitted to the Contract Administrator for each shipment of elements at least five Business Days prior to shipping the elements from the precast plant.

The precast report shall contain the following information:

- a) List of elements including their identification number, lot number and description.
- b) Mill certificates for the steel reinforcement used in the elements.
- c) Summary of all measurements and inspections carried out prior to concrete placement to verify compliance with the Contract Documents including reinforcement placement, and other pre-pour checks.
- d) Temperature records for formwork and steel at the time of concrete placement.
- e) Temperature records for the concrete, including location of thermocouple wires, and graphical plots verifying that the requirements for maximum and minimum temperature, maximum allowable temperature difference, and maximum cooling rate, have been met. The format of the temperature plots shall be acceptable to the Owner.
- f) Record of inspection of moist curing.
- g) Summary of material test results for plastic concrete: air content, slump and concrete temperature.
- h) Summary of material test results for hardened concrete: stripping strength, confirmation of the projected 28-Day compressive strength. If test results are not available at the time of shipping, they may be submitted within four Business Days following completion of testing.
- i) Summary of all measurements and inspections required by this specification, including the concrete cover over steel reinforcement, crack measurement summary, and dimensional verification.
- j) Documentation, including colour photographs (labelled and dated), confirming that any defects repairable by standard methods have been identified, evaluated, and repaired as detailed in the Repair of Defects and Deficiencies Repairable by Standard Methods clause.
- k) When steam curing is used, test results showing that time of initial set was determined, unless standard delay periods are used, according to the Steam Curing and Other Application of Heat clause of OPSS 909.

A Request to Proceed shall be submitted to the Contract Administrator before each shipment of elements to the site.

The elements shall not be delivered to the site until the Contract Administrator has received the manufacturer's Certificate of Conformance, the precast report, and Request to Proceed, and the Contractor has received a Notice to Proceed.

912.05 MATERIALS

912.05.01 Backfill

912.05.01.01 Backfill to Structure

Backfill to the structure shall be one of the following, or as specified in the Contract Documents:

- a) Granular A, according to OPSS 1010.
- b) Granular B, Type I or II, with 100% passing the 26.5 mm sieve, according to OPSS 1010.

The 19.0 mm clear stone for wall drains shall be according to OPSS 1004.

912.05.01.02 Backfill Beyond Structure

Backfill beyond the structure shall be one of the following, or as specified in the Contract Documents:

- a) Granular A, according to OPSS 1010.
- b) Granular B, Type I or II, with 100% passing the 26.5 mm sieve, according to OPSS 1010.
- c) Native material.

912.05.02 Bedding

Bedding shall be as specified in the Contract Documents. The nominal maximum aggregate size for bedding shall not exceed 26.5 mm in diameter, unless the bedding layer has a thickness of 150 mm or greater, in which case the nominal maximum aggregate size shall not exceed 37.5 mm in diameter.

912.05.03 Burlap

Burlap shall be according to OPSS 1306.

912.05.04 Clay Seal

Clay seal, if required, shall be according to OPSS 1205.

912.05.05 Concrete

Concrete materials for precast components shall be according to the Materials section of OPSS 1350 with the following additions and amendments:

- a) Compressive strength shall be as specified in the Contract Documents.
- b) The air void system spacing factor, when tested according to LS-432, shall be 0.200 mm maximum.
- c) The nominal maximum size of coarse aggregate shall be 19.0 mm, except when a smaller nominal size is required in order to meet the requirements of CSA S6.
- d) Air-cooled blast furnace slag shall not be used as aggregate.

Concrete for cast-in-place concrete appurtenances, protection slabs and distribution slabs shall be according to OPSS 1350. Compressive strength for cast-in-place concrete appurtenances, protection slabs and distribution slabs shall be as specified in the Contract Documents.

912.05.06 Concrete Sealers

Concrete sealers, if required, shall be from the Owner's list of acceptable sealers. The list shall be obtained from the Contract Administrator.

912.05.07 Formwork

All formwork shall be according to OPSS 919 and CSA A23.4. Formwork shall be fabricated to meet the dimensional tolerances and finishes as specified in the Contract Documents. Textile form liners shall not be used.

912.05.08 Geotextile

Geotextiles shall be according to OPSS 1860 and shall be of the type, class and filtration opening size (FOS) specified in the Contract Documents.

912.05.09 Granular Cover

Granular cover shall be one of the following, or as specified in the Contract Documents:

- a) Granular A, according to OPSS 1010.
- b) Granular B, Type I or II, with 100% passing the 26.5 mm sieve, according to OPSS 1010.

912.05.10 Hardware

Hardware shall be made of stainless steel according to OPSS 1440 or be galvanized according to ASTM A153, except that galvanized hardware located within 50 mm of the concrete surface shall be chromate coated over an electro-deposited coating of zinc according to ASTM B633.

912.05.11 Moisture Vapour Barrier

The moisture vapour barrier shall be white opaque polyethylene film according to ASTM C171 and shall not be less than 100 µm thick.

912.05.12 Native Material

Native and imported material shall be approved by the Contract Administrator. All material shall be free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 150 mm in any dimension, and other deleterious material.

912.05.13 Preformed Joint Seal

Preformed joint seals shall be used for sealing the joint between elements. Preformed joint seals shall be butyl rubber according to ASTM C990.

912.05.14 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's List of Acceptable Concrete Patching Materials. The list of proprietary patching materials shall be obtained from the Contract Administrator.

912.05.15 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

912.05.16 Water

Water used for curing, including steam curing and pre-soaking of burlap, and water used in proprietary patching materials shall be according to OPSS 1302.

912.06 EQUIPMENT

912.06.01 General

Equipment made of aluminum, including tools, shall not come in contact with the plastic concrete.

912.06.02 Temperature Monitoring and Recording System

The temperature monitoring and recording system shall provide unalterable records of temperature during the recording period. Prior to use on the Contract, the temperature monitoring and recording system shall be confirmed by the Owner, in writing, to be acceptable.

Thermocouples and associated instrumentation shall have an accuracy of ± 1.5 °C and shall record temperatures at time intervals not exceeding 15 minutes and shall digitally display the temperature.

912.06.03 Chipping Hammers

Chipping hammers shall have a maximum weight of 9.0 kg and a maximum piston stroke of 102 mm. All hammers shall have the manufacturer's name and model number legibly engraved on them by the manufacturer.

912.07 CONSTRUCTION

912.07.01 Production of Precast Concrete Culverts

912.07.01.01 Precast Plant Certification

Precast culverts shall be fabricated by a plant certified according to one of the following:

- a) Canadian Precast Concrete Quality Assurance (CPCQA) Certification Program, Group B, Precast Bridge Products (B1 minimum), or
- b) Canadian Standards Association (CSA) Pre-cast Concrete Products Certification Program, Group B, Bridge Products (B1 minimum).

If concrete is supplied by a ready-mix concrete plant, the concrete production facility shall be certified by the Ready Mixed Concrete Association of Ontario (RMCAO).

912.07.01.02 Markings

As a minimum, the following information shall be embossed using numbers and letters 30 mm wide, 35 mm high and 5 mm deep on an upper top haunch of each element in the following order, readily visible for inspection:

- a) Prequalification stamp in accordance with the published requirements of the CPCQA or CSA Certification Program.
- b) Name or trademark of the manufacturer.
- c) Identification of plant if manufacturer has more than one plant.
- d) Date of manufacture (yyyy-mm-dd).
- e) Unique Number.
- f) Specification designation.
- g) MTO Site Number on end pieces.

In addition, the word "top" shall be lettered with waterproof paint on the top surface. This requirement shall be waived if the manufacturer installs lifting devices in the top slab only.

912.07.01.03 Steel Reinforcement, Mechanical Connectors, and Associated Hardware

912.07.01.03.01 Placement of Reinforcement

The placement of steel reinforcement shall be according to OPSS 905.

Under no circumstances shall reinforcement be inserted into plastic concrete.

912.07.01.03.02 Welding

Welding of steel hardware shall be according to CSA W59 and shall be performed by a welder qualified by the Canadian Welding Bureau (CWB) working for a company certified in accordance with CSA W47.1, Division 1 or 2.

Welding of reinforcing steel bars shall be according to OPSS 905. The reinforcing steel welding shall be performed by a welder qualified by the CWB working for a company certified in accordance with CSA W186.

912.07.01.04 Production of Concrete

Production of concrete shall be according to the General, Temperature Control, Mixing Time and Mixing Rate, and Delivery subsections of OPSS 1350.

When there are multiple batches of concrete in a single ready-mix truck, hopper or other container, discharge times shall be measured from the time of introduction of water to cement for the first batch of concrete in the truck, hopper or other container. Discharge of all concrete in the truck, hopper or other container shall be completed within 1.5 hours, except when the air temperature exceeds 28 °C and the concrete temperature exceeds 25 °C, the discharge shall be completed within 1 hour.

912.07.01.05 Sampling and Testing of Plastic Concrete

Sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350. The results of these tests shall be recorded. The minimum frequency of testing shall be as follows:

- a) For concrete supplied by an external concrete supplier and delivered by a ready-mix truck, once for each of the first three trucks, until satisfactory control is established, and then once every third truck.

- b) For batches of concrete produced at the precast plant and transported by a ready-mix truck, once for each of the first three trucks, until satisfactory control is established, and then once every third truck.
- c) For batches of concrete produced at the precast plant, and not delivered by a truck, once for each of the first five batches of concrete, until satisfactory control is established, and then once every fifth batch.
- d) For batches of concrete produced at a precast plant with an integrated mixing and delivery system (e.g. Autocor), once for every second batch for the first six batches, until satisfactory control is established, and then once every 7 m³ of concrete.

Satisfactory control is established when three or five consecutive tests of concrete, as specified above, are within the specified requirements, without adjustments. If any adjustments are required or conducted, testing shall continue until three or five consecutive tests, as specified above, meet the requirements with no adjustments. Satisfactory control shall be established each Day or when there is a break in production longer than 1.5 hours.

Testing of plastic concrete shall be carried out as close as possible to the location of discharge of concrete into the formwork.

Sampling and testing of slump, air content and temperature of plastic concrete shall be carried out by a technician holding either of the following certifications:

- a) CCIL Certified Field Testing Technician; or
- b) ACI Concrete Field Testing Technician - Grade 1.

This technician shall have a valid, original card issued by the certifying agency in his or her possession at all times.

912.07.01.06 Verification Cylinders for 28-Day Compressive Strength Testing

One set of three 100 mm diameter x 200 mm long cylinders shall be cast per lot for 28-Day compressive strength testing by the Owner. Cylinders shall be cast by a certified technician. Cylinders shall be cast with an element selected randomly from the lot by the Contract Administrator.

All concrete test cylinders shall be cast in new, single-use moulds conforming to the requirements of CSA A23.2-1D and made of plastic, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide watertight closure for the moulds.

Concrete test cylinders shall be cast, cured, and transported to the designated laboratory according to CSA A23.2-3C with the exception that cylinders shall be cured with the element with which they were made, prior to delivery to the laboratory. Cylinders shall be delivered to the laboratory for demoulding.

Test information shall be recorded on MTO form PH-CC 322. A copy of the form shall be submitted with each set of the concrete cylinders along with a transmittal form and PH-CC-433A (Form A) of the concrete mix design for the culvert. No referee cylinders are required for this testing.

Cylinder test results will be used by the ministry to verify compliance with the requirements of CSA S6.

912.07.01.07 Placing of Concrete

912.07.01.07.01 General

The method of transporting, placing, and consolidating the concrete shall be such as to prevent segregation.

Concrete placing and transporting devices shall not be supported by the steel reinforcement.

Concrete shall be deposited within 0.5 m of the top of the reinforcement and 2.5 m horizontally of its final position.

Concrete shall be placed at a steady rate such that a monolithic concrete is obtained without the formation of cold joints or pour lines.

When there is an interruption in placing concrete greater than 20 minutes, the top of the formwork shall be covered with wet burlap to maintain 100% relative humidity above the concrete. The Contract Administrator shall be notified of any interruption resulting in a cold joint.

912.07.01.07.02 Concrete Placing Restrictions

All surfaces against which concrete is to be placed shall be free of standing water. Fresh concrete shall be protected from contact with rain or snow. Deicing chemicals shall not be used.

All debris shall be removed from the area where concrete is to be placed.

Any surface against where concrete is placed, including existing concrete, steel reinforcement, structural steel, forms, or other surfaces, shall be at a minimum temperature of 5 °C immediately prior to commencement of placing concrete.

The temperature of the formwork, steel reinforcement or any other material against which concrete is to be placed shall not exceed 30 °C.

Temperature measurements shall be taken no more than 10 minutes prior to concrete placement, for each element. Temperature measurements shall be made with a contact thermometer with an accuracy of ± 0.5 °C.

912.07.01.07.03 Consolidation

Internal or external vibrators or both shall be used to thoroughly consolidate the concrete, as it is placed. Concrete shall be thoroughly consolidated around all steel reinforcement.

Each layer of concrete shall be vibrated. Vibrators shall extend into the previous layer to produce a homogenous mixture at the layer interface and prevent the formation of pour lines or cold joints.

Vibration shall not be used to make the concrete flow or to spread the concrete more than 1.5 m from the point of deposit.

The requirements of this clause do not apply to self-consolidating concrete (SCC), where accepted for use by the Owner.

912.07.01.07.04 Concrete Finishing

Finishing of the concrete surface shall be done immediately following placement. No material shall be applied to the concrete surface or the finishing tools to aid in the finishing.

Except as indicated below, finished surfaces shall be smooth, free from open texturing, undulations, projections, and ridges. The concrete shall be struck off to the required dimensions and cross-section and shall be hand finished with a float.

Concrete surfaces against which new concrete is to be placed shall be:

- a) Left with a rough surface finish (so that the depth of the indentations is at least 5 mm and the spacing is not greater than 15 mm), except for concrete surfaces against which protection slabs or distribution slabs shall be placed, and
- b) Abrasive blast cleaned according to OPSS 929, prior to placing any additional concrete.

The requirement to hand finish the concrete with a float does not apply to SCC, where accepted for use by the Owner.

912.07.01.08 Control of Temperature

912.07.01.08.01 General

For all concrete, all necessary actions shall be taken to maintain temperatures within the specified limits. During production, moist curing and the cold weather protection period, the following temperature requirements shall be met:

- a) The concrete temperature shall not exceed 60 °C, except if the concrete has a maximum thickness greater than 500 mm, then the concrete temperature shall not exceed 65 °C.
- b) The concrete temperature shall not fall below 10 °C before the end of moist curing.
- c) The concrete temperature shall not fall below 0 °C before the end of the cold weather protection period.
- d) The temperature difference, as measured between thermocouples at the following locations, shall not exceed 20 °C:
 - i. Internal concrete temperature and the corresponding surface concrete temperatures.
 - ii. Internal concrete temperatures at different locations within the element.
- e) The maximum cooling rate of concrete shall not exceed 15.0 °C per hour until the concrete is not more than 20.0 °C above the air temperature. Air temperature is temperature next to the concrete, within the curing enclosure.

912.07.01.08.02 Temperature Monitoring and Records

The concrete and air temperatures during the curing period and, if applicable, the cold weather protection period shall be monitored and recorded. The concrete temperature shall be measured and recorded for each element.

Thermocouples shall be placed in the following locations at a minimum:

- a) Ambient air temperature adjacent to the concrete.
- b) The expected point of maximum internal temperature, located centrally within the concrete at the maximum section thickness, typically a haunch.
- c) Corresponding surface concrete temperature, with the thermocouple imbedded in the concrete within 5 mm of the surface, at the maximum section thickness.
- d) Centrally at mid-span and mid-depth of the longest span, typically the top or bottom of the element.

A set of a) to d) thermocouples shall be placed in each element at mid-length.

For culverts with a span greater than 6 m, an additional set of b) and c) thermocouples shall be imbedded in each element in another location of maximum section thickness so that temperatures are monitored in both halves of the span.

Recording of concrete and air temperatures shall begin at the start of concrete placement. The temperature shall be recorded automatically at time intervals not exceeding 15 minutes until the end of the curing period and, if applicable, the end of the cold weather protection period. The temperature monitoring system shall be left in place until the end of the monitoring period.

When requested, the Contract Administrator and any other Owner's representatives shall be provided access to verify temperature readings and thermocouple function.

Temperature records shall be submitted for the duration of the temperature monitoring period.

Temperature records, including a graphical plot of temperature versus time, shall be submitted to the Contract Administrator in the precast report.

912.07.01.09 Curing

912.07.01.09.01 General

Concrete shall be moist cured for four Days except for concrete containing silica fume which shall be moist cured for seven Days. Curing in cold weather conditions shall be according to the Cold Weather Protection Period section of this specification.

Moist curing of exposed surfaces shall commence immediately after concrete finishing, except for culverts produced in an indoor precast concrete plant and not containing silica fume; for such culverts, exposed surfaces may be covered with moisture vapour barrier between concrete placement and concrete finishing, for the shortest practical time period and in no cases exceeding 40 minutes.

912.07.01.09.02 Moist Curing

Moist curing shall be sufficient to keep all surfaces of the concrete in a continuously wet condition, with no dry areas, by applying one or a combination of the following methods:

- a) Curing according to the Curing with Burlap and Water clause.
- b) Curing by means of continuous water application, e.g. mist.
- c) Curing according to the Steam Curing and Other Application of Heat clause.
- d) Curing by means of immersion in water.

Records of moist curing shall be maintained and submitted according to the requirements of this specification.

The records shall provide verification that curing is in accordance with this specification. As a minimum, records of moist curing shall include the identification of the person checking the moist curing system, the time that it was verified and photo documentation of the curing chamber in operation during the curing period as follows:

- a) Photographs shall be taken every 8 hours for the first 24 hours of the curing period.
- b) Photographs shall be taken every 24 hours as a minimum for the remainder of the curing period.
- c) Each photo shall include a date and time stamp of when the photo was taken.

Elements whose surfaces have not been kept in a continuously wet condition shall be deemed rejectable.

Formwork shall be removed within four Days of concrete placement and the concrete shall be moist cured for the remainder of the minimum curing period and no less than 24 hours.

Concrete may be exposed to ambient conditions, during the moist curing period, according to the Exposure clause of this specification.

912.07.01.09.03 Curing with Burlap and Water

Curing with burlap and water shall be done according to the Curing with Burlap and Water clause of OPSS 909 with the addition of the following:

- a) Burlap shall be held in place without marring the surface of the concrete.

912.07.01.09.04 Steam Curing and Other Application of Heat

Steam curing and application of heat, if used, shall be according to the requirements of the Steam Curing and Other Application of Heat section of OPSS 909.

912.07.01.10 Exposure

During moist curing and cold weather protection periods, the element may be exposed for a maximum total period of one hour per day for the purposes of formwork removal, inspection or relocation within the plant, except for indoor precast concrete plants, where the exposure period shall not exceed two hours per day.

During the exposure period:

- a) The requirements in the Control of Temperature clause do not apply.
- b) There shall be no more than three consecutive thermocouple measurements of surface temperature below 10.0 °C, and none below 5.0 °C, when measured at 15 minute intervals at locations according to the Temperature Monitoring and Records clause.

On the day formwork is removed, the moist curing may be suspended during the 1-hour exposure period, or 2-hour exposure period for indoor plants, except for concrete containing silica fume. For concrete containing silica fume, continuous moist curing shall be applied throughout the exposure period.

912.07.01.11 Cold Weather Protection Period

If cold weather conditions are present at the end of the curing period, the elements shall be provided with protection from cold weather and moisture loss for an additional 24 hours, prior to exposure to cold weather conditions. Protection shall be extended if required to meet the requirements in the Control of Temperature clause.

912.07.01.12 Stripping Strength

For each element, it shall be demonstrated that the stripping strength as specified in the Working Drawings has been achieved prior to stripping the formwork. The Contractor, when requested by the Owner, shall participate in standard cylinder correlation strength testing programs conducted by the Owner.

912.07.01.13 Concrete Cover

The Contractor shall carry out, at the precasting facility, a covermeter survey on all elements until satisfactory control is established. For each design and size of element, satisfactory control shall be established when three consecutive elements of the same design are within the specified tolerances. After satisfactory control has been established, testing shall be carried out on every fifth element. If testing indicates that cover measurements for an element do not meet the tolerances specified in Table 1, testing shall resume on each element until satisfactory control is re-established.

Concrete cover readings shall be taken evenly spaced across the surface of the concrete at grid points, along the longitudinal and transverse axes, at a spacing of 1 to 3 m, providing a minimum of 20 measurement points per element.

912.07.01.14 Dimensional Tolerances

The Contractor shall carry out measurements on each element prior to shipping and on each culvert, after installation, to determine compliance with tolerance requirements. Elements and culverts shall meet the tolerances specified in the Contract Documents and Table 1 of this specification.

For dimensional tolerances not specified, the maximum allowable dimensional variation shall be 1:800 or ± 5 mm, whichever is greater.

912.07.01.15 Surface Finish

912.07.01.15.01 General

Concrete surfaces shall not be treated with cement slurry or paste.

Surface defects and deficiencies with dimensions according to Table 2 are repairable by standard methods according to Table 2.

A repair proposal shall be submitted to the Contract Administrator to repair surface defects and deficiencies not listed in Table 2.

912.07.01.15.02 Exposed Surfaces

The appearance of the concrete and repairs shall be uniform in colour, pattern, and texture when viewed from a distance of 15 m. Material, including all patching materials, shall be selected to achieve uniformity of colour and appearance.

All projections, such as fins and bulges, and all blemishes, such as stains, shall be removed.

912.07.01.15.03 Surface Tolerance

Formed and unformed surfaces shall be such that when tested with a 3 m long straight edge placed anywhere in any direction on the surface, there shall be no gap greater than 6 mm between the bottom of the straight edge and the surface of the concrete.

912.07.02 Installation

912.07.02.01 Foundations – General

The culvert shall be placed on competent in situ soil or compacted backfill, or as specified in the Contract Documents.

When unsuitable material is encountered during excavation for the culvert foundation, the unsuitable material shall be removed to competent stratum and replaced to the foundation grade with compacted granular material, as specified in the Contract Documents.

The final founding elevations shall be as specified in the Contract Documents or an elevation approved in writing by the Contract Administrator.

912.07.02.01.01 Support Systems

Support systems shall be according to OPSS 404.

912.07.02.01.02 Temporary Protection Systems

Temporary protection systems shall be according to OPSS 539.

912.07.02.01.03 Excavation

The excavation for the installation of the culvert shall be according to OPSS 902, including frost tapers and culvert end treatments.

Swamp excavation shall be according to OPSS 209.

912.07.02.01.04 Dewatering

Dewatering shall be according to OPSS 517.

912.07.02.01.05 Bedding

Bedding shall be placed as specified in the Contract Documents and compacted according to OPSS 501. Bedding shall ensure uniform support under the full width and length of the culvert.

The bedding shall be placed in uniform lifts not exceeding 200 mm in thickness. Bedding shall not be placed on frozen material.

Bedding and subgrade material shall be protected from disturbance during construction.

912.07.02.01.06 Levelling Course

When a leveling course is specified, it shall consist of a 75 mm minimum thickness of fine aggregate. Fine aggregate for levelling courses shall be according to OPSS 1002.

912.07.02.02 Delivery

The Contract Administrator shall be notified in writing a minimum of three Business Days prior to delivery of the elements.

Delivery shall include transportation, loading and unloading, and storage of the elements. Transportation and storage of the elements shall be according to CSA A23.4.

Elements shall be loaded for shipping in such a manner that they can be transported and unloaded at their destination without being damaged or exposed to stresses for which they were not designed. Elements, when stored, shall be stored in such a manner to avoid damage or excessive stress.

Storage includes, but is not limited to, storage while awaiting delivery in temporary locations or, at the job site. Lifting, storing, and transporting shall be as specified in the Working Drawings.

Advertising by means of removable signing shall be permitted on elements only while in transit to the site. Any permanent markings on a surface that would be visible after installation shall not be permitted.

912.07.02.03 Installation of Precast Concrete Culvert

The Contract Administrator shall be notified in writing of the installation date a minimum of three Business Days prior to the commencement of installation. Installation shall be according to CSA A23.4 and as specified in the Contract Documents.

The Work shall consist of installation and stabilization of the elements. Elements shall be lifted and placed in a manner to ensure they are not overstressed, unstable, or unsafe at any time.

After installation of the elements, concrete patching material, from the Ministry's list of acceptable patching materials, shall be used to provide required concrete cover over lifting devices.

A copy of the Working Drawings shall be kept on the site during installation of the elements.

The Contractor shall inspect the elements for defects before installation.

912.07.02.04 Cast-in-Place Concrete Appurtenances, Protection Slabs and Distribution Slabs

Cast-in-place concrete appurtenances, protection slabs and distribution slabs shall be according to OPSS 904. Reinforcing steel shall be placed according to OPSS 905.

When a protection slab or distribution slab is required, it shall be as specified Contract Documents. The protection slab or distribution slab shall be placed without any damage to or movement of the culvert.

912.07.02.05 Joints Between Elements

912.07.02.05.01 General

All joints between elements of the culvert shall be constructed and treated to prevent leakage and infiltration.

All elements shall be provided with bell and spigot ends. The ends shall be of such design that when the elements are laid together they will make a continuous culvert with a smooth interior free of irregularities in the flow line. The gap at the joints shall not exceed the maximum value provided in Table 1. The gap between adjacent side-by-side (multi-cell) box culverts shall be 60 mm, with a tolerance specified in Table 1. Joint treatment shall be as shown in the Contract Documents.

912.07.02.05.02 Preformed Seals

Preformed seals shall be placed according to the manufacturer's recommendations.

912.07.02.06 Alignment

The position of the inner and outer top edges of elements shall be set true to the elevations and alignment as specified in the Contract Documents. Culverts shall be constructed to the specified geometry, plumbness, and alignment and shall not exceed the tolerances outlined in Table 1.

912.07.02.07 Inspection After the Installation of the Culvert and Prior to Waterproofing

After installation of all elements of a culvert within a construction stage, and prior to waterproofing, a Request to Proceed shall be submitted to the Contract Administrator. The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

912.07.02.08 Waterproofing of the Culvert

Waterproofing of the culvert shall be as specified in the Contract Documents.

912.07.02.09 Geotextile at Joints

After completion of waterproofing, including placement of protection board, the joints shall be covered with a minimum 600 mm wide geotextile, unless otherwise specified, to prevent influx of material from the backfill or native soil or both. The 600 mm wide strip of geotextile shall be placed to form a continuous barrier centered on the exterior of all buried joints, including on top of areas of the joint that are waterproofed.

The geotextile and the seam requirements at the joints shall be according to OPSS 1860.

Geotextile shall be free of folds, tears, and wrinkles. The geotextile shall be joined so that the material laps a minimum of 500 mm, and shall be pinned together.

912.07.02.10 Inspection After the Waterproofing of the Culvert and Prior to Backfilling

After waterproofing of all elements of a culvert within a construction stage, and prior to backfilling, a Request to Proceed shall be submitted to the Contract Administrator. The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

912.07.02.11 Backfilling

Backfilling shall be according to OPSS 902. Backfill shall be placed without any damage to or movement of the elements.

912.07.02.12 Granular Cover

Cover shall be placed in layers not exceeding 200 mm in thickness, loose measurement, and each layer shall be compacted according to OPSS 501. The cover material shall be placed without any damage to or movement of the culvert.

912.07.02.13 Clay Seals

When a clay seal is specified in the Contract Documents, the clay seal shall be placed to the dimensions specified in the Contract Documents and compacted to a minimum of 95% of the maximum dry density (MDD). The MDD shall be determined according to LS-706, carried out on a single representative sample. Field density and field moisture determinations shall be made according to ASTM D6938.

912.07.03 Repair of Defects and Deficiencies Repairable by Standard Methods

912.07.03.01 General

All concrete shall be routinely inspected for any defects and deficiencies up to the date of Completion of the work. Defects and deficiencies shall be identified and documented including their location, size, and frequency.

Areas requiring repair or replacement shall be based on the criteria shown in Table 2. The limits of repair and replacement for each area shall be identified.

Any element having one or more of the defects and deficiencies identified in Table 2 shall be repaired according to the repair method specified. Such repairs do not require proposals or Owner approval prior to repair.

Where more than one of the defects or deficiencies listed in Table 2, excluding bugholes, is located in the same area in the element, a repair proposal shall be submitted to the Contract Administrator. The repair proposal shall be according to the Quality Assurance section.

All causes, preventative actions, and corrective actions, including repair methods and materials used, shall be documented and submitted in the precast report.

912.07.03.02 Assessment of Repair

At the discretion of the Owner, additional visual inspection or other investigative measures, including the removal of cores, may be required to assess the effectiveness of the repair. The filling of core holes shall be according to the Filling of Core Holes subsection in OPSS 1350.

912.07.04 Material Sampling for Acceptance Testing

912.07.04.01 Sampling of Steel Reinforcement

Samples of steel reinforcement shall be provided to the Owner according to OPSS 905.

912.07.04.02 Sampling of Water, Admixtures, and Cementing Materials

Samples of all water, admixtures, and cementing materials shall be provided to the Owner for testing, according to OPSS 1350.

912.07.04.03 Sampling of Hardened Concrete for Acceptance Testing

912.07.04.03.01 General

Hardened concrete shall be sampled on a lot basis according to the Coring clause and Lot Size subsection of this specification. Test specimens shall consist of cores removed from the hardened concrete for testing by the Owner of compressive strength, air void system parameters and rapid chloride permeability.

912.07.04.03.02 Notification

A list of elements and their identification numbers shall be submitted to the Contract Administrator within 24 hours of the completion of a lot, to facilitate selection by the Contract Administrator of elements for acceptance testing.

912.07.04.03.03 Coring

One set of cores shall be obtained from each lot for quality assurance testing. Locations of core removal shall be randomly selected from each lot by the Contract Administrator. A set of cores shall consist of five cores, 100 mm in diameter and 220 mm in length. If the element is less than 220 mm thick, the full depth of the element shall be cored.

Cores shall be removed when the concrete is between 7 to 10 Days of age, and prior to application of waterproofing membrane. Cores shall be removed in the presence of the Contract Administrator or Owner's representative. No core shall be taken within 250 mm of any joint or edge or within a distance 500 mm from another core. No core shall be taken through the waterproofing system. All cores of the same set shall be removed at a location no more than 3 m from the location of the first core for that set. Cores shall be removed from the sides or haunch of the elements.

Coring shall be carried out according to CSA A23.2-14C. Cores shall not contain reinforcement or other embedded material. A covermeter capable of detecting the type(s) of reinforcing materials in the element shall be used to establish the location of reinforcement and other embedded material prior to coring.

The contract number, lot number, and element identification number shall be marked legibly on each core with durable ink. Each core shall be placed in a plastic bag, sealed to prevent loss of moisture, and fitted with a security tag by the Contract Administrator. All acceptance cores shall immediately be given to the Contract Administrator, with the transmittal form and PH-CC-433A (Form A) of the concrete mix design, for transportation to the designated laboratory.

The core holes shall be filled, within three Days, according to the Filling of Core Holes subsection of OPSS 1350.

912.07.05 Access for Quality Assurance

Unhindered access for inspection and testing of all the work shall be provided to the Contract Administrator or Owner's representative.

Any debris and obstructions shall be removed to allow access for the purposes of covermeter and dimensional measurements or inspection.

912.07.06 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

912.08 QUALITY ASSURANCE

912.08.01 General

The acceptance of culverts shall be according to the requirements of this specification, including satisfactory completion any repairs.

Acceptance of compressive strength, air void system parameters, and rapid chloride permeability shall be on a lot basis.

Lots not meeting the requirements of the Contract Documents shall be deemed rejectable.

912.08.02 Lot Size

The Contract Administrator shall determine the limits of each lot prior to commencing production, based on the lot size definition, and shall confirm the specific elements to be included in each lot prior to commencing production of that lot.

912.08.03 Acceptance of Compressive Strength of Concrete in Place

Testing of compressive strength shall be according to LS-410.

Three cores shall be tested to determine the acceptability of compressive strength of the lot. The 28-Day concrete compressive strength of a lot shall be considered acceptable when:

- a) The average of the three individual compressive strength cores is equal to or greater than the specified strength, and
- b) No individual core result is more than 10% below the specified 28-Day compressive strength.

Unacceptable lots shall be deemed rejectable, but may, at the discretion of the Owner, be permitted to stay in the work. When the Owner permits the work to remain in place, it shall be subject to a payment adjustment

calculated according to the Basis of Payment section.
Test results shall be forwarded to the Contractor as they become available.

912.08.03.01 Referee Testing of Compressive Strength of Concrete In Place

Referee testing of compressive strength may only be invoked by the Contractor within five Business Days of receipt of the acceptance test result.

Referee testing of compressive strength shall be carried out on a set of three cores taken, within three Business Days of invoking referee testing, by the Contractor from the same element which the acceptance cores were taken, in accordance with the Coring clause. Referee cores shall immediately be given to the Contract Administrator for transportation to the designated laboratory.

The referee laboratory shall be designated by the Owner based on the applicable roster and cores shall be tested according to LS-410.

Referee test results shall be forwarded to the Contractor as they become available.

The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cores, expressed to one decimal place.

If the difference between the referee test result and the acceptance test result is less than the confirmation value, the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of acceptance of the lot. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded.

The cost of referee testing of compressive strength shall be according to OPSS 1350.

912.08.04 Acceptance of Air Void System in Hardened Concrete

Testing of air void system shall be according to LS-432. One half of a core shall be tested to determine the acceptability of the lot. The other half of the core shall be retained by the Owner for audit purposes.

Test results shall be forwarded to the Contractor as they become available.

For the lot to be considered acceptable, the sample shall have a minimum air content of 3.0% and a spacing factor of 0.200 mm or less. Acceptable lots shall be subject to full payment.

Lots with a sample with a spacing factor greater than 0.200 mm and less than or equal to 0.250 mm are unacceptable. If the Owner permits the work to remain in place, lots with a spacing factor greater than 0.200 mm and less than or equal to 0.250 mm shall be subject to a payment adjustment calculated according to the Basis of Payment section.

Lots with a sample with a spacing factor more than 0.250 mm or air content less than 3.0% shall be deemed rejectable.

912.08.04.01 Referee Testing of Air Void System in Hardened Concrete

Referee testing of air void system parameters shall be according to OPSS 1350.

The cost of air void system referee testing shall be according to OPSS 1350.

912.08.05 Acceptance of Rapid Chloride Permeability

912.08.05.01 General

Acceptance of rapid chloride permeability shall be based on the result of the core representing the lot, tested according to LS-433 at 28-32 Days of age.

Two samples 50 mm long shall be cut from the core, tested, and the results averaged to determine the acceptance of the lot.

Test results shall be forwarded to the Contractor as they become available.

912.08.05.02 Concrete Without Silica Fume

Lots with rapid chloride permeability less than or equal to 2,500 coulombs are considered acceptable. Acceptable lots shall be subject to full payment.

Lots with a rapid chloride permeability result greater than 2,500 coulombs are unacceptable. If the Owner permits the work to remain in place, lots with an average value of rapid chloride permeability exceeding 2,500 coulombs and less than 3,500 coulombs shall be subject to a payment adjustment calculated according to the Basis of Payment section.

Lots with rapid chloride permeability results exceeding 3,500 coulombs shall be deemed rejectable.

912.08.05.03 Concrete Containing Silica Fume

Lots with rapid chloride permeability less than or equal to 1,000 coulombs are considered acceptable. Acceptable lots shall be subject to full payment.

Lots with a rapid chloride permeability result greater than 1,000 coulombs are unacceptable. If the Owner permits the work to remain in place, lots with an average value of rapid chloride permeability exceeding 1,000 coulombs and less than 2,000 coulombs shall be subject to a payment adjustment calculated according to the Basis of Payment section.

Lots with rapid chloride permeability results exceeding 2,000 coulombs shall be deemed rejectable.

912.08.05.04 Referee Testing of Rapid Chloride Permeability

912.08.05.04.01 General

Referee testing of rapid chloride permeability may only be invoked by the Contractor within five Business Days of receipt of the acceptance test result.

Referee testing shall be carried out on a core taken, within three Business Days of invoking referee testing, by the Contractor from the same element which the acceptance core was taken, in accordance with the Coring clause. The referee core shall immediately be given to the Contract Administrator for transportation to the designated laboratory.

Referee testing shall be done on two-50 mm samples obtained from the core representing the lot for which referee testing was invoked, and the results shall be averaged to obtain the test result for the lot.

Cores shall be tested according to LS-433.

The referee laboratory shall be designated by the Owner based on the applicable roster and cores shall be tested by that laboratory.

Referee test results shall be forwarded to the Contractor as they become available.

The cost of referee testing of rapid chloride permeability for all concrete shall be according to the Referee Testing Cost clause in the Acceptance of Rapid Chloride Permeability subsection in OPSS 1350.

912.08.05.04.02 Concrete Without Silica Fume

When the referee result is greater than the acceptance test result or no more than 500 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the lot is more than 500 coulombs below the acceptance test result, the acceptance test result is then not confirmed, and the referee test result shall be used for determining acceptability of the lot.

912.08.05.04.03 Concrete Containing Silica Fume

When the referee result is greater than the acceptance test result or no more than 300 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid. When the referee test result for the lot is more than 300 coulombs below the acceptance test result, the acceptance test result is then not confirmed, and the referee test result shall be used for determining acceptability of the lot.

912.08.05.04.04 Cost of Referee Testing for Rapid Chloride Permeability

The cost of rapid chloride permeability referee testing shall be as specified in the Contract Documents.

When the referee result confirms the acceptance test result, the Contractor shall be charged the cost of rapid chloride permeability referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

912.08.06 Acceptance of Water, Admixtures, and Cementing Materials

Acceptance of water, admixtures and cementing materials shall be according to OPSS 1350.

912.08.07 Acceptance of Concrete Temperature

Elements that meet the temperature requirements of this specification during production, the curing period, and, if applicable, the cold weather protection period, shall be considered acceptable. Elements that do not meet one or more of the temperature requirements of this specification are deemed rejectable.

912.08.08 Acceptance of Surface Finish

All elements meeting the surface finish requirements of this specification shall be considered acceptable. For elements that do not meet the surface finish requirements of this specification, a proposal for repair or remediation may be submitted by the Contractor, according to the All Other Defects and Deficiencies clause.

912.08.09 Dimensional Verification and Concrete Cover Measurements

The Contract Administrator shall carry out measurements on interior and exterior surfaces on at least one element per lot, prior to any waterproofing or backfilling operations, to confirm compliance with the requirements of Table 1. The Contract Administrator shall be notified in writing when the test area is ready for the concrete covermeter survey and dimensional verification.

If an element fails to meet the dimensional or cover tolerances specified in Table 1,

- a) It shall be deemed rejectable and,

- b) A consultant shall be retained by the Owner, at the Contractor's expense, to verify that all the other elements in the lot are within the tolerances of Table 1.

912.08.10 Dowels

When dowels are specified in the Contract Documents, they shall be according to the visual acceptance criteria and pull testing criteria requirements as specified in the Contract Documents.

912.08.11 Defects and Deficiencies

912.08.11.01 Defects and Deficiencies Repairable by Standard Methods

Any individual element having one or more of the defects and deficiencies listed in Table 2 shall be deemed unacceptable and shall be repaired according to Table 2.

912.08.11.02 Defects and Deficiencies Causing Rejection

An element having one or more of the following defects and deficiencies shall be deemed rejectable:

- a) If concrete temperature of an element less than 500 mm in thickness exceeds 60 °C, or if the concrete has a maximum thickness greater than 500 mm and the concrete temperature exceeds 65 °C, at any time during the curing period.
- b) If concrete temperature of an element falls below 10 °C during the moist curing period or 0 °C during the cold weather protection period.
- c) If an element has honeycombing, voids, cavities, spalls, delaminations, or cracks, in the concrete that exceed the conditions described in Table 2.
- d) If an element has a crack that is greater than 1.0 mm in width or if there is a crack of any width that extends through to the opposite face of the element.
- e) If an element contains a cold joint.

912.08.11.03 All Other Defects and Deficiencies

A repair proposal for repair or remediation signed and sealed by an Engineer may be submitted to the Contract Administrator for acceptance when,

- a) Failure to maintain moist curing has occurred; or
- b) An element has defects or deficiencies that are not identified as rejectable or included in Table 2 in the list of defects and deficiencies repairable by standard methods; or
- c) More than one of the defects or deficiencies listed in Table 2, except for bugholes, are located in the same area in the element; or
- d) Three occurrences of the same defect are present in the element; or
- e) Surface finish is unacceptable; or
- f) Dimensional tolerances of the element or culvert do not meet the requirements of this specification.

912.08.11.03.01 Repair Proposal

The repair proposal shall include as a minimum:

- a) Identification of the culvert or element and description of the defects or deficiencies.
- b) High resolution photographs and detailed sketches showing the width, length, depth, location, nature and frequency of any defects.
- c) An assessment of any impact of the repaired defect(s) on durability, structural adequacy and integrity of the element or on the culvert.
- d) A detailed repair plan including materials, method, and equipment to be used.
- e) Verification that the repair plan complies with the applicable Standards for the type of work.
- f) All relevant supporting information, including material test results, field measurements and observations, production records, photographs, and structural analysis calculations, used for determining that the performance and function originally expected from the element or culvert shall be met.
- g) Cause(s) of the defect and corrective action to be taken to prevent recurrence of the defect in future production, delivery, or installation.

If the repair proposal is deemed acceptable by the Owner, the culvert or element shall be repaired according to the proposal. Repairs shall not be carried out without the prior written acceptance of the proposal by the Contract Administrator. If the repair proposal is not acceptable to the Owner, the element or culvert shall be replaced.

912.08.11.04 Assessment of Repairs

The Contract Administrator shall inspect the repaired work. This inspection may include covermeter surveys, coring, and any other testing deemed necessary to assess the effectiveness and acceptability of the repair.

912.09 MEASUREMENT FOR PAYMENT

912.09.01 Actual Measurement

912.09.01.01 Precast Concrete Box Culvert, Fabrication

Measurement for the fabrication of precast concrete culverts shall be by the horizontal length in metres along the centerline of the invert of the culvert.

912.09.01.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

912.10 BASIS OF PAYMENT

- 912.10.01 Precast Concrete Box Culvert, Fabrication (Span ≥ 3.0 to < 4.0 m) - Item**
- Precast Concrete Box Culvert, Fabrication (Span ≥ 4.0 to < 5.0 m) - Item**
- Precast Concrete Box Culvert, Fabrication (Span ≥ 5.0 to ≤ 6.1 m) - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

Elements deemed rejectable shall be replaced at no additional cost to the owner.

912.10.01.01 Payment Adjustment for Compressive Strength of Concrete in Place

Payment adjustment for an unacceptable lot represented by cores shall be calculated according to the following:

$$\text{Payment Adjustment} = \text{lot quantity/tender quantity} \times \text{Price} \times ((100 - P)/100)$$

Where:

Payment Adjustment = payment reduction for a lot (\$)
 Lot quantity = volume of concrete in a lot (m³) (calculated based on plan dimension)
 Tender quantity = volume of concrete in tender (m³) (calculated based on plan dimension)
 Price = Contract price for the Fabrication tender item
 P = pay factor for the lot according to the table below:

Average of the three individual compressive strength cores, as percentage of specified strength	Lowest of the three individual compressive strength cores, as percentage of specified strength	Pay Factor (P)
≥ 90%	≥ 80%	100
< 90% but ≥ 85%	≥ 80%	95
< 85% but ≥ 80%	≥ 75%	85
< 80%	Not Applicable	Reject

912.10.01.02 Payment Adjustment for Air Void System in Hardened Concrete

Payment adjustment for an unacceptable lot represented by cores shall be calculated according to the following:

$$\text{Payment Adjustment} = \text{lot quantity/tender quantity} \times \text{Price} \times ((100 - P)/100)$$

Where:

Payment Adjustment = payment reduction for a lot (\$)
 Lot quantity = volume of concrete in a lot (m³) (calculated based on plan dimension)
 Tender quantity = volume of concrete in tender (m³) (calculated based on plan dimension)
 Price = Contract price for the Fabrication tender item
 P = pay factor for the lot according to the table below:

Spacing Factor, mm	Pay Factor (P)
> 0.200 but ≤ 0.220	90
> 0.220 but ≤ 0.240	80
> 0.240 but ≤ 0.250	70

912.10.01.03 Payment Adjustment for Rapid Chloride Permeability

The payment adjustment shall be calculated based on individual lots and applied as follows:

$$\text{Payment adjustment} = \text{lot quantity} \times (C-2500)/5$$

Where:

Payment adjustment	= payment reduction for a lot (\$)
C	= rapid chloride permeability of a lot (coulombs)
Lot quantity	= volume of concrete in a lot (m ³) (calculated based on plan dimension)

The payment adjustment for concrete containing silica fume shall be calculated based on individual lots and applied as follows:

$$\text{Payment adjustment} = \text{lot quantity} \times (C-1000)/5$$

Where:

Payment adjustment	= payment reduction for a lot (\$)
C	= rapid chloride permeability of a lot (coulombs)
Lot quantity	= volume of concrete in a lot (m ³) (calculated based on plan dimension)

912.10.02 Precast Concrete Box Culvert, Delivery and Install (Span ≥ 3.0 to < 4.0 m) - Item Precast Concrete Box Culvert, Delivery and Install (Span ≥ 4.0 to < 5.0 m) - Item Precast Concrete Box Culvert, Delivery and Install (Span ≥ 5.0 to ≤ 6.1 m) - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

912.10.03 Excavation for Culverts

Payment for earth and rock excavation shall be at the Contract price for the tender items "Earth Excavation for Structure" and "Rock Excavation for Structure", according to OPSS 902.

912.10.04 Swamp Excavation

Payment for swamp excavation shall be at the Contract price for the tender item Earth Excavation, Grading, according to OPSS 206.

Payment shall not be made for the removal of materials that slide or slough inside the excavation limits.

912.10.05 Granular

Granular material used for bedding, backfill, cover, and frost tapers shall be paid for under the appropriate granular items specified in the Contract Documents.

Payment will not be made for granular used to fill any area excavated beyond the lines specified in the Contract Documents.

912.10.06 Concrete in Cast-in-Place Appurtenances, Protection Slabs and Distribution Slabs

Payment shall be at the Contract price for the tender item "Concrete in Culverts", according to OPSS 904.

912.10.07 Steel Reinforcement in Cast-in-Place Concrete Appurtenances, Protection Slabs and Distribution Slabs

Payment shall be at the Contract price for the tender items "Reinforcing Steel Bar", "Stainless Steel Reinforcing Bar", "Mechanical Connectors" and "Stainless Steel Mechanical Connectors" according to OPSS 905.

912.10.08 Clay Seal - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Tolerances

Item	Tolerances
Span (Straight-line measurement taken horizontally at the mid-height of element perpendicular to the centre line of the culvert.)	± 15 mm from design drawings
Height	± 15 mm from design drawings
Length	+ 15 / - 5 mm
Wall and Slab Thickness	+ 10 mm, - 5 mm
Haunch	± 10 mm
End Squareness or Skew (Note 1)	< 15 mm along its length
Plumbness	1 in 300 maximum
Location of Blockouts	± 15 mm
Location of Inserts	± 10 mm
Concrete Cover	Concrete cover shall be 50 mm, tolerances for cover and placement accuracy shall be according to OPSS 905, or as specified in the Contract Documents.
Alignment of elements	± 10 mm
Joint Gap	20 mm maximum
Gap between adjacent side-by-side box (multi-cell culverts)	± 10 mm
Notes: 1. Variations in the lengths of two opposite surfaces of the element. The ends of the element shall be normal to the wall and centreline of the element within the tolerances specified elsewhere in this Table except where special culvert elements, e.g. end walls, toe walls, etc. are specified.	

TABLE 2
Defects and Deficiencies Repairable by Standard Methods

Repairable Defects and Deficiencies	Condition	Repair Method
Bugholes	a) Bugholes with depth > 5 mm and all dimensions at the surface not exceeding 25 mm, b) Bugholes with a depth ≤ 5 mm and any dimension at the surface greater than 50 mm and not exceeding 100 mm.	i. Blast surfaces with high pressure water to remove any weak or loose material. ii. Fill Bugholes with a proprietary patching material placed and cured according to the manufacturer's instructions. Patching materials shall be from the Ministry's list of acceptable patching materials.
Honeycombing, Voids, Cavities, Spalls, and Delaminations	Any area less than an equivalent area of 300 mm x 300 mm with no steel reinforcement exposed. Cumulative total area of this type of repair shall not exceed 2% of any face of the culvert.	a) Square all sides of the repair area. b) Sawcut perimeter of removal area to a depth of 10 mm or to the depth of the steel reinforcement, whichever is less. c) Remove all unsound concrete using a chipping hammer or hand tools. d) Insert corrosion resistant wires and anchors, according to OPSS 930 and OPSS 1440. e) Abrasive blast clean all concrete surfaces to be patched according to OPSS 929. f) Remove all dust and loose material from the prepared surface by using compressed air. h) Moisten area to be repaired. i) Fill repair area with concrete and cure concrete according to this specification. j) An acceptable concrete patching material may be used. Patching materials shall be from the Ministry's list of acceptable patching materials and shall be placed and cured according to the manufacturer's recommendations.
Cracks	For width of crack ≥ 0.30 mm and ≤ 1.0 mm, total linear measurement of crack per m² is < 2 m and the crack does not extend through to the opposite face of the element.	Repair according to OPSS 932.



Note: The PROV published in November 2017 replaces OPSS 913 COMMON, November 2014 with no technical content changes.

CONSTRUCTION SPECIFICATION FOR EMBEDDED WORK IN STRUCTURES FOR ELECTRICAL SYSTEMS

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913.01 SCOPE

This specification covers the requirements for the installation of electrical and communication materials to be embedded in structures.

913.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 603	Installation of Ducts
OPSS 616	Footings and Pads for Electrical Equipment

CSA Standards

C22.2 No. 40-M1989 (R2009)	Cutout, Junction, and Pull Boxes
C22.2 No. 85-14	Rigid PVC Boxes and Fittings
C22.2 No. 211.2-06 (R2011)	Rigid PVC (Unplasticized) Conduit
C22.2 No. 227.1-06 (R2011)	Electrical Nonmetallic Tubing

913.05 MATERIALS

913.05.01 Junction Boxes and Fittings

Junction boxes and fittings shall be according to CSA C22.2 No. 85.

913.05.02 Rigid Ducts

Rigid ducts to be embedded shall be according to OPSS 603, Table 1.

Ducts less than 60 mm diameter shall be rigid PVC and according to CSA C22.2 No. 211.2. The associated cleaner and solvent cement shall be according to the duct manufacturer's recommendations.

913.05.03 Flexible Ducts and Fittings

Flexible ducts and fittings shall be according to CAN/CSA C22.2 No. 227.1.

913.05.04 Fish Line

Fish line shall be nylon or polypropylene materials with a minimum test strength of 400 N.

913.05.05 Anchorage Assemblies and Hardware

Anchorage assemblies and hardware shall be according to OPSS 616.

913.05.05.01 Anchor Assembly Struts

Anchor assembly struts shall be according to OPSS 616.

913.05.05.02 Studs, Nuts, and Washers

Studs, nuts, and washers shall be according to OPSS 616.

913.05.05.03 Ferrules

Ferrules shall be according to OPSS 616.

913.07 CONSTRUCTION

913.07.01 Embedded Work in Structure

All components shall be installed at locations specified in the Contract Documents. Components shall be secured and supported in place so that shifting or deflection of the components does not occur during the placing of concrete or under other such loads as may be encountered during construction.

913.07.01.01 Junction Boxes

Junction boxes shall be installed so that the outside faces of the covers are flush with the finished surface of the concrete, except for barrier walls. Junction boxes shall be recessed 50 mm in barrier walls and have grounded galvanized steel treaded covers according to CSA C22.2 No. 40 and the Contract Documents.

Junction boxes shall be drilled to accept conduit fittings as specified in the Contract Documents. Ducts and conduit fittings shall be connected to junction boxes using appropriate solvent cement.

913.07.01.02 Ducts

Ducts shall be installed using CSA approved fittings, couplings, and accessories for the type of duct used. Adapter couplings shall be installed between ducts of dissimilar materials. Expansion and deflection fitting assemblies or wobble joints shall be installed at structural expansion joints.

Expansion and deflection coupling joints shall be according to the Contract Documents and manufacturer's specifications. Duct to couplings and fittings connections shall be made with a cleaner and solvent cement suitable for the type of duct installed.

Ducts ending at vertical concrete faces shall be terminated with fittings as specified in the Contract Documents.

Ducts shall be free of debris, water, breakage, and distortion and verified by pulling a mandrel through the ducts.

All open ends in ducts shall be plugged with plastic plugs.

913.07.01.03 Fish Line

A fish line shall be installed in all duct systems. A 1.5 m length of fish line shall be left coiled in each junction box and at each duct termination at a concrete face by bringing the fish line out of the duct beside the plastic plug.

913.07.01.04 Anchorage Assemblies

Anchorage assemblies shall be installed according to OPSS 616.

913.07.02 Embedded Work in Structure for Other than Owner

The work for embedded work in structure for other than the Owner shall be according to subsection Embedded Work in Structure and as specified in the Contract Documents.

When material supplied by others to the Contractor is specified in the Contract Documents, the Contractor shall notify the Contract Administrator in writing of the need for the material a minimum of 30 Days in advance of the date when the material is required.

913.10 BASIS OF PAYMENT

913.10.01 Embedded Work in Structure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.



**CONSTRUCTION SPECIFICATION FOR
WATERPROOFING BRIDGE DECKS AND CULVERTS
WITH HOT-APPLIED RUBBERIZED ASPHALT
WATERPROOFING MEMBRANE**

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914.01 SCOPE

This specification covers the requirements for waterproofing of new and existing concrete bridge decks and concrete culverts with hot-applied rubberized asphalt (HRA) waterproofing membrane.

914.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standards Specifications, Construction

OPSS 912	Precast Concrete Culverts with Spans Greater than 3.0 m
OPSS 929	Abrasive Blast Cleaning - Concrete

Ontario Provincial Standards Specifications, Material

OPSS 1212	Hot-Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1213	Hot-Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1215	Protection Board
OPSS 1216	Primer used with Hot-Applied Rubberized Asphalt Waterproofing Membrane
OPSS 1217	Membrane Reinforcement for Hot-Applied Rubberized Asphalt Waterproofing Membrane

Ontario Ministry of Transportation Publications

Field Guide for the Acceptance of Hot Mix Asphalt and Hot-applied Rubberized Asphalt Waterproofing Membrane

Laboratory Testing Manual

LS-359 Method of Test for Measuring Thickness of Protection Boards

MTO Forms:

PH-CC-340 Field Sample Data Sheet - Concrete

PH-CC-701 Request to Proceed

PH-CC-702 Notice to Proceed

ASTM International

D2995-14 Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors

914.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Culvert means as defined in OPSS 912.

Distribution Slab means as defined in OPSS 912.

Hot-Applied Rubberized Asphalt (HRA) Waterproofing Membrane means a liquid-applied membrane that is a 100% solids blend of asphalts, synthetic rubber polymers and filler formulated to provide toughness with flexibility and low moisture vapour permeance, which is melted in a kettle and spread out hot onto a concrete surface as a waterproofing membrane.

Joint Sealing Compound means a material used to fill joints in structures prior to waterproofing.

Primer means a cut-back bitumen substance used as a preparatory coat on the exposed concrete surface of a bridge deck or culvert to improve the adhesion of the HRA waterproofing membrane.

Protection Board means a durable panel specifically designed to provide an interface protection barrier between the asphalt and the HRA waterproofing membrane.

Protection Slab means as defined in OPSS 912.

Random Location means a location determined by the Contract Administrator based on random numbers or, if protection boards are used, it means the exposed corner of a protection board closest to that location.

Reinforcement means a non-woven sheet material used at joints, cracks, transitions and other areas to strengthen the HRA waterproofing membrane at locations where movement is expected to occur. Also referred to as membrane reinforcement.

Tack Coat means an emulsified asphalt used to bond hot mix asphalt (HMA) to either the protection board, an existing pavement, or another HMA binder course.

Waterproofing System means all components of the waterproofing including, primer, two layers of HRA waterproofing membrane, membrane reinforcement and protection board.

914.04 DESIGN AND SUBMISSION REQUIREMENTS

914.04.01 Submission Requirements

914.04.01.01 HRA Waterproofing Membrane Supporting Documentation

Prior to commencing the waterproofing operation, the following supporting documentation shall be submitted to the Contract Administrator:

- a) Complete details of all equipment to be used for the waterproofing operations.
- b) Sketch of the bridge deck and/or culvert including:
 - i. All locations to receive membrane reinforcement.
 - ii. Designated material laydown areas.
 - iii. Orientation and lapping direction of the protection boards.
 - iv. Joint details for staged construction.
 - v. Direction of application of waterproofing operation on the bridge deck or culvert.
 - vi. Location of kettles during application and location of any other equipment used to perform waterproofing operations.
 - vii. Any other pertinent details.
- c) The following product information, obtained from the manufacturer for every batch or lot of HRA waterproofing membrane, primer, membrane reinforcement, protection board and joint sealing compound to be used in the operation:
 - i. Product name and manufacturer.
 - ii. The manufacturer's batch or lot number.
 - iii. The size of the batch or lot.
 - iv. Application recommendations.
 - v. Manufacturer's recommended heating time and heating temperature range.

914.04.01.02 Cold Weather Protection Plan

When proposing to waterproof at temperatures between 0 °C and 5 °C, a cold weather protection plan shall be submitted to the Contract Administrator for acceptance a minimum of 14 Days prior to commencing waterproofing if the expected ambient air or concrete surface temperature will be between 0 °C and 5 °C.

The plan shall include methods for controlling and monitoring the temperature of the bridge deck or culvert prior to and during placement of the HRA waterproofing membrane.

The cold weather protection plan shall include, as a minimum, the following:

- a) Bridge deck and/or culvert for which the plan applies.
- b) Cold weather protection measures to be used to maintain the concrete deck or culvert at a minimum temperature of 10 °C or higher for a period of 24 hours prior to application of the HRA waterproofing membrane.
- c) Details of the temperature monitoring system, including the locations and frequencies of temperature recordings.
- d) If applicable, type of insulation, R value and number of layers, including test data verifying the R value. The submission for cold weather protective measures shall be accompanied by samples of insulation, if requested by the Contract Administrator.
- e) If applicable, type and layout of heaters and method for ventilation of heater exhaust and type and extent of housing.

- f) Procedure for withdrawing cold weather protective measures.
- g) Method for protecting the placed protection board from snow, rain or ice, prior to paving.
- h) Any other measures to be taken.

914.04.01.03 Protection Board

The manufacturer's recommendations for handling and storage of the protection board shall be submitted to the Contract Administrator a minimum of 7 Days prior to placement of HRA waterproofing membrane.

914.05 MATERIALS

914.05.01 Hot Poured Rubberized Asphalt Joint Sealing Compound

Hot poured rubberized asphalt joint sealing compound shall be according to OPSS 1212.

914.05.02 HRA Waterproofing Membrane

The HRA waterproofing membrane shall be according to OPSS 1213 and supplied to the job site in the manufacturer's sealed and labelled packages ready for melting and application.

914.05.03 Membrane Reinforcement

Reinforcement for HRA waterproofing membrane shall be according to OPSS 1217.

Each meter of reinforcement shall be labelled with the product name and grade.

914.05.04 Primer

Primer for HRA waterproofing membrane shall be according to OPSS 1216.

914.05.05 Protection Board

Protection board shall be according to OPSS 1215.

914.06 EQUIPMENT

914.06.01 Air Compressor

The air compressor shall provide oil and water-free compressed air. The air compressor shall have a minimum capacity of 3.5 m³/min.

914.06.02 Heating and Mixing Kettle for HRA Waterproofing Membrane and Hot-Poured Rubberized Asphalt Joint Sealing Compound

Heating and mixing kettles shall be used for the HRA waterproofing membrane and the hot-poured rubberized asphalt joint sealing compound.

The kettles shall be of the double boiler oil heat transfer type with a built-in agitator and equipped with two functional permanently installed dial type thermometers with an accuracy of ± 2 °C to measure the temperature of the melted compound and the temperature of the oil. Heating shall be controlled by an automatic thermostat to maintain the temperature of the product used within the range specified by the manufacturer. Infrared or direct heat kettles shall not be used.

Certificates of calibration from an organization accredited by the Standards Council of Canada shall be supplied for each gauge certifying that the thermometers can measure the temperature within a tolerance of ± 2 °C.

914.06.03 Thermometer

A separate calibrated thermometer with an accuracy of ± 2 °C for verification of the material temperature shall be available on the site.

914.07 CONSTRUCTION

914.07.01 Existing Asphalt Covered Decks

When an asphalt riding surface is to be stripped from the existing concrete structure deck, at least 7 Days prior to the commencement of the asphalt stripping operation, the Contract Administrator shall be informed, in writing, of the date and time that the work is to commence.

914.07.02 Notice to Proceed with Waterproofing Operations

At least 48 hours prior to each placement of waterproofing, a MTO form PH-CC-701, Request to Proceed accompanied with all supporting documentation shall be submitted to the Contract Administrator.

Waterproofing shall not commence until a MTO form PH-CC-702, Notice to Proceed has been received from the Contract Administrator.

914.07.03 General Waterproofing Operations and Operational Constraints

Concrete bridge deck or culvert waterproofing shall consist of:

- a) Bridge deck or culvert surface preparation.
- b) Application of primer.
- c) Application of first layer of HRA waterproofing membrane.
- d) Application of the membrane reinforcement immediately after application of the first layer of waterproofing membrane.
- e) Application of second layer of HRA waterproofing membrane.
- f) Application of protection board immediately after placement of the second layer of HRA waterproofing membrane.
- g) If applicable, forming grooves along the surface that is to receive HRA waterproofing membrane and filling them monolithically with the application of joint sealing compound where there are no separate tender items for this work.

The waterproofing operations shall be performed sequentially with no delay between operations. Any part of the bridge deck or culvert to be waterproofed shall be primed the same Day as the HRA waterproofing membrane is applied.

Waterproofing of bridge decks shall include the waterproofing of approach slabs.

Waterproofing operations, filling of grooves, and joint sealing shall only be carried out when:

- a) The air and concrete surface temperature are 5 °C or higher; and
- b) Precipitation is not expected to occur during the work.

Waterproofing and joint sealing shall not be acceptable if placed when the ambient air temperature is below 0 °C.

A proposal to carry out waterproofing operations when the ambient air temperature is between 0 °C and 5 °C may be submitted. If the proposal is accepted by the Owner, waterproofing operations shall be according to the approved cold weather protection plan and all surfaces against which the waterproofing system is placed shall be at a minimum temperature of 10 °C for a minimum period of 24 hours prior to application of the waterproofing system.

All concrete surfaces against which the waterproofing system is applied shall be air cured, with no exposure to precipitation or water, for at least 72 hours immediately prior to the application of the waterproofing system.

Primer and protection board shall be stored at a minimum temperature of 10 °C for 24 hours prior to application and within the manufacturer's recommended temperature range, and in conditions that prevent exposure to water or precipitation. HRA waterproofing membrane and membrane reinforcement shall be stored within the manufacturer's recommended temperature range, and in conditions that prevent exposure to water or precipitation. The Contract Administrator shall be granted access to randomly inspect off-site material storage if requested.

Drainage holes through the deck shall not be plugged or covered by HRA waterproofing membrane, reinforcement, or protection boards.

914.07.04 Applicators

HRA waterproofing membrane applicators shall be from the current Approved Applicators List for Waterproofing Membrane from the manufacturer of the HRA waterproofing membrane that is used.

914.07.05 Bridge Deck or Culvert Surface Preparation

914.07.05.01 Treatment of Grout Tubes on Bridge Deck Surfaces

Grout tubes shall be cut flush with the bridge deck surface prior to abrasive blast cleaning and shall be recut flush with the concrete surface if abrasive blast cleaning results in the tube projecting from above the concrete. A 450 x 450 mm piece of membrane reinforcement, centred on the tube, shall be installed.

914.07.05.02 New Concrete Bridge Decks, Culverts and Concrete Bridge Deck Overlays

The surface of the concrete shall be completely treated by abrasive blast cleaning, according to OPSS 929, to expose sound, laitance-free concrete. Curing compound, if used on the concrete surface, shall be completely removed. All dirt and debris shall be removed from the bridge deck or culvert and adjacent surfaces. Immediately prior to the application of the primer, the concrete surface shall be cleaned with an air compressor to remove all dust, debris, and other foreign material.

After abrasive blast cleaning operations have commenced, equipment and any vehicles shall not be allowed on the abrasive blast cleaned area other than the construction equipment directly associated with the waterproofing operations.

914.07.05.03 Existing Bridge Deck or Culvert Surface Preparation

All areas of the concrete bridge deck or culvert that have a textured surface, not including sawcut grooves, shall be bush hammered, ground down, or scabbled to reduce the depth of texture to 2 mm or less prior to abrasive blast cleaning operations for waterproofing.

Prior to waterproofing, all existing waterproofing material shall be removed and all concrete surfaces prepared according to the New Concrete Bridge Decks, Culverts and Concrete Bridge Deck Overlays clause. No residual HRA waterproofing membrane shall be on the prepared concrete surface to be primed and waterproofed.

914.07.05.04 Modification of Deck Joint Assemblies of Existing Bridge Decks

Modifications to the deck joint assemblies involving welding or other means of attachment to existing armouring shall be carried out as specified in the Contract Documents prior to waterproofing.

914.07.05.05 Modification of Deck Drains

Modification of deck drains shall be as specified in the Contract Documents. The modifications shall be carried out prior to waterproofing the deck.

914.07.05.06 Contamination of Bridge Deck or Culvert Surface

If an oil spill or any other contamination of the bridge deck or culvert surface occurs on the concrete prior to or during the waterproofing operation, the waterproofing operations shall not proceed until:

- a) A repair proposal to address the contamination has been accepted by the Contract Administrator; and
- b) The repair has been carried out to the satisfaction of the Contract Administrator.

914.07.06 Primer

The primer shall be applied when the concrete is surface dry and clean. Primer shall not be applied if there is any dust, debris and other foreign material on the concrete surface to be primed. Primer shall be applied wherever HRA waterproofing membrane is to be applied. The primer shall extend into the chase or, where there is no chase, be extended up the face of the curbs, concrete barrier walls, concrete parapet walls, deck joint assemblies and deck drains to the level of the top of the proposed HMA base course, if applicable.

The primer material shall be uniformly applied at a rate of 0.25 l/m² or as required by the manufacturer, without puddling, using equipment approved by the manufacturer of the primer material. Primer shall only be applied to areas that will be waterproofed during the same Day.

Waterproofing equipment and any vehicles shall not be permitted upon the primer until it has fully cured. Primer is cured when it reaches a tacky condition to touch without leaving residue on one's finger. After the primer has fully cured, equipment and any vehicles shall not be allowed on the primed surface other than the construction equipment directly associated with the waterproofing operations.

Drying of the concrete or primed surface shall not be expedited by use of a torch or open flame.

If the primed surface is exposed to any precipitation or water, the surface shall be re-primed prior to application of HRA waterproofing membrane.

914.07.07 HRA Waterproofing Membrane and Hot Poured Joint Sealing Compound Preparation

The HRA waterproofing membrane and joint sealing compound shall be slowly melted with constant agitation within the application temperature range recommended by the manufacturer for the application until it is in a lump-free, and free-flowing state.

Packages of HRA waterproofing membrane and joint sealing compound shall be melted at the job site and shall be continuously agitated in the mechanically agitated heating and mixing kettle. The contents shall be continuously agitated until the material is homogenous and can be drawn free flowing and lump free from the mixing kettle at a temperature within the range recommended by the manufacturer.

HRA waterproofing membrane and joint sealing compound shall not be re-heated.

The Contract Administrator shall be informed at least 24 hours prior to the charging of the kettle with HRA waterproofing membrane or joint sealing compound. The initial charge of material shall be placed in an empty kettle for each Day's placement of waterproofing. The Contract Administrator shall be granted access to witness the empty kettle and initial charge of sealant upon request. HRA waterproofing membrane and joint sealant compound shall not to be mixed together in the same kettle.

914.07.08**Application of HRA Waterproofing Membrane**

Areas of the bridge deck or culvert with sawcut grooves shall be filled with a scratch coat of HRA waterproofing membrane after the primer coat has cured. The HRA waterproofing membrane shall be applied immediately after application of the scratch coat.

The waterproofing membrane shall be applied in two layers, interlayered with membrane reinforcement. The first layer of HRA waterproofing membrane shall not be applied until the primer has cured completely. The primer shall be free of any surface moisture. The HRA waterproofing membrane shall be applied within the temperature range recommended by the manufacturer to form a uniform film having a thickness of 2 to 3 mm in each layer. The combined total thickness of both layers of HRA waterproofing membrane and the membrane reinforcement shall be 5 mm $\pm$ 1 mm. There shall be no discontinuities, such as bubbles or other voids that extend through the full depth of the HRA waterproofing membrane.

The application of the HRA waterproofing membrane shall be continuous. If discontinuities cannot be avoided, the HRA waterproofing membrane shall be lapped a minimum of 150 mm.

The HRA waterproofing membrane shall extend into the chase or, where there is no chase, be extended up the face of curbs, concrete barrier walls, concrete parapet walls, deck joint assemblies, and deck drains to the level of the top of the proposed HMA base course, if applicable and according to the Contract Documents.

914.07.09**Membrane Reinforcement**

The membrane reinforcement shall be:

- a) Placed directly over the first layer of HRA waterproofing membrane and pressed in while it is still tacky.
- b) Lapped 10 to 15 mm.
- c) Free of any visible voids or air pockets.
- d) Pressed into to the first layer of HRA waterproofing membrane ensuring the reinforcement is adhered to the HRA waterproofing membrane.
- e) Extend into the chase or, where there is no chase, be extended up the face of the curbs, concrete barrier walls, expansion joints, and deck drains to the level of the top of the proposed hot mix base course.
- f) Completely covered with a second layer of HRA waterproofing membrane.

914.07.10**Application of Protection Board**

The protection board shall be placed immediately after application of the second layer of HRA waterproofing membrane, while the HRA waterproofing membrane is still tacky. The protection board shall bond with the HRA waterproofing membrane. The protection board shall be laid transverse to the centreline of the bridge deck or culvert. Sand used to separate individual protection boards, or any other material, shall be prevented from getting blown onto the abrasive blast cleaned surface, primed surface or the HRA waterproofing membrane surface prior the installation of the protection board. The protection boards shall be placed with all edges overlapping 12 mm $\pm$ 6 mm. The protection board edge shall be within 6 mm of all curbs, vertical faces of drains, and vertical faces of expansion joints. Where there is a chase, the protection board edge shall extend into the chase. Protection boards shall be placed so that the joints lap in the direction of traffic flow and staggered a minimum of 150 mm.

No construction equipment or any vehicles shall be allowed on the protection boards once placed, except construction equipment directly associated with the paving operations, that follow after the HRA waterproofing membrane has fully set. The HRA waterproofing membrane is set when the liquid membrane is solidified and there is no movement of the protection board when pressure is applied.

Drying or heating of the protection board, after placement, shall not be expedited by use of a torch or open flame.

If paving is specified, the binder course pavement shall be placed within 7 Days of waterproofing. Prior to placement of the binder course, the protection board shall be clean, dry, free of sand and other debris and contamination and protected from ice, snow and rain. The protection board shall remain stable, with no movement, and shall have no perforations prior to and during placement of binder course pavement.

914.07.11 Additional Requirements for Waterproofing of Culverts

HRA waterproofing membrane with protection board shall be applied to the top surface of the culvert except when a protection or distribution slab is specified, where waterproofing shall be applied to the top of the protection slab or distribution slab.

The application shall be to the top surface of the culvert that will be covered with fill material and extend to 1000 mm beyond the limit of the fill material specified in the Contract Documents.

The HRA waterproofing membrane application, including the protection board, shall extend 300 mm down the vertical faces from:

- a) The top of the culvert or, when specified.
- b) The top of the protection or distribution slab.

If a headwall is specified in the Contract Documents, the application shall extend a minimum of 50 mm up the headwall.

Protection board shall extend over all areas of waterproofing on the culvert.

For precast concrete culverts:

- a) Application of HRA waterproofing membrane to the top surface of the culvert shall be done after application of self-adhering waterproofing membrane to the joints, as specified elsewhere in the Contract Documents.
- b) The HRA waterproofing membrane shall be applied on top of the self-adhering waterproofing membrane applied to the joints.

914.07.12 Form and Fill Grooves

Where forming and filling grooves are specified in the Contract Documents, the grooves shall be made by dry sawing. Forming and filling of grooves shall be performed within 14 Days of surface course asphalt placement at each groove location.

Immediately prior to placing the joint sealing compound, the groove shall be dried, and any dust or debris cleaned using an air compressor.

Joint sealing compound shall be poured using hand pouring pots, mechanical methods, or any other method that gives acceptable results.

Shields shall be provided to prevent joint sealing compound from spilling onto existing surfaces, such as concrete curbs, concrete barrier, concrete parapet walls, deck joint assemblies, deck drains, and on the newly placed pavement.

Sufficient joint sealing compound shall be poured into the groove so that upon completion of the work, the surface of the compound is flush with the surface of the pavement. If the compound subsides to a level below the surface of the pavement, a second pouring shall be done. When more than one pouring is required to fill the groove, succeeding pours shall be made immediately.

Any damage to the joint sealing compound caused by construction operations shall be repaired.

Traffic shall not be permitted over the joint sealing compound until the compound has cooled to ambient temperature.

914.07.13 Material Sampling and Testing

For each lot, as defined in the Quality Assurance section of this specification, representative samples of the following shall be taken for quality assurance testing by the Owner:

- a) A 4 litre sample of HRA waterproofing membrane sampled from the heating and mixing kettle.
- b) A 1 litre sample of primer.
- c) A 300 x 300 mm piece of membrane reinforcement.
- d) A 300 x 300 mm piece of protection board.
- e) A 1 litre sample of joint sealing compound, when specified.

Sampling of the lot shall be as directed by the Contract Administrator. The time of sampling shall be determined using the Field Guide for the Acceptance of Hot Mix Asphalt and Hot-applied Rubberized Asphalt Waterproofing Membrane.

Additional samples from the lot may be taken at the discretion of the Owner to determine acceptability of the lot, if changes are noted in the HRA waterproofing membrane, after the quality assurance sample is taken. The Contract Administrator shall note on form PH-CC-340, Field Sample Data Sheet - Concrete, that the sample is an additional sample for quality assurance testing of the lot as well as reason for taking the additional sample.

All containers used for sampling the HRA waterproofing membrane, primer and joint sealing compound, if used, shall be metal, with double tight lids. The Contract Administrator shall be allowed to examine the sample containers prior to sampling to ensure they are clean and free of debris.

A single 4 L container shall be used to sample the HRA waterproofing membrane. The HRA waterproofing membrane sample will be split at the laboratory into two parts; one part will be tested for acceptance and the other will be retained for referee testing.

For sampling of the primer, the sample shall be taken from the discharge point of the equipment used to apply the primer. The lid of the sample container shall be immediately applied and sealed after the primer sample is taken.

The Contract number, date sampled, manufacturer name, product name and manufacturer's lot/batch number(s) shall be marked legibly on all containers used for sampling.

The membrane reinforcement samples shall be taken from a section labelled with manufacturer and product information.

The samples of HRA waterproofing membrane, primer, membrane reinforcement and protection board for each lot shall be placed in a single plastic bag along with a MTO form PH-CC-340, Field Sample Data Sheet - Concrete and fitted with a security tag by the Contract Administrator. Samples of joint sealing compound, if used, shall be placed in a plastic bag along with a MTO form PH-CC-340, Field Sample Data Sheet - Concrete, and fitted with a security tag by the Contract Administrator. All samples shall immediately be given to the Contract Administrator, with a transmittal form, for transportation to the designated laboratory.

914.07.14 Repairs

A repair proposal may be submitted for work that does not meet the requirements of this specification. The repair proposal is subject to acceptance by the Owner, prior to the repair being carried out.

Repairs shall be full lane or full shoulder width except where localized repairs are permitted or specified in the Contract Documents. New HRA waterproofing membrane material shall be lapped according to the Application of HRA Waterproofing Membrane clause.

The repairs shall meet all requirements of this specification.

Lots that have been repaired or replaced shall be subject to the Quality Assurance acceptance requirements.

The Contractor shall be responsible for all costs associated with repairs.

914.07.15 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

914.08 QUALITY ASSURANCE

914.08.01 General

The waterproofing system shall be acceptable if the requirements of this specification are met.

Unacceptable lots may be rejected, and removed and replaced, or may be left in place with a payment adjustment calculated according to this specification. Rejectable waterproofing system shall be removed and replaced.

Removal and replacement of rejectable lots shall consist of the removal and replacement of the waterproofing system, and pavement, if applicable, to neat lines. The construction of the replacement waterproofing system shall be according to this specification.

The replacement waterproofing system for lots that have been removed and replaced shall be evaluated for acceptance on the same basis as the original lots.

The Contractor shall be responsible for all costs associated with removing and replacing rejectable lots.

914.08.02 Field Inspection

The Contract Administrator will inspect the work and will reject all or a portion of the work based on the presence of one or more of the following defects:

- a) Surface preparation not meeting the requirements of this specification:
 - i. Existing waterproofing that has not been properly removed.
 - ii. Grout tubes that have not been properly treated, when applicable.
 - iii. Textured surfaces, when applicable, that have not been properly ground down to 2 mm or less.
 - iv. Improper abrasive blast cleaning.
 - v. Improper cleaning of the concrete surface prior to applying the primer.
 - vi. Presence of any contamination on the concrete surface prior to application of primer.
- b) Areas without sufficient application of primer, based on visual inspection.
- c) Application of HRA waterproofing membrane that is not within the acceptable manufacturer's recommended temperature range.
- d) The presence of discontinuities, including bubbles or other voids in the HRA waterproofing membrane that extend through the full depth of the HRA waterproofing membrane.
- e) HRA waterproofing membrane that is not adhered to the primed concrete surface.
- f) Protection board that is not properly coated with asphalt.
- g) Membrane reinforcement or protection board that is not bonded to the HRA waterproofing membrane.
- h) Protection board that is cracked, torn or damaged.
- i) Grooves or joint sealing compounds that have damages and are not as specified in the Contract Documents.

914.08.03 Verification of Application Rate of Primer

The Owner may verify the application rate of primer according to ASTM D2995 (Option A). Lots not meeting the primer application rate of this specification shall be removed and replaced.

914.08.04 Acceptance of HRA Waterproofing Membrane Quality

914.08.04.01 Lot Size

Acceptance of the HRA waterproofing membrane quality shall be on a lot basis.

A lot shall be a single bridge deck or culvert or part of a bridge deck or culvert with a surface area of 800 m² or less. Bridge decks or culverts larger than 800 m² shall be divided into the least number of equal sized lots of 800 m² or less. Bridge decks or culverts separated into segments for staged construction shall be treated as separate lots. The Contract Administrator shall determine the limits of each lot prior to commencement of the waterproofing operations.

914.08.04.02 Basis of Acceptance

A lot shall receive a HRA waterproofing membrane quality payment adjustment factor of one if all the test results for the sample representing that lot are within the specification limits shown in Table 2.

If the sample test results are in the marginal range of Table 2 for one or more tests, the payment adjustment shall be determined according to the Payment Adjustment Due to HRA Waterproofing Membrane Quality Deficiency clause.

A lot is rejectable if any of the following criteria are met:

- a) The total number of adjustment points (PT), as shown in Table 2 is greater than 20.
- b) Any test result for a sample is in the rejection value range, as shown in Table 2.
- c) The sample representing the lot is not able to be tested due to the condition in which it is received (e.g., the sample is too hard, too fluid, contaminated, or in an unacceptable container).

Rejectable lots shall be removed and replaced.

914.08.04.03 Referee Testing

Referee testing of HRA waterproofing membrane quality may only be invoked by the Contractor within 3 Business Days of receiving notification of payment adjustment or rejection of the lot. Lots for which quality assurance testing was not able to be performed due to the condition of the sample shall not be tested for referee, but the sample shall be available for viewing at the designated laboratory. Lots for which an insufficient sample size was received shall not be tested for referee, and acceptance shall be based on the quality assurance testing.

Referee testing shall be carried out for all properties specified in Table 2.

The results of the referee test shall replace the acceptance test results and shall be used for acceptance determination. If the referee testing results in either a payment adjustment or rejection of the lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

914.08.05 Acceptance of HRA Waterproofing Membrane Thickness

914.08.05.01 General

The Contract Administrator shall determine the acceptability of the HRA waterproofing membrane thickness by measurement on a lot basis.

Lots for HRA waterproofing membrane thickness acceptance shall match the lots established for HRA waterproofing membrane quality acceptance. Each lot shall be divided into 10 equal sublots.

914.08.05.02 Testing

A measurement shall be taken by the Contract Administrator at a random location in each subplot according to the Field Guide for the Acceptance of Hot Mix Asphalt and Hot-applied Rubberized Asphalt Waterproofing Membrane and shall be taken after each lot has been completed, including the placement of protection board. The measurement shall include the thickness of the two-layers of HRA waterproofing membrane, including the membrane reinforcement.

914.08.05.03 Basis of Acceptance

The decision to accept the HRA waterproofing membrane thickness shall be based on the mean and standard deviation of each lot.

If the lot mean is less than 4.0 mm or greater than 6.0 mm, the entire lot is rejectable and the Contractor shall remove and replace the waterproofing system of the lot.

If the lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm, the mean and the standard deviation shall be rounded to the closest 0.1 mm and 0.05 mm, respectively, and shall then be applied to Table 1 to determine if the lot is in the acceptable, marginal, or rejectable range. If the lot is within the marginal range as shown in Table 1, the Contractor may repair the lot as outlined below or request that the Owner accept the lot as is with a payment adjustment as outlined in the Payment Adjustment Due to HRA Waterproofing Membrane Thickness Deficiency clause. If the lot is within the rejectable range as shown in Table 1, the Contractor shall remove and replace the waterproofing system of the lot.

When the HRA waterproofing membrane thickness lot mean is greater than 6.0 mm, the Contractor may submit a proposal in writing for an alternative to removal and replacement for rejectable HRA waterproofing membrane thickness for the Owner's consideration.

914.08.05.04 Referee Testing

The Contractor may request referee testing of the lot, immediately after being advised of test results, and challenge any or all of the 10 subplot test values. If this occurs, 10 new thickness measurements shall be taken at new random locations within the lot by the Contract Administrator in the presence of the Contractor. The new test values shall replace the acceptance results and shall be used to determine acceptance. Acceptance shall be based on the criteria specified in the Acceptance of HRA Waterproofing Membrane Thickness subsection.

If the referee testing results in either a marginal or a rejectable lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in an acceptable lot, the Owner shall bear the cost of the referee testing.

914.08.06 Acceptance of Protection Board Thickness

914.08.06.01 Lot Size

Acceptability of protection board thickness shall be determined on a lot basis. A lot shall be the total number of protection boards required to cover a single bridge deck or culvert or part of a bridge deck or culvert with a surface area of 800 m² or less. Bridge decks or culverts larger than 800 m² shall be divided into the least number of equal sized lots of 800 m² or less. Bridge decks or culverts separated into segments for staged construction shall be treated as separate lots. The Contract Administrator shall determine the limits of each lot.

914.08.06.02 Testing

Two protection boards per lot shall be randomly selected by the Contract Administrator for testing of thickness; one board for measurement in the field by the Contract Administrator (field-tested), and one board for testing at the designated laboratory (laboratory-tested). Thickness of the field-tested board shall be measured by the Contract Administrator according to LS-359.

914.08.06.03 Basis of Acceptance

Protection board shall be acceptable if it meets the requirements of OPSS 1215 and this specification.

Lots shall be acceptable when the two protection boards measured for acceptance meet the thickness requirements of this specification. Lots where any of the measured protection boards have an average thickness less than 3.2 mm or greater than 4.0 mm shall be rejectable.

All of the protection boards in a failed lot shall not be placed in the work. All of the protection boards from failed lots that have been placed in the work, along with the entire waterproofing system, shall be removed and replaced.

914.08.06.04 Referee Testing

The Contractor may request referee testing for thickness of protection board.

For the field-tested protection boards, the Contractor shall invoke referee testing immediately after quality assurance testing is complete. If this occurs, the same protection board, as was used for field quality assurance testing shall be used for referee testing. Referee thickness testing and basis of acceptance shall be according to the Acceptance of Protection Board Thickness subsection of this specification. The new test values shall then be used to determine acceptance.

For the laboratory-tested protection board, referee testing may only be invoked by the Contractor within 3 Business Days of receipt of the acceptance test result. Referee thickness testing shall be carried out on the same board as was used for laboratory quality assurance testing. The new test value shall then be used to determine acceptance.

914.09 MEASUREMENT FOR PAYMENT

914.09.01 Actual Measurement

914.09.01.01 Membrane Reinforcement

Measurement of membrane reinforcement shall be by length in metres. Allowance shall not be made in the measurement for the turn-up at vertical faces or for any overlap.

914.09.01.02 Form and Fill Grooves

Measurement of forming and filling grooves shall be by length in metres.

914.09.01.03 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified, regardless of type and size.

914.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

914.10 BASIS OF PAYMENT

**914.10.01 Bridge Deck Waterproofing - Item
Culvert Waterproofing - Item**

914.10.01.01 General

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustment.

When the Contract Administrator directs repairs or remedial work that is not specified in the Contract Documents to the concrete deck or culvert prior to abrasive blast cleaning the work directed shall be administered as a Change in the Work.

914.10.01.02 Payment Adjustment Due to HRA Waterproofing Membrane Thickness Deficiency

When a lot is within the acceptable range as shown in Table 1, a thickness adjustment factor of 1.00 shall be applied to the Contract price for the lot.

When a lot is within the marginal range as shown in Table 1 and the Contractor requests that the Owner accept the lot as is, the HRA waterproofing membrane thickness adjustment factor as shown in Table 1 shall be applied. Where a lot with mean thickness greater than 6.0 mm has been deemed acceptable and the Contractor requests that the Owner accept the lot as is, a payment adjustment factor of 0.60 shall be applied due to membrane thickness deficiency.

914.10.01.03 Payment Adjustment Due to HRA Waterproofing Membrane Quality Deficiency

HRA Waterproofing membrane quality adjustment factors are calculated as follows:

- a) If the sample test results are in the marginal range for one or more tests, the adjustment points as shown in Table 2 for each borderline test result shall be totalled. If the total exceeds 20, the lot is rejectable. If the total is less than or equal to 20, the Contract Administrator shall assign a payment adjustment factor which shall be 100 minus the total of all the adjustment points (PT) and the result divided by 100.
- b) If the sample test results meet all specification limits as shown in Table 2, the Contract Administrator shall assign a payment adjustment factor of 1.00.

914.10.01.04 Calculation for Total Payment Adjustment

The total payment adjustment for the lot shall be based on the thickness and on the quality for the HRA waterproofing membrane and is calculated as follows:

- a) The Contract price for the lot shall be multiplied by the HRA waterproofing membrane thickness adjustment factor and the results shall then be multiplied by the HRA waterproofing membrane quality adjustment factor.

**914.10.02 Form and Fill Grooves - Item
Membrane Reinforcement - Item
Modification of Deck Drains - Item**

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Acceptance Determination and Payment Adjustment Factors for HRA Waterproofing Membrane Thickness

		Lot Mean														
		4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1			5.2
Lot Standard Deviation	0.0														0.0	Lot Standard Deviation
	.05														.05	
	.10														.10	
	.15														.15	
	.20														.20	
	.25														.25	
	.30														.30	
	.35														.35	
	.40														.40	
	.45	Acc													.45	
	.50	.99	Acc												.50	
	.55	.94	.99	Acc											.55	
	.60	.83	.95	.99	Acc										.60	
	.65	Rej	.86	.95	.99	Acc									.65	
	.70	Rej	.59	.87	.96	.99	Acc								.70	
	.75		Rej	.71	.89	.96	.99	Acc							.75	
	.80			Rej	.76	.91	.96	.99	Acc						.80	
	.85				Rej	.81	.91	.96	.99	Acc	Acc				.85	
	.90					Rej	.83	.92	.97	.99	.99	Acc			.90	
	.95					Rej	.64	.84	.93	.97	.99	.99	Acc		.95	
	1.00						Rej	.71	.87	.93	.97	.99	.99	Acc	1.00	

Continues on Next Page

TABLE 1 (Cont'd)
Acceptance Determination and Payment Adjustment Factors for HRA Waterproofing Membrane Thickness

		Lot Mean																
		4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9		6.0	
Lot Standard Deviation	1.05	Rej	.76	.87	.94	.97	.99	.99	Acc								1.05	Lot Standard Deviation
	1.10		Rej	.79	.89	.94	.97	.99	.99	Acc							1.10	
	1.15		Rej	.59	.81	.90	.95	.97	.99	.99	Acc						1.15	
	1.20			Rej	.64	.83	.91	.95	.97	.99	.99	Acc					1.20	
	1.25				Rej	.71	.84	.91	.95	.97	.99	.99	Acc				1.25	
	1.30					Rej	.76	.86	.92	.95	.97	.99	.99	Acc			1.30	
	1.35						Rej	.77	.87	.92	.95	.98	.99	.99	Acc		1.35	
	1.40						Rej	.59	.79	.87	.93	.96	.98	.99	.99	Acc	1.40	
	1.45							Rej	.68	.82	.88	.93	.96	.98	.99	.99	1.45	
	1.50								Rej	.71	.83	.89	.93	.96	.98	.99	1.50	
	1.55									Rej	.74	.84	.90	.94	.96	.98	1.55	
	1.60										Rej	.78	.86	.91	.94	.96	1.60	
	1.65										Rej	.64	.79	.87	.91	.94	1.65	
	1.70											Rej	.68	.81	.87	.91	1.70	
	1.75												Rej	.71	.82	.87	1.75	
	1.80													Rej	.74	.83	1.80	
	1.85													Rej	.59	.76	1.85	
	1.90														Rej	.64	1.90	
	1.95															Rej	1.95	
	2.00															Rej	2.00	
Notes:																		
A. Cells containing the Payment Adjustment Factors form the marginal range.																		
B. "Acc" means acceptable.																		
C. "Rej" means rejectable.																		

TABLE 2
Acceptance Determination and Payment Adjustment Factors for HRA Waterproofing Membrane Quality

Test	Specification Limits	Marginal Range (B)	Adjustment Points	Rejection Value
Low Temperature Flexibility at -25 °C	Pass	N/A	N/A	Fail
Cone Penetration at 25 °C (0.1 mm)	Max. 110	111 to 130	$P1 = 0.4 \times (B - 110)$	> 130
Cone Penetration at 50 °C (0.1 mm)	Max. 160	161 to 180	$P2 = 0.4 \times (B - 160)$	> 180
Flow at 60 °C (mm)	Max. 3 mm	3.1 to 5.0	$P3 = 4 \times (B - 3)$	> 5
Toughness (joules)	Min. 5.5	5.4 to 4.0	$P4 = 5 \times (5.5 - B)$	< 4.0
Toughness/Peak Load (joules/newton)	Min. 0.040	0.039 to 0.030	$P5 = 500 \times (0.040 - B)$	< 0.030
Adhesion	Pass	N/A	N/A	Fail
PT = P1 + P2 + P3 + P4 + P5				
Notes: A. B is an observed test result within the marginal range to be used for calculation of adjustment points.				



CONSTRUCTION SPECIFICATION FOR SIGN SUPPORT STRUCTURES

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915.01 SCOPE

This specification covers the requirements for the design and construction of the tri-chord, cantilever tri-chord, cantilever, variable message, pole mounted variable message, monotube overhead, bridge mounted, and roadside breakaway and non-breakaway sign support structures, including their footings.

915.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 603	Installation of Ducts
OPSS 609	Grounding
OPSS 902	Excavating and Backfilling - Structures
OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 906	Structural Steel for Bridges
OPSS 907	Structural Wood Systems

OPSS 911 Coating Structural Steel Systems
OPSS 919 Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1010 Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1350 Concrete - Materials and Production
OPSS 1440 Steel Reinforcement for Concrete
OPSS 1601 Wood - Preservative Treatment and Shop Fabrication

Ontario Ministry of Transportation Publications

Sign Support Manual
Structural Manual

MTO Forms:
PH-CC-701 Request to Proceed
PH-CC-702 Notice to Proceed

CSA Standards

G40.20-13/G40.21-13 (R2018) General Requirements for Rolled or Welded Structural Quality Steel /
Structural Quality Steel
S6-19 Canadian Highway Bridge Design Code
S157-17/S157.1-17 Strength Design in Aluminum / Commentary on CSA S157-17, Strength
Design in Aluminum
W47.2-11 (R2020) Certification of Companies for Fusion Welding of Aluminum
W59-18 Welded Steel Construction
W59.2-18 Welded Aluminum Construction
W178.1-18 Certification of Welding Inspection Organizations
W178.2-18 Certification of Welding Inspectors

American Association of State Highway and Transportation Officials (AASHTO)

LRFDLTS-1 LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and
Traffic Signals, 1st Edition and Interim Revisions

ASTM International

A307-21 Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength
A500/A500M-21a Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and
Shapes
A563/A563M-21ae1 Carbon and Alloy Steel Nuts (Inch and Metric)
B209/209M-21a Aluminum and Aluminum-Alloy Sheet and Plate
B221M-21 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
(Metric)
F436/F436M-19 Hardened Steel Washers Inch and Metric Dimensions
F593-17 Stainless Steel Bolts, Hex Cap Screws, and Studs
F3125/F3125M-22 High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat
Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and
Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

Canadian General Standards Board (CGSB)

48.9712-2014 Non-Destructive Testing - Qualification and Certification of NDT Personnel

Canadian Geotechnical Society

Canadian Foundation Engineering Manual, 4th Edition

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025:2017 General Requirements for the Competence of the Testing and Calibration Laboratories

915.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bridge Mounted Sign Support Structure means a static sign support structure attached to the side of a bridge.

Cantilever Sign Support Structure means an overhead sign support structure consisting of horizontal members mounted to one side, both sides, or centre mounted, to a single vertical leg.

Cantilever Tri-Chord Sign Support Structure means a static sign support structure consisting of a galvanized steel overhead truss constructed in the form of a three-chord system mounted to a single vertical leg.

Column means the vertical member of a roadside sign support structure that has the base section of the member buried below grade and the upper section connected to a sign or sign support.

Leg means the vertical member of an overhead sign support structure that connects to the sign support footing.

Overhead Monotube Sign Support Structure means an overhead sign support structure consisting of two vertical single steel tubing legs spanned by a single steel tubing member.

Overhead Sign Support Structure means a structure for supporting signs over a roadway.

Pole Mounted Variable Message Sign Support Structure means an overhead sign support structure consisting of a variable message board centre mounted to a single vertical galvanized steel pole.

Roadside Sign Support Structure means a timber or steel, breakaway or non-breakaway, sign support structure, consisting of two or more columns on the side of the roadway.

Sign and Sign Board means a traffic control device mounted on a fixed support that conveys a specific message by means of symbols and/or words, and is officially installed for the purpose of regulating, warning, informing, and guiding traffic.

Sign Support Structure means an overhead sign support structure or a roadside sign support structure.

Sweep means the deviation from straightness of a member or any portion of a member with respect to its minor axis.

Tri-Chord Sign Support Structure means a static sign support structure consisting of a galvanized steel overhead truss constructed in the form of a three-chord system and having two tubular legs.

Variable Message Sign Support Structure means an overhead sign support structure with two steel legs, consisting of a pair of trussed members, and an aluminum truss spanning the roadway.

Variable Message Sign (VMS) means a Variable Message Sign that includes display elements, sign case, VMS controller, controller enclosure and all other mechanisms and equipment required to enable placement of the VMS on the support structure.

915.04 DESIGN AND SUBMISSION REQUIREMENTS

915.04.01 Design Requirements

Sign support structure design shall be according to the Sign Support Manual, Structural Manual, CSA S6, AASHTO LRFDLTS-1, and the requirements of this specification. In addition, aluminum components shall also be designed according to CSA S157.

The catwalk grating shall be designed for a live load of 5 kPa.

Welding design shall be according to CSA W59.2 for aluminum and CSA W59 for steel.

915.04.02 Submission Requirements

915.04.02.01 General

When other authorities are involved in the approval of the design or construction of a highway structure, the submission shall be made at least 5 weeks prior to commencement of work.

915.04.02.02 Working Drawings for Sign Support Structures

Working Drawings shall be submitted to the Contract Administrator at least 7 Days prior to commencement of fabrication of overhead sign support structures, for information purposes only.

Working Drawings shall be according to the Contract Documents. An Engineer's seal and signature shall be affixed on the Working Drawings verifying that they are consistent with the requirements of the Contract Documents.

The fabricator shall have a sealed and signed copy of the Working Drawings at the manufacturing facility during fabrication. Working Drawings shall include at least the following information:

- a) Fabrication details.
- b) Specifications of the material to be used.
- c) Design, assembly, and detail drawings including welding procedures according to CSA W59.2 for aluminum and CSA W59 for steel.
- d) Fastener torquing values and methods.
- e) For variable message sign support structures, structural details including the catwalk, aluminum skin, and attachment of the VMS to the sign support structure.
- f) Coating requirements.

915.04.02.03 Mill Test Certificates

Mill test certificates shall be according to OPSS 906.

915.04.02.04 Verification of Fasteners

Verification that bolts, nuts, and washers meet the chemical composition, mechanical properties, dimensions, workmanship, and head burst as required by the appropriate ASTM specification specified in the Contract Documents shall be submitted to the Contract Administrator.

915.04.02.05 Delivery Schedule for Overhead Sign Support Structures

The delivery schedule of overhead sign support structures and their components to the galvanizing or painting facility or both, and to the site, shall be provided to the Contract Administrator not less than 7 Days before shipping begins.

915.04.02.06 Rock Excavation Plan

If rock is present within the depth of the footing as specified in the Contract Documents a proposed method of rock excavation shall be submitted to the Contract Administrator at least 14 Days prior to the commencement of excavation, for information purposes only.

915.04.02.07 Erection Procedures for Overhead Sign Support Structures

Erection procedures shall be submitted to the Contract Administrator at least 7 Days prior to the commencement of overhead sign support structure erection, for information purposes only.

Erection procedures shall be according to the Contract Documents. An Engineer's seal and signature shall be affixed on the erection procedures verifying that they are consistent with the requirements of the Contract Documents.

A copy of the erection procedures shall be at the site during erection. The erection procedures shall include at least the following:

- a) Proposed method and sequence of erection.
- b) Weight and lifting points of the members.
- c) Locations and lifting capacities of the cranes to be used to lift the members.
- d) Details of temporary bracing and temporary supports used during construction, including time and sequence of removal.
- e) Calculations.
- f) Fastener torquing values and methods.
- g) Method of maintaining the columns and anchorages vertical and in the specified location in the footings until the concrete has set.
- h) Erection tolerance between the end diagonal and the corbel for the tri-chord sign support structure truss.

915.04.02.08 Inspection Company and Inspector Information

The names of the inspection company, inspectors, and non-destructive testing technicians, together with proof of certification, shall be submitted to the Contract Administrator a minimum of 7 Days prior to commencement of fabrication of overhead sign support structures, for information purposes only.

915.04.02.09 Signboards

915.04.02.09.01 Sign Ordering

A list of required signboards and tabs shall be submitted to the Contract Administrator a minimum of 12 weeks prior to the date of installation and shall contain the quantity, sign details, and the date for pick-up.

915.04.02.09.02 Sign Confirmation and Inspection

Confirmation in writing shall be provided to the Contract Administrator within 5 Business Days stating that all the supplied signs were received according to the list of required signboards and tabs. The Owner shall be responsible for the cost of replacing any incorrect signs identified prior to the confirmation. Once the confirmation has been received the Owner shall not be responsible for the cost of replacing any damaged, missing, and incorrect signs.

915.05 MATERIALS

915.05.01 General

All material used shall be appropriate for its end use and shall be compatible with the sign structure metal.

915.05.02 Aluminum

Extruded aluminum tubing shall be 6061-T6 alloy according to ASTM B221M.

Aluminum sheet and plate shall be 6061-T6 alloy according to ASTM B209.

Dissimilar metal shall not come in contact with aluminum.

915.05.03 Anchorage Assembly

Bolts, studs, struts, and coils shall be as specified in the Contract Documents. The anchorage assembly shall be hot dip galvanized according to the Coating clause. The anchorage assembly shall be supplied with the fasteners installed in a rigid template.

915.05.04 Clamps

Clamps shall be as specified in the Contract Documents.

915.05.05 Coatings

Paint and metallic coatings shall be as specified in the Contract Documents and according to OPSS 911.

915.05.06 Concrete

Concrete shall be according to OPSS 1350. Compressive strength shall be as specified in the Contract Documents.

915.05.07 Electrical

Ducts and fittings for electrical work shall be as specified in the Contract Documents and according to OPSS 603.

Electrical grounding posts at handholes shall be according to OPSS 609.

915.05.08 Fasteners

Stainless steel fasteners shall be alloy 304 or 316 according to ASTM F593.

Lock nuts shall be nylon insert type.

Galvanized steel fasteners shall be according to ASTM A307 or ASTM F3125, grade A325 or grade A325M, Type 1 as specified in the Contract Documents.

High strength nuts, and hardened washers shall be suitable for use with the types of bolts being specified and shall be according to ASTM A563 and ASTM F436.

The nuts, bolts, and washers shall be supplied and shipped together as an assembly from the same manufacturer.

915.05.09 Granular Backfill

Granular backfill shall be as specified in the Contract Documents and according to OPSS 1010.

915.05.10 Primer and Locking Compound

The thread-locking compound shall be a removable medium strength, single component anaerobic thread locking material that allows disassembly with hand tools. The primer shall be as recommended by the manufacturer of the thread-locking compound.

915.05.11 Reinforcing Steel

Reinforcing steel shall be according to OPSS 1440 and as specified in the Contract Documents.

915.05.12 Steel

Steel shall be according to CSA G40.20/G40.21, ASTM A500, OPSS 906, and as specified in the Contract Documents.

915.05.13 Wood

Wood shall be grade No. 1 Coast Douglas Fir, or grade No. 1 Jack Pine - Beam and Stringer grade, or Post and Timber grade categories as specified in the Contract Documents and shall be according to OPSS 1601.

Wood shall be pressure preservative treated according to OPSS 1601.

915.07 CONSTRUCTION

915.07.01 Fabrication

915.07.01.01 Aluminum Sign Support Structures

915.07.01.01.01 General

The aluminum fabrication shall be according to CSA W59.2.

Cutting shall be done by shearing, sawing, milling, or plasma arc. Flame cutting of components is not permitted. In straightening out parts, only plastic or rubber hammers shall be used. All sharp edges and burrs shall be removed. Components cracked or ruptured at any time shall be replaced and not be used in the work.

915.07.01.01.02 Welding

All welding shall be according to CSA W59.2.

The company performing the welding shall be certified according to CSA W47.2, Division 1 or Division 2.

All welding shall be carried out by welders having a CSA W47.2 identification card valid for the type of welding to be done and for the duration of the welding work. Prior to commencement of welding, the identification cards for each tack welder, welder, or welding operator to be employed on the work shall be made available to the Contract Administrator. Identification cards shall be currently valid and shall indicate the welding processes and the welding positions for which the personnel are qualified to weld.

Welding jigs and fixtures shall be used to hold the connector assemblies in position during fabrication.

All areas to be welded shall be free of grease and cleaned with grease free aluminum or stainless steel brushes. All welds shall be according to CSA W59.2 and made using an inert-gas shielded arc process. All welds shall be cleaned of soot.

Components to be joined by fillet welding shall have a separation no greater than 1.5 mm.

Unless specified on the Working Drawings or otherwise approved in writing by the Contract Administrator, field welding shall not be permitted. When field welding is permitted, it shall be done by a welder certified for all position welding according to CSA W47.2.

915.07.01.02 Steel Sign Support Structures

915.07.01.02.01 General

The steel fabrication shall be according to the Working Drawings and OPSS 906, except as specified in this specification.

Circular structural tubing shall have no more than one longitudinal weld. Octagonal legs shall have no more than two longitudinal welds. Longitudinal welds in legs shall be full penetration and done using an automatic welding process. Longitudinal welds in legs shall be in a plane through the centroid of the section that is parallel to the signboard.

If an octagonal cross section is used for the legs, it shall be produced by mechanically bending the material. The centroid of the octagonal section shall be coincident with the specified circular shape.

915.07.01.02.02 Welding

Welding shall be according to CSA W59. All accessible welds, except fillet welds, shall be ground smooth.

915.07.01.02.03 Steel Monotube Overhead Sign Support Structures

The members shall be octagonal in cross-section and when tapered, the taper shall be uniform. Legs shall have one or two longitudinal automated electrically welded joints along their full length.

Circumferential welds shall be full penetration welds and shall be ground flush on the exterior face. The maximum permitted number of circumferential welded joints in a member length, as measured between the connections shall be as follows:

- a) Up to and including 9 m - one weld.
- b) Greater than 9 m - two welds.

Circumferential welds shall not be located less than 2.7 m from a bolted connection and all welding shall be carried out prior to galvanizing.

Sweep, in millimetres, shall not exceed:

$$\text{Sweep} \leq (\text{Total Length of Member in Metres} / 15) \times 10.4 \text{ mm}$$

All welding at flange plates shall develop the full strength of the adjacent shaft section.

The column base plates shall be flush with the bottom of the columns. The base plates shall be positioned perpendicular to the centreline of the columns. The flange plates shall be positioned to provide the specified camber of the horizontal member after erection. After fabrication, the faces of the base plates and flange plates shall be true and free from distortion.

A waterproof removable galvanized steel top cap shall be furnished with each leg. The caps shall blend with the general column design to present a neat overall appearance. Each cap shall be rigidly secured to the column by a hexagonal head stainless steel set screw. The flange plates, handholes, access nipples for wiring, grounding lugs, and mounting brackets shall be accurately positioned on the members. The wiring apertures shall provide a smooth cable entrance into the members.

915.07.01.02.04 Coating

All steel components of steel sign support structures, including the anchorage assembly, shall be hot dip galvanized according to OPSS 911.

Legs of sign supports, shall be subsequently coated with an approved paint system according to OPSS 911.

915.07.01.03 Mechanical Access for Electrical Work

Legs adjacent to the power source shall be fabricated with handhole frames complete with covers and gaskets. The strength of the leg at the section through the handhole shall not be less than the original section. When specified in the Contract Documents, grounding lugs, fuse clips, and access nipples for wiring shall be installed during shop fabrication.

915.07.01.04 Identification of Overhead Sign Support Structures

Each sign support structure shall have a site identification marking located approximately 1 m above the footing showing the following information:

- a) Site identification number.
- b) Manufacturer's name or trademark.
- c) Date of manufacture.
- d) Maximum sign area.
- e) Design wind pressure.

The marking shall be on a corrosion resistant plate securely attached by means of stainless steel band clamps. The plate shall be attached on the right leg viewed in the direction of traffic. The maximum size of plate shall be 150 x 150 mm.

The site identification number, maximum sign area, and design wind pressure for each sign support structure shall be as specified in the Contract Documents.

915.07.02 Shipment of Sign Support Structures and Their Components

915.07.02.01 General

Each sign support structure shall be shipped, complete with hardware, suitably packaged to ensure that all components are delivered together with tags attached noting the site identification number. The fuse connector clip and grounding post shall be assembled inside the leg before shipment.

915.07.02.02 Transporting, Unloading, Storing, and Handling Components

The components shall only be handled at the lifting points shown in the Working Drawings using non-metallic lifting slings.

The components that are to receive a paint coating after galvanizing shall be identified when delivered to the galvanizing plant.

All work necessary to ensure safe loading, delivery, unloading, and storage of components at the specified site shall be performed. Components shall be loaded for shipping in a manner that they can be transported and unloaded at its destination without being overstressed or damaged. When stored, components shall be stockpiled to avoid permanent deformation or damage.

Advertising by means of removable signing is permitted on elements only while in transit to the specified site. Painting of advertisements directly on elements is not permitted.

915.07.02.03 Storage of Signboard Chord Clamps

When the Contract Documents do not include the installation of the signboard for each overhead sign structure, the chord clamps required for fastening the sign shall be placed in burlap bags with tags. The tags shall be marked with the size of clamps and the identification number of the sign structure on which they are to be used. Chord clamps prepared in this manner shall be delivered to the Owner for storage as specified in the Contract Documents.

915.07.03 Footings for Overhead Sign Support Structures

915.07.03.01 General

The footings shall be constructed plumb to within 1H:100V.

The tolerance for the location of the centre of the constructed footing shall be 75 mm from the location specified in the Contract Documents.

915.07.03.02 Excavation

The excavation shall be to the lines and grades specified in the Contract Documents and according to OPSS 902.

Cylindrical shaft footings for overhead sign support structures shall be constructed as caisson piles according to OPSS 903.

When the following conditions are encountered the excavation shall be stopped, observations shall be recorded, and the Contract Administrator shall be notified immediately:

- a) Different subsurface conditions and/or unexpected conditions such as obstructions within the foundations; or
- b) Unexpected rock is encountered at a depth less than the full depth of the footing; or
- c) Soil with unexpectedly lower strengths that compromise the bearing capacity.

915.07.03.03 Formwork

Formwork shall be according to OPSS 919.

The footing shall be formed to a minimum of 150 mm below finish grade. Formwork shall be removed to a minimum depth of 150 mm below finished grade prior to placing granular backfill.

915.07.03.04 Reinforcing Steel

Reinforcing steel shall be placed according to OPSS 905.

915.07.03.05 Anchorage Assembly

The anchorage assembly shall be installed level to the tolerances as specified in the Contract Documents. The tolerance for the location of the centre of the anchorage assembly shall be 50 mm from the centre of the footing. Anchorage assemblies shall be securely tied to the reinforcing steel and provided with supports to maintain its position during the placing of concrete. The anchorage assembly shall not be welded to the reinforcing cage and shall remain plumb to within 1H:200V. The anchorage assembly setting templates shall remain in place until after the curing period of the concrete.

The centre to centre tolerance of the anchorage assemblies for the following structure types shall be:

Tri-chord sign support structure:	- 25 mm to + 50 mm
Variable message sign support structure:	± 25 mm
Monotube overhead sign support structure:	± 25 mm

Bedding grout shall not be used under the base plates of tri-chord, cantilever tri-chord, cantilever, pole mounted variable message, and monotube overhead sign support structures.

915.07.03.06 Electrical Ducts and Fittings

All work for electrical ducts and fittings shall be according to OPSS 603.

When rigid duct sleeves in footings are specified in the Contract Documents, they shall be located to suit incoming duct or cable systems and shall be securely tied to steel reinforcement, prior to placing concrete.

All rigid duct sleeves shall be cut off cleanly above the footing ensuring a minimum projection of 150 mm above the base plates. Rigid duct sleeves shall be temporarily plugged or sealed until the ducts or cable systems are installed.

915.07.03.07 Concrete

915.07.03.07.01 General

Concrete shall be according to OPSS 904, with the following additions:

- a) All loosed, softened, and deleterious material within the foundation shall be removed prior to concreting.
- b) The foundation shall be inspected by the Contract Administrator prior to concreting.

- c) Concrete shall be placed against undisturbed soil and the top of the footing shall be float finished level within ± 10 mm of the elevation specified in the Contract Documents.
- d) When white-pigmented membrane is used as a curing compound on an adjacent concrete barrier, a minimum of one coat of the curing compound shall be applied to the concrete footing after completion of the curing with burlap and water of the footing, for colour uniformity. Additional curing compound shall be applied, as necessary, to ensure colour uniformity. The curing compound shall only be used on the exposed surfaces of the footings. No curing compound shall be applied to construction joints.

915.07.03.07.02 Early Loading of Sign Support Structure Concrete

Early erection of the sign support structure shall be according to the Early Loading of Structural Concrete subsection of OPSS 904 with the following exception:

- a) Prior to any early loading, it shall be demonstrated that the concrete has reached a compressive strength of 25 MPa by preparing, curing, and transporting early strength cylinders according to the Testing for Early Strength subsection of OPSS 904.

915.07.03.08 Inspection after Construction of the Footings

An Owner standard form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator upon completion of the construction of the footing, and prior to the installation of the overhead sign support structure.

The installation of overhead sign support structure shall not proceed until an Owner standard form PH-CC-702, Notice to Proceed, has been received from the Contract Administrator.

915.07.04 Erection of Overhead Sign Support Structures

915.07.04.01 General

The Contract Administrator shall be notified in writing a minimum of 7 Days prior to the commencement of field operations and erection work.

Components shall be erected using appropriate lifting equipment, temporary bracing, guys, and stiffening devices so that the components are at no time overstressed, unstable, unsafe, or damaged.

The fully assembled truss of the variable message sign support structure shall be erected in one lift.

Legs of structures with rigid corners shall not be forced into position on to the anchorage bolts.

A primer and locking compound shall be applied to the anchor bolts during erection of the overhead sign structure.

915.07.04.02 Legs

Legs of structures shall be erected plumb to within a tolerance of 1H:200V.

915.07.04.03 Field Cutting

Field cutting of material is not permitted.

915.07.04.04 Attachments to Sign Support Structures

Attachments to the sign support structure shall only be made with clamps. Welding shall not be used for any attachment to the sign support structure.

915.07.04.05 Field Splices

Bolted field splices shall be as specified in the Contract Documents, have full contact bearing when assembled and shall not have a separation exceeding 0.5 mm for at least 75% of the entire contact area. The separation of any remaining portion shall not exceed 1 mm.

915.07.04.06 Fastener Torquing

Fasteners shall be torqued as specified in the Contract Documents.

915.07.05 Breakaway and Non-Breakaway Roadside Sign Support Structures

915.07.05.01 General

915.07.05.01.01 Excavation

The excavation for the footings of the steel columns and the installation of the wood columns shall be augered in undisturbed soil to the dimensions and at the locations specified in the Contract Documents. The elevation of the bottom of the excavation shall be as specified in the Contract Documents or as determined by the Contract Administrator. Sidewall stability shall be maintained throughout the excavation and concrete placement for steel columns, and installation of wood columns. The formation of cavities in the wall and the flow of soil or water into the excavation shall be prevented. All loose material shall be removed from the bottom of the excavation.

The MTO form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator upon completion of the excavation. The work shall not proceed until the Contract Administrator has inspected the excavation and issued the MTO form PH-CC-702, Notice to Proceed.

When the following conditions are encountered the excavation shall be stopped, observations shall be recorded, and the Contract Administrator shall be notified immediately:

- a) Different subsurface conditions and/or unexpected conditions such as obstructions within the foundations; or,
- b) Unexpected rock is encountered at a depth less than the full depth of the footing; or,
- c) Soil with unexpectedly lower strengths that comprise the bearing capacity.

915.07.05.01.02 Tolerances

Centreline of the columns and column stubs shall be within 50 mm of the centreline of the as-built footing.

Centre to centre spacing of columns, column stubs, or column assemblies shall be ± 50 mm.

Height of signboard attachment holes shall be ± 10 mm.

915.07.05.02 Steel Roadside Sign Support Structures

915.07.05.02.01 Footings

Concrete shall be according to OPSS 904. Concrete for footings shall be placed against undisturbed soil.

The top of the footing shall be shaped to a dome with the top of the dome a minimum of 25 mm above the surrounding ground.

Minimum edge distance of the column components from the edge of concrete footing shall be 75 mm.

915.07.05.02.02 Column Erection

The columns shall be maintained vertical to within a tolerance of 1H:200V and oriented within the tolerances as specified in the Contract Documents until the concrete has set.

For the transverse alignment of the columns, the column components shall be installed so that the faces in contact with the cross-arms shall line up and be coplanar. The cross-arms and sign panels shall not be distorted.

The assembled elements constituting the column shall be straight and concentric with a maximum offset from the vertical axis of 5 mm at any joint.

Shims shall not be used in the assembly of the columns and joints, except at the column stub to lower column connection.

915.07.05.02.01 Breakaway Type Columns

The top surface of the friction plate on the column stub shall be installed level at the elevation specified in the Contract Documents and maintained in this position during the placing and setting of the concrete. The contact areas of the friction plate, fuse plate, and column flange shall be; smooth; clean; and free of galvanized beads, runs, and other imperfections that may impair the sliding action.

915.07.05.03 Wood Roadside Sign Support Structures

915.07.05.03.01 Footings

The columns shall be maintained vertical to within a tolerance of 1H:200V and within the tolerances as specified in the Contract Documents until the backfill has been completed.

Granular backfill shall be compacted according to OPSS 501. The top layer shall extend 100 mm above the surrounding ground and shall be sloped away from the column to provide water run off.

The backfill operation shall be completed prior to the attachment of the signs.

915.07.05.03.02 Field Installation

Field erection and cut surface treatment shall be according to OPSS 907.

The pressed steel shear plates shall be installed in grooves according to manufacturer's recommendations.

The splice surfaces shall be flat and perpendicular to the centreline of the post to ensure full plate contact and shall be used as templates for drilling the holes.

915.07.06 Site Trimming Around Footings

The area surrounding the footing shall be trimmed and finished as specified in the Contract Documents.

915.07.07 Bridge Mounted Sign Support Structures

When the location of attachment on a structure is not specified in the Contract Documents, the attachment to the structure shall be located to minimize the fatigue affects on the support structure as determined by the Contract Administrator.

The Contract Administrator shall be notified in writing a minimum of 7 Days prior to the commencement of field operations and erection work.

Components shall be erected using appropriate lifting equipment, temporary bracing, guys, and stiffening devices so that the components are at no time overstressed, unstable, unsafe, or damaged.

Installation of anchors shall be according to the Contract Documents.

915.07.08 Attachment of New Signboards

915.07.08.01 General

The signboards shall be installed at the locations as specified in the Contract Documents using fasteners appropriate for the application.

All new signboards and tabs to be installed on all new sign support structures will be supplied by the Owner.

Tabs placed on signboards shall be installed with self-tapping screws, #3 Tek screws, with a minimum distance between screws of 300 mm.

915.07.08.02 Sign Pick-Up

All ordered signboards and tabs shall be picked up at the location provided in the "Schedule of Materials to be Supplied by the Owner" within 10 Business Days of receiving notice from the Contract Administrator that the signs are ready for pick-up.

915.07.09 Quality Control

915.07.09.01 General

The quality control of all fabrication processes shall be according to OPSS 906, except as modified in this specification.

Visual inspection and non-destructive testing of steel components shall be according to CSA W59 and as specified in this specification. The acceptance standards of CSA W59 for dynamically loaded structures shall apply.

Visual inspection and non-destructive testing of aluminum components shall be according to CSA W59.2 and as specified in this specification. The acceptance standards of CSA W59.2 for dynamically loaded structures shall apply.

915.07.09.02 Certification of Testing Company, Inspectors and Technicians

An inspector performing the visual inspection shall be certified according to CSA W178.2. Certification shall be to either CWB Level 2 or CWB Level 3.

A testing company shall be employed by the Contractor to do the non-destructive testing of welds and shall be an independent testing organization that is certified by the Canadian Welding Bureau to the requirements of CSA W178.1 for testing of industrial structures. Certification shall include all non-destructive testing methods required to fulfill the inspection and testing requirements of this specification.

Non-destructive testing shall be done by a technician certified in accordance with CGSB 48.9712. Certification shall be to either CGSB Level 2 or CGSB Level 3 for the method used.

The technician and the testing company shall not be changed without the prior approval of the Contract Administrator.

915.07.09.03 Inspection and Testing Reports

A copy of all inspection and testing reports shall be submitted to the Contract Administrator within 7 Days after inspection.

Inspection reports shall bear the seal and signature of an Engineer.

915.07.09.04 Material Certification

Prior to fabrication, the materials used shall be certified to be according to the requirements specified in the Material section.

915.07.09.05 Inspection of Welds

Upon completion of fabrication, all welds in the structure shall be visually inspected and the following welds and connections shall be tested to confirm the acceptability of the fabrication:

- a) The following steel connections shall be tested by magnetic particle testing:
 - i. All column to base plate, stiffeners to column, and stiffeners to base plate for the cantilever, tri-chord, cantilever tri-chord, variable message, pole mounted variable message, and overhead monotube sign support structures.
 - ii. All arm to leg connection plates, stiffeners to arm connection plate, and stiffeners to leg connection plate for cantilever and cantilever tri-chord sign support structures.
- b) The following welds shall be tested using ultrasonic testing methods:
 - i. All longitudinal groove welds in the first 2 m of the leg measured from the base plate of the tri-chord, pole mounted variable message, and overhead monotube sign support structures.
 - ii. All longitudinal groove welds along the full length of the legs of cantilever tri-chord and cantilever sign support structures.
 - iii. All circumferential welds.
 - iv. All full penetration groove welds at the eight inclined chord / horizontal aluminum chord node locations of the end panels of variable message sign support structures.

915.07.09.06 Inspection of Galvanizing

Upon completion of the galvanizing of tri-chord, cantilever tri-chord, and cantilever sign support structures; the truss portion of the structure shall be visually inspected to confirm that the elements have not been damaged due to the galvanization process.

A written inspection and testing report shall be prepared.

915.07.09.07 Inspection of Coating

Coating inspection shall be according to OPSS 911.

A written inspection report of the observations shall be prepared.

915.07.09.08 Inspection after the Fabrication and Coating of the Overhead Sign Support Structure

A Manufacturer's Certificate of Conformance and an Owner standard form PH-CC-701, Request to Proceed, shall be submitted to the Contract Administrator upon completion of the fabrication and coating of the overhead sign support structure.

The overhead sign support structure shall not be shipped from the plant until the Contract Administrator has issued an Owner standard form PH-CC-702, Notice to Proceed.

915.07.09.09 Inspection of Erected Sign Structure

915.07.09.09.01 General

An inspector shall be provided and in attendance to observe the erection operation and to report on compatibility of anchor layout and holes in the base plate and the general alignment, fit up, and bolting.

Bolted construction shall be according to the Bolted Construction General clause in OPSS 906.

The inspector shall visually inspect all components for dents, cracks, ruptures, and loose or improperly fitted clamps and fasteners, including tensioning of fasteners, as well as the presence of all drain and vent holes as specified in the Contract Documents.

A written inspection report of the observations shall be prepared.

915.07.09.09.02 Inspection of Tri-Chord and Cantilever Tri-Chord

An inspector shall confirm that the tolerance is as specified in the Contract Documents between the first diagonal and the corbel is maintained in the tri-chord sign support structure.

915.07.10 Repair of Sign Support Structures

915.07.10.01 General

Repair of sign support structures shall only apply to rehabilitation and refurbishment of existing sign support structures.

915.07.10.02 Steel

Salvaged steel components may be used as specified in the Contract Documents. A written certification bearing the seal and signature of an Engineer shall be submitted to the Contract Administrator certifying that salvaged components are defect free and are according to the Contract Documents.

915.07.10.03 Aluminum

Cracked or ruptured welds may be repaired. Distorted, cracked, or ruptured members or components shall be replaced subject to approval by the Contract Administrator as specified in the Contract Documents. Salvaged members shall not be used.

915.07.10.04 Inspection of Repairs

An inspection of the repairs and replaced components shall be completed as specified in the Quality Control subsection.

915.07.11 As-Built Drawings

For overhead sign support structures, as-built drawings shall be prepared and submitted to the Contract Administrator in a reproducible format prior to Contract Completion and shall include the following information:

- a) All work incorporated in the completed structure that required the submission of Working Drawings.
- b) All changes that have been made from the original Contract Documents.

The as-built drawings shall bear the seal and signature of an Engineer.

915.07.12 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

915.08 QUALITY ASSURANCE

915.08.01 General

The Owner, at its discretion, may choose to do inspection, testing, and sampling in the fabricating shop and field to confirm that the materials supplied, the fabrication of sign support structures, and the erection of sign support structures have been completed as specified in the Contract Documents.

The Contractor shall provide a free and safe access, and protection from the weather for inspection and testing of materials and structural components, during all aspects of the fabrication, delivery, and erection of the sign support structures, at no additional cost to the Owner.

915.09 MEASUREMENT FOR PAYMENT

915.09.01 Actual Measurement

915.09.01.01 Sign Support Footings

For measurement purposes, a count shall be made of the number of sign support footings installed.

915.09.01.02 Sign Support Structures

For measurement purposes, a count shall be made of the number of sign support structures installed.

915.09.01.03 Attachment of New Signboards

For measurement purposes, a count shall be made of the number of signboards and tabs installed.

915.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

915.10 BASIS OF PAYMENT

- 915.10.01**
- Concrete in Ground Mounted Static Sign Support Footings, Tri-Chord and Cantilever - Item**
 - Concrete in Median Mounted Static Sign Support Footings Tri-Chord and Cantilever - Item**
 - Cantilever Tri-Chord Static Sign Support Structures, Class - Item**
 - Concrete in Ground Mounted Variable Message Sign Support Footings - Item**
 - Concrete in Median Mounted Variable Message Sign Support Footings - Item**
 - Concrete in Steel Monotube Overhead Sign Support Footings - Item**
 - Concrete in Steel Column Breakaway Sign Support Footings - Item**
 - Concrete in Steel Column Non-Breakaway Sign Support Footings - Item**
 - Tri-Chord Static Sign Support Structures, Span in Metres - Item**
 - Cantilever Static Sign Support Structures, Class - Item**

Pole Mounted Variable Message Sign Support Structures - Item
Steel Monotube Overhead Sign Support Structures, Span in Metres - Item
Variable Message Sign Support Structures, Span in Metres - Item
Steel Column Breakaway Sign Support Structures - Item
Steel Column Non-Breakaway Sign Support Structures - Item
Wood Column Breakaway Sign Support Structures - Item
Wood Column Non-Breakaway Sign Support Structures - Item
Aluminum Bridge Mounted Sign Support Structures - Item
Repair of Existing Structure - Item
Attachment of New Signboards - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

For payment purposes, the fabrication and delivery of the sign support structures to the work site shall constitute 60% of the work of the tender item.

Replacement of aluminum components that were cracked, ruptured, or damaged during fabrication or erection shall be at no additional cost to the Owner.



CONSTRUCTION SPECIFICATION FOR MODULAR BRIDGE STRUCTURES FOR TEMPORARY INSTALLATIONS

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918.01 SCOPE

This specification covers the requirements for the design, supply, construction, maintenance, and removal of modular bridge structures used for temporary installations, including ramps, bank seats, decking, sidewalks, and railings.

918.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

918.01.02 Appendices Significance and Use

Appendices are not for use in provincial Contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

918.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 906	Structural Steel for Bridges
OPSS 907	Structural Wood Systems
OPSS 908	Metal Traffic Barriers and Metal Railings for Structures

Ontario Provincial Standard Specifications, Material

OPSS 1601	Wood, Preservative Treatment, and Shop Fabrication

Ontario Ministry of Transportation Publications

Structural Manual

CSA Standards

CSA S6-14	Canadian Highway Bridge Design Code

918.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Bank Seats means mud sills, timber matting and other components to support the base plates and ramps.

Modular Bridge means a superstructure comprised of commercially available standard proprietary prefabricated components that can be assembled and disassembled on site.

Temporary Installation means an installation that maintains traffic at a construction site for a length of time not exceeding three years.

918.04

DESIGN AND SUBMISSION REQUIREMENTS

918.04.01

Design Requirements

The modular bridge structure shall be designed according to the Contract Documents, CAN/CSA S6 and the Structural Manual except that:

- a) The following requirements of the CAN/CSA S6 are not mandatory:
 - i. Traffic lane widths, side clearance, and sidewalks.
 - ii. Deck crossfall and drain outlets.
 - iii. Limitation of maximum deflection.
 - iv. Designing floor beam and diaphragms for jacking.
 - v. Provision of a protective coating.
 - vi. Fatigue.
 - vii. Accessibility for inspection and coating, the avoidance of pockets, and the provision of drain holes in pockets and their filling with waterproofing.
 - viii. Camber.
 - ix. Provision of two bolts at the end of bracing members.
 - x. Nuts with safety pins or snap rings may be used instead of hexagonal recessed nuts or hexagonal solid nuts with washers.
- b) In addition to the requirements of CAN/CSA S6, a minimum of three girders or two pairs of trusses shall be used to form the main load carrying system of the bridge.

918.04.02

Submission Requirements

918.04.02.01

Working Drawings, Procedures & Certifications

The following documents, bearing the seal and signature of a design Engineer and a design-checking Engineer, shall be submitted to the Contract Administrator at least 7 Days prior to commencement of the installation of the modular bridge, for information purposes only:

- a) Working Drawings of the modular bridge.
- b) Launching, installation and removal procedures.
- c) A letter and design calculations certifying that the modular bridge has been designed according to the Contract Documents.

- d) Where modular bridge components are fabricated outside of Canada, a letter shall be submitted certifying that the materials used, and the fabrication of the modular bridge components are according to the Contract Documents.
- e) Where the load carrying capacity of the modular bridge or any of its components has been established by testing, the load test reports provided by the manufacturer of the modular bridge shall be submitted confirming the bridge satisfies the requirements of the Evaluation Section of CAN/CSA S6, using a Reliability Index (β) not less than 3.75.

Where previously used components are utilized in the modular bridge, a letter signed and sealed by an Engineer shall be submitted certifying that all used components are in good structural condition and free from any damage or defects that could adversely affect their load carrying capacity and performance.

When other authorities are involved in the approval of the design or construction of the modular bridge, submissions shall be made at least 5 weeks prior to commencement of work and one additional copy of the submission shall be provided for each authority.

The requirements of each authority shall be satisfied prior to commencement of the work.

918.04.02.02 Notice of Installation

A written notice shall be submitted to the Contract Administrator at least 7 Days prior to the installation of the modular bridge superstructure.

918.05 MATERIALS

918.05.01 General

All materials and components shall be according to the Working Drawings.

918.05.02 Modular Bridge Components

All modular bridge steel components shall be fabricated according to the requirements of OPSS 906.

The use of modular bridge components that have been used previously is permitted provided they are free from damages or defects that could adversely affect their load carrying capacity and performance.

918.05.03 Hardware

The hardware used in the assembly and installation of the modular bridge shall be according to the modular bridge manufacturer's requirements.

918.05.04 Structural Steel

Any structural steel components that are not part of the modular bridge shall be designed and constructed according to OPSS 906.

918.05.05 Wood

Wood shall be according to OPSS 1601. Preservative treatment of wood is not required. Fasteners and hardware for wood construction shall be according to OPSS 907.

918.05.06 Railings

Railings shall be according to OPSS 908 or an equivalent modular bridge manufacturer railing system.

918.07 CONSTRUCTION

918.07.01 General

Documentation indicating that the modular bridge Superintendent who shall be in charge of the installation of the modular bridge has had experience and has successfully performed these duties on at least 3 similar bridges shall be submitted to the Contract Administrator at least 7 Days prior to installation of the modular bridge.

918.07.02 Construction of Bank Seats

Fill under bank seats shall be compacted according to OPSS 501 to a minimum of 95% of the maximum dry density.

918.07.03 Installation and Removal of Modular Bridge

The modular bridge, including bank seats, shall be assembled, installed, and removed according to the Working Drawings, procedures and Contract Documents.

918.07.04 Certificate of Conformance

Upon the completion of construction of the modular bridge, a Certificate of Conformance bearing the seal and signature of a Quality Verification Engineer shall be submitted to the Contract Administrator. The certificate shall state that the modular bridge has been constructed in general conformance with the Working Drawings, procedures and Contract Documents.

918.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

918.07.06 Modular Bridge Maintenance

For the duration of the Contract, excluding seasonal shutdown, the modular bridge, including bearings, bank seats, ramps, decking, sidewalks, railing, approaches, and substructure elements shall be inspected, and have any deficiencies corrected, to ensure its structural integrity, safety and performance are not compromised.

918.10 BASIS OF PAYMENT

918.10.01 Temporary Modular Bridge - Item

Payment at the Contract price for the above item shall be full compensation for all labour, Equipment, and Material to do the work.

For payment purposes, the construction of the modular bridge shall constitute 50% of the work of the tender item.



CONSTRUCTION SPECIFICATION FOR FORMWORK AND FALSEWORK

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919.10	BASIS OF PAYMENT

919.01 SCOPE

This specification covers the design and construction requirements for formwork, falsework, and temporary supports used in the construction and rehabilitation of structures.

919.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 906	Structural Steel
OPSS 910	Stressing Systems for Post-Tensioning

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Selected Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Guideline for Foundation Engineering Services

MTO Forms:

PH-CC-701	Request to Proceed
PH-CC-702	Notice to Proceed
PH-CC-822	Certificate of Conformance

CSA Standards

A23.3:19	Design of Concrete Structures
G40.20/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
O86:19	Engineering Design in Wood
O121:17 (R2022)	Douglas Fir Plywood
O122-16 (R2021)	Structural Glued-Laminated Timber
O151:17 (R2022)	Canadian Softwood Plywood
O153:19	Poplar Plywood
S16:19	Design of Steel Structures
S157/S157.1-17 (R2022)	Strength Design in Aluminum/Commentary on CSA S157-17, Strength Design in Aluminum
S269.1-16 (R2021)	Falsework and Formwork

ASTM International

A123/A123M-17	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
D1037-12(2020)	Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

National Research Council (NRC)

National Building Code of Canada-2020

919.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Architectural Concrete means concrete that is permanently exposed to view and is designated as architectural concrete in the Contract Documents, and therefore requires special care in selection of the concrete materials, forming, placing, and finishing to obtain the desired architectural appearance.

Bulkhead means the vertical form that supports the end width of a concrete deck pour.

Closure Strip means a temporary separation between two regions of slab, typically precast, that will be constructed of cast-in-place concrete separately.

Culvert means a structure with a span greater than 3.0 m that is typically embedded in fill, and is used to convey water, pedestrians, vehicles, cyclists, or animals.

Draft means a small angle or taper in the formwork for re-entrant formed surfaces that facilitates release when the form is stripped.

Exposed Surface means all external formed surfaces not to be covered by backfill material.

Falsework means any temporary structural support including supporting members, bracing, and hardware, used to support all or part of the formwork or of the structure during its construction or rehabilitation until it becomes self-supporting.

Formwork means the total system of support for freshly placed concrete, including the mould, sheathing or liner that contacts the freshly placed concrete, but excluding the falsework.

Foundation means the ground immediately below the mudsills that supports the falsework or that portion of ground supporting the falsework piles.

Grade means:

- a) For steel, the designation of the quality of the steel that can be determined by referring to the appropriate CSA standard or by specimen testing.
- b) For wood, the designation of the quality of a piece of wood that can be determined by referring to the appropriate CSA Standard.
- c) For aluminum, the designation of the quality of the aluminum that can be determined by referring to the appropriate CSA standard.

Hardwood means a wood species with an average Janka hardness, according to ASTM D1037, equal to or greater than 5700 N, such as hard maple, northern red oak, or American beech.

Joist means one of a series of parallel, horizontal members, usually loaded on its narrow face, by which form material is supported.

Ledger means a horizontal flexural member usually supporting joists and resting on vertical supports.

Liner means a multi-use lining material attached to the forms that imparts an architectural face design, texture, arrangement, or configuration on the finished concrete.

Mudsill means a plank, lumber, or timber assembly, or a small footing that bears on soil and is used as a base to support falsework, framed construction, or formwork.

Shoring means a system of vertical or inclined support members, or braced frames, for forms or structure components. Shoring may be wood, metal posts, sheets, scaffold-type frames, various patented members or other system of falsework.

Stay-in-Place Forms means forms that are not removed.

Structure means any bridge, culvert, building, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

Stud means one of a series of usually vertical members used in framing to support the plywood or formwork fastened to it.

Timber means felled trees or logs suitable for conversion by sawing or otherwise, or a piece of lumber, 114 mm or more in its smaller dimension, with a larger dimension not more than 51 mm greater than the smaller dimension.

Tower means a composite vertical structure of frames, braces and accessories.

Wood means lumber and timber.

919.04 DESIGN AND SUBMISSION REQUIREMENTS

919.04.01 Design Requirements

919.04.01.01 Formwork Design

Formwork design shall be according to CSA S269.1.

Deck formwork design for precast prestressed NU girder bridges shall not rely solely on the restraint provided by temporary bracing for girders.

919.04.01.02 Falsework Design

Falsework design shall be according to CSA S269.1 and:

- a) Wood components shall be designed according to CSA O86;
- b) Structural steel components shall be designed according to CSA S16;
- c) Aluminum components shall be designed according to CSA S157;
- d) Concrete components shall be designed according to CSA A23.3;
- e) Deflections shall be designed so the finished concrete surface meets the tolerances specified in Table 1 for the surface class specified in the Contract Documents. Where the surface class of a component is not specified, it shall be assumed to be class C.

The maximum effective deflection of beams shall be limited to $L/270$, where L is the length of span. The loading for deflection shall be the weight of concrete and formwork. When deflection of a beam is 10 mm or more, provision shall be made to compensate for deflection;

- f) Where scaffolding, fabricated shoring, or proprietary products are used, the design shall be according to the manufacturer's recommendations; and,
- g) Where another authority is involved, any additional requirements specified by the authority shall also be satisfied.

919.04.01.03 Vertical Loadings

The vertical loadings shall include the effects of environmental factors, such as rain, snow; wind load; weight of reinforced concrete; self-weight of equipment; live load due to workers; material loads; any additional construction loads; post-tensioning loads; and other pertinent factors.

Falsework shall be subject to the following vertical loads:

- a) The weight of the concrete being supported or 2.5 kN/m^2 on the horizontal projected area of the formwork, whichever is the greater;
- b) The weight of concrete as it is placed. The Engineer shall consider the concrete, as it is placed, as a liquid. Unless otherwise specified in the Contract Documents, the weight of normal concrete shall be taken as 24 kN/m^3 ;
- c) The weight of the formwork supported by the falsework or 0.5 kN/m^2 of the horizontal projected area, whichever is greater;
- d) The weight of workers, equipment, and tools that is to be supported during the concrete placing and finishing operations or 2.0 kN/m^2 of horizontal projected area of formwork whichever is greater. When motorized placing equipment is used this minimum load shall be increased to 3.1 kN/m^2 ;

- e) The load due to any special conditions of construction likely to occur, such as unsymmetrical placement of concrete, impact, uplift, concentrated loads, and the additional pressure due to placing concrete by pump;
- f) The loads for temporary supports as specified in the Contract Documents;
- g) The loads due to stored materials and equipment, alterations or repair of structures; and,
- h) The accumulative loads on the falsework due to construction methodology and sequencing such as when closure strips are specified on the Contract Documents.

When there is a post-tensioning operation, the loads on falsework due to post-tensioning shall be considered.

919.04.01.04 Horizontal Loading

The horizontal loadings shall include the effects of environmental factors, such as rain, snow; wind load; concrete pressure including the rate of placing of concrete; the temperature of the concrete; the effect of vibration of the concrete; the consistency of the mix; any additional construction loads; post-tensioning loads; and other pertinent factors.

Falsework shall be subject to the following horizontal loads:

- a) The greater of:
 - i. Calculated lateral wind forces based on 1/50 probability pressures not less than those recommended by the National Building Code of Canada, with a gust effect factor of 2 and a minimum wind pressure of 0.8 kPa. A reduction factor of 0.75 may be applied to the design values for falsework and formwork systems where the duration is less than 2 years;
 - ii. A minimum transverse and longitudinal force of 2% of the total vertical loads assumed to act at the centre of gravity of these applied loads, or 1.50 kN/m of deck edge applied at the mid-depth of the deck, whichever is greater;
 - iii. Any other loads due to environmental conditions. Other environmental loads such as, but not limited to, rain and snow shall be taken into account in the design, where applicable, at the falsework Engineer's discretion unless otherwise specified in the Contract Documents;
- b) Lateral force components that would develop from vertical loads specified in the Vertical Loadings clause if applied to sloping members requiring horizontal restraint; and,
- c) Any calculated or reasonably anticipated lateral forces that may be applied to the falsework such as cable tension, inclined supports or impact from concrete placing operations or moving equipment.

919.04.01.05 Tower Leg Loads

The vertical loads on the tower legs may be based on simple span assumptions. The loads supported by a tower leg may be assumed to be those loads applied to the area immediately above the tower leg that is bounded by lines located at the centreline between each of the bays adjacent to the tower leg being considered.

When locating towers, the following criteria shall apply:

- a) The maximum design load on one leg of a frame shall not exceed four times the design load on the other leg under full or partial loading conditions; and,
- b) The maximum design load on one of the two frames making up a tower shall not exceed four times the design load on the opposite frame under any loading condition.

919.04.01.06 Minimum Bracing Requirements

919.04.01.06.01 General

The minimum bracing requirements are according to the Minimum Bracing Requirements clauses.

919.04.01.06.02 Connections Between Joists and Ledgers

Every fourth joist shall be connected to a ledger.

Ledgers on top of frames shall be axially continuous across the shoring system to evenly distribute horizontal forces to individual scaffold towers below. Ledgers with a splice designed to take the axial load are considered axially continuous.

919.04.01.06.03 Bracing in the Transverse Direction

When the shoring height is composed of three frames, or the shoring height is more than three times the tower width, or the total shoring height is more than 5 m, one horizontal brace made continuous shall be installed on one face of each tower.

The brace shall be located at the mid-height of a two-frame tower and at the top of the second frame for a three-frame tower.

When shoring towers are adequately braced against transverse movement by tying to an adjacent structure or adjacent tower, the above height-to-width restriction applies only to the tower grouping.

When the shoring height is composed of more than three frames, at least one horizontal brace made continuous and one diagonal brace made continuous shall be attached to one transverse face of each tower for every three frames of shoring height. In addition, the maximum spacing of the horizontal brace shall be three times the tower width. The horizontal brace shall be located near the top of a frame. Diagonal braces on adjacent towers shall be installed in opposite directions.

When superelevation is 4% or greater, a horizontal transverse brace shall be attached to one tower face of the top frame in addition to the bracing required by the preceding paragraph.

When the shoring height is greater than 20 m, guy wires shall be installed. The spacing of the guy wires shall not be greater than 15 m horizontally.

919.04.01.06.04 Bracing in the Longitudinal Direction

When the shoring height is composed of three frames or the total height is more than 5 m, one horizontal brace made continuous shall be installed with a horizontal spacing no more than 6 m apart. The brace shall be located at the top of the first frame of a two-frame tower and the top of the second frame of a three-frame tower.

When the shoring height is composed of four frames or more, horizontal braces and diagonal braces made continuous shall be attached on a tower and spaced horizontally not more than 6 m apart. The lowest brace shall be located no higher than the third frame and additional braces shall be spaced vertically at the top of every third frame thereafter.

When the bridge is on a longitudinal grade of 4% or greater, braces parallel to the grade shall be attached to one tower face of the top frame and spaced not more than 6 m apart horizontally.

919.04.01.06.05 Tie Back Bracing - Falsework Opening Towers

The falsework opening towers shall be longitudinally braced to two rows of scaffold towers behind them according to the Bracing in the Longitudinal Direction clause requirements, regardless of the height, and shall be continuously braced transversely.

919.04.01.07 Mudsills

Mudsills shall be designed such that the settlement of mudsills shall not exceed 12 mm.

919.04.02 Submission Requirements

919.04.02.01 Working Drawings

919.04.02.01.01 General

The seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings, including any revisions, verifying that the drawings are consistent with the requirements of the Contract Documents and sound engineering practices. The Contractor's Engineer shall clearly indicate on the Working Drawings whether or not post tensioning effects are taken into consideration.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

When other authorities are involved, one set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction.

The Contractor shall have a sealed and signed copy of the Working Drawings on the site at all times from assembly, erection, use and cycling, through to dismantling.

919.04.02.01.02 Falsework

Working Drawings shall be submitted for all falsework used in the construction or rehabilitation of structures, except for culverts less than 3.0 m in span.

Falsework Working Drawings shall be submitted to the Contract Administrator at least 1 Day prior to commencement of erection of falsework for each structure.

The Working Drawings for the falsework for each structure shall include all details of all falsework to be erected and shall include at least the following:

- a) Longitudinal, lateral, vertical, live, impact, and anticipated construction loads used in the design;
- b) A description of the subsurface conditions;
- c) Allowable bearing capacity of the soil beneath the mudsills. Reduction of the bearing capacity of existing ground or compacted fill, due to water or ice, shall be prevented by suitable drainage or protection;
- d) Details of foundation on sloping ground;
- e) Foundation preparation details;
- f) Foundation construction details;
- g) Maximum column loads;
- h) Deflection diagrams for beams having a deflection of 10 mm or more;
- i) The grade and actual size of all structural materials;
- j) Posts, connections, bracing and welding sufficiently detailed to demonstrate compliance with the structural analysis and erection requirements;
- k) Fully detailed frame shoring;
- l) Type and mass of moving or stationary equipment to be supported by the falsework;

- m) Sequence, method, and rate of concrete placement;
- n) All proprietary equipment sufficiently identified to demonstrate compliance with the structural analysis and erection requirements;
- o) Full details and locations of all splices;
- p) Method of maintaining rotational and lateral stability of structure members;
- q) Vertical stiffening details and lateral restraint for ledgers and subledgers;
- r) Lateral restraint details for falsework supporting beams spanning openings;
- s) Fluid concrete loads, assumed for design purposes;
- t) Location of screed rail supports and design load;
- u) Anticipated settlement of falsework, including settlement of mudsill.

919.04.02.01.03 Formwork

919.04.02.01.03.01 General

Working Drawings are required for the following formwork:

- a) Inside forms for internal voids in post-tensioned decks;
- b) Bulkheads in post-tensioned decks 2.0 m or greater in height;
- c) All columns and walls, 2.4 m or greater in height, of abutments, piers, and retaining walls;
- d) Architectural finishes except those for components in structural Standard Drawings.

Working Drawings for other formwork shall only be submitted when specified in the Contract Documents.

Formwork Working Drawings shall be submitted to the Contract Administrator at least 1 Day prior to commencement of erection of formwork.

The Working Drawings shall show all necessary design and construction details, including the grade and size of materials used, and the pressure diagrams used in the design.

919.04.02.01.03.02 Splices for Stay-In-Place Forms

Details of the method of joining stay-in-place forms shall be shown on the Working Drawings.

919.04.02.01.03.03 Architectural Finishes

Working Drawings for architectural concrete shall also include jointing of facing panels; locations and details of form ties, rustications, and recesses; and details of joints, anchorages, types of liner material and other accessories for formed surfaces designated as architectural concrete in the Contract Documents.

919.04.02.02 Falsework Foundation Design Report

The subsurface conditions shall be assessed at the site to determine if additional information is required to facilitate the design and construction of the falsework foundation. If additional subsurface information is required, a field investigation and laboratory analyses shall be conducted according to the most current version of the Guideline for Foundation Engineering Services.

A falsework foundation design report shall be submitted to the Contract Administrator at least 3 weeks prior to commencement of work under this item. The falsework foundation design report shall be signed and sealed by a foundation Engineer and foundation checking Engineer employed by a firm registered in RAQS - Geotechnical (Structures and Embankments) - medium complexity.

The falsework foundation design report shall include:

- a) A description of the subsurface and groundwater conditions;
- b) Discussion and recommendations regarding the foundation options and vertical and horizontal bearing/axial resistances; and,
- c) Construction considerations including but not limited to site preparation details.

919.04.02.03 Permission to Use Other Structures

Formwork and falsework shall not be supported by, braced to, or come in contact with another structure unless written permission is received from the owner of the other structure. A request to receive written permission shall be submitted to the owner of the other structure including a copy of Working Drawings showing the support locations and imposed loads as they are applied to that structure, and certification that the structure can safely support all the imposed loads from the Contractor's method of construction.

919.04.02.04 Proprietary Shoring, Forms, and Accessories

When proprietary shoring, forms, and accessories are used, the manufacturers' documentation shall be submitted with the Working Drawings including but not limited to:

- a) Rated capacities indicating limit states or working stress method of all components and assemblies with supporting test data where applicable;
- b) Load and deflection charts for standard applications;
- c) Recommended use for intended applications;
- d) Method of erection and dismantling of equipment;
- e) Maintenance manuals and procedures, including items requiring special attention during formwork erection or dismantling; and,
- f) Safety factors, according to CSA S269.1, used to establish safe working loads for components and assemblies.

919.04.02.05 Revised Submissions

When falsework design considerations or field conditions necessitate amendments to the falsework, revisions shall be submitted to the Contract Administrator according to the Working Drawings clause.

919.05 MATERIALS

919.05.01 General

Forms and falsework shall be constructed of wood, metal, concrete, or foam.

Substitution of other materials is not permitted unless approval is received from the Contract Administrator.

919.05.02 Accessories

All accessories used shall comply with the details shown on the Working Drawings or with the recommendations of the manufacturer of the specified accessory.

Deck hangers and hardware left embedded in concrete shall be hot dip galvanized. Only bridge deck hangers shall be permitted to protrude from the concrete surface.

All form ties left in place in concrete barrier and concrete parapet walls shall be hot dip galvanized or non-corrodible.

Where stainless steel or glass fibre reinforced polymer (GFRP) reinforcement is used within a form, all form ties, hangers, and hardware left in place shall be stainless steel type 304.

The maximum diameter of plastic cones for form ties shall be 30 mm.

Hot dip galvanizing shall be according to ASTM A123/A123M.

919.05.03 Concrete

Concrete shall be according to OPSS 1350.

919.05.04 Foam

Foam shall be a closed cell solid such as expanded or extruded polystyrene.

919.05.05 Granular A

Granular A shall be according to OPSS 1010.

919.05.06 Liners

Form liners and flexible formwork shall not be fabric or textiles.

919.05.07 Metal

Structural steel shall be according to CSA G40.20/G40.21 and be of the grade shown on the Working Drawings.

Aluminum shall be according to CSA S157 and be of the alloy and temper shown on the Working Drawings.

Used metal shall be in good condition and examined prior to use. All previous fabrication, adversely affecting the required strength, or any obvious defects or signs of deterioration, deformation, or corrosion shall be corrected.

919.05.08 Plywood

Plywood for formwork shall be:

- a) Identified with a durable, legible marking from an accredited certification body, indicating the manufacturer, bond type, species, grade, and conformance to the appropriate CSA standard or approved equivalent; and,
- b) Douglas fir plywood according to CSA O121 with bond classified as exterior or exposure 1, and grade of veneer according to Table 1 for the class of concrete surface; or,
- c) Canadian softwood plywood according to CSA O151 with bond classified as exterior or exposure 1, and grade of veneer according to Table 1 for the class of concrete surface; or,
- d) Poplar plywood according to CSA O153 with bond classified as exterior or exposure 1, and grade of veneer according to Table 1 for the class of concrete surface.

Unless specified otherwise, the finish side of plywood forms for exposed surfaces are not required to meet veneer grade requirements in the following locations:

- a) The underside of a deck between girders;
- b) The ends of decks;
- c) The face of ballast walls; and,
- d) The internal faces of a culvert.

919.05.09 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry's list of concrete patching materials.

919.05.10 Rustication and Reveal Strips

Materials used for forming rustications or reveals shall not be metallic.

919.05.11 Structural Glued-Laminated Timber

Structural glued-laminated timber shall be exterior grade according to CSA O122.

919.05.12 Void Tubes

919.05.12.01 Post-Tensioned Decks

Ducts for internal post-tensioning shall be according to OPSS 910.

919.05.12.02 Cross Sonic Logging (CSL) Access Tubes and Caps

Cross sonic logging (CSL) access tubes shall be according to the Contract Documents.

919.05.13 Wood

Wood shall be according to CSA O86.

919.07 CONSTRUCTION

919.07.01 Formwork

919.07.01.01 General

Forms shall be smooth; clean; free from warps, splits, holes, and bulges; and constructed and maintained to be mortar tight.

919.07.01.02 Exposed Surfaces

919.07.01.02.01 General

Forms for exposed surfaces shall be new, except that forms may be re-used for exposed surfaces providing their condition is such as to produce a surface equal to one that would be attained using new materials. Where possible, plywood used on exposed surfaces shall be in full sheets and, except when used to form the underside of deck slabs for slab-on-girder construction, shall be so arranged that the face grain is perpendicular to the studs or joists.

919.07.01.02.02 Architectural Exposed Surfaces

Forms for exposed surfaces identified as architectural concrete shall be as specified in the Contract Documents.

Contact surfaces of the formwork shall be carefully installed to produce neat and symmetrical joint patterns, unless otherwise specified. Joints shall be either vertical or horizontal and, where possible, shall be staggered to maintain structural continuity.

Panel area joints may be recessed into the concrete surface by applying rustication strips on the formed surfaces. Rustication strips may be used for construction joints on final faces only, as needed by the Contractor. Waterstops, keyways, and joint sealants may be included where required. Chamfer, rustication, or isolation strips may be placed so as to cover form joints.

Architecturally acceptable concrete surfaces shall be aesthetically compatible with minimal colour and texture variations and surface defects when viewed at a distance of 6 m or more, or as otherwise specified in the Contract Documents.

919.07.01.03 Rustication Strips

Formwork rustication strips shall have a draft of at least 15 degrees. Wooden strips shall have widths at least equal to their depths and shall be kerfed on the backside to prevent binding. All rustication strips or other inserts shall be installed continuously tight to the form contact surface. Rustication strips shall be uniform in dimensions, nonabsorbent, and of sufficient stiffness to maintain alignment during concrete placement operations. Intersections of rustication strips shall be mitered or coped to fit snugly.

919.07.01.04 Studs, Joists, and Decking

Studs and joists shall be spaced not more than 400 mm on centres. Edges of abutting sheets shall be nailed to the same stud or joist with 50 mm nails at not more than 200 mm centres. When used to form the underside of deck slabs in post-tensioned slab and rigid frame bridges, the joints between sheets abutting over joists shall be staggered a minimum of 400 mm. When prefabricated form panels are used, adjacent panels shall be placed such that the joints are maintained flush.

919.07.01.05 Form Release Oil

Non-staining form release oil shall be applied to the faces of forms against which concrete is to be placed. The form release oil shall be applied before placing steel reinforcement.

919.07.01.06 Form Ties

When internal form ties are used, concrete cover to any metal left upon removal of the forms shall be 20 mm minimum.

All ties, securing stay-in-place forms in position and extending below the deck soffit shall be loosened before any stressing commences.

Holes left in the deck soffit after removal of hanger coil rods shall be left open. Holes left in concrete from the use of sleeved form ties shall be filled with a mortar from the ministry's list of proprietary patching material, after removal of formwork.

919.07.01.07 Exposed Corners

All exposed corners on concrete work and the edges of the box void slabs on the soffit of the structure shall be chamfered. The chamfer shall have a vertical and horizontal dimension of 20 mm, unless otherwise specified in the Contract Documents.

919.07.01.08 Stay-in-Place Forms

Stay-in-place forms shall only be used when specified in the Contract Documents or under the following conditions:

- a) Round void tubes in cast-in-place hollow prestressed concrete decks and in precast prestressed hollow slab deck units. Void tubes shall be formed with foam.

Where round voids are used, individual lengths shall be joined by an inner or outer sleeve or other method. Details of the method of joining shall be submitted to the Contract Administrator; or

- b) Box girder voids less than 1.2 m in depth, which shall be formed with foam.

919.07.02 Falsework

919.07.02.01 General

Sound, adjustable falsework shall be built such that the structure remains true to line and grade after anticipated settlement.

A set of falsework Working Drawings shall be on site prior to placement of mudsills.

Hangers or other attachments shall not be welded to structural steel, except that tack welds may be used on shear studs where it is not detrimental to the connection between the stud and the structural steel. All welding of structural steel shall be according to OPSS 906.

Temporary hangers or other attachments shall not be affixed to exposed surfaces of concrete girders. Drill holes or anchoring into the bridge deck fascia to support falsework, working platforms or scaffolding shall not be permitted.

919.07.02.02 Foundation Work

The falsework shall be supported on a foundation that satisfies the performance requirements of the Contract Documents. The foundation type shall be suitable for the applied loadings and the subsurface conditions.

Deep foundation alternatives shall be installed according to OPSS 903.

For traffic openings, a minimum horizontal space of 1.0 m shall be provided between the back face of the concrete barrier and the front edge of the mudsill.

Levelling pads shall be constructed according to the Working Drawings.

For foundations on sloping ground surfaces, the foundation shall be installed according to the Working Drawings.

919.07.02.03 Wooden Shoring

All wooden posts shall be solid, and not built up. Where splicing is necessary, the posts shall be cut square and the two pieces shall be in full contact over the splice. Scabbing shall be provided on all four faces of a post to be spliced. Each post shall be braced in two directions both above and below the splice immediately adjacent to the scabbing. Splices on adjacent posts shall be staggered.

Splicing of round posts shall not be permitted.

Bracing material shall be at least 38 mm x 89 mm lumber except for cross bracing for side forms where 19 mm x 138 mm lumber may be used. Bracing shall be nailed to each post with at least two 100 mm nails for 38 mm x 89 mm lumber and two 75 mm nails for 19 mm x 138 mm lumber. Splicing of bracing shall not be permitted.

Wedges used for purposes of falsework adjustment or to facilitate removal shall be hardwood.

919.07.02.04 Metal Shoring

Metal frame shoring shall be according to CSA S269.1.

The maximum extension of jacks shall not exceed the lesser of the manufacturer's recommendations or 600 mm.

Shims used for levelling mudsills shall be fir plywood or solid lumber.

Wedges used to provide full bearing in U-heads shall be hardwood.

919.07.03 Temporary Supports

The construction of temporary supports shall be as specified in the Contract Documents.

A MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator upon completion of the temporary supports. The next operation shall not proceed until the Contract Administrator has issued a MTO form PH-CC-702, Notice to Proceed.

919.07.04 Screed Rail Supports in Slab on Girder Construction

In slab-on-girder construction, screed rail supports shall be positioned directly over the flange of the exterior girders within 100 mm of the centreline of the web.

919.07.05 Inspection after the Completion of the Construction of the Falsework and Formwork

A MTO form PH-CC-822, Certificate of Conformance and a MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator:

- a) Upon completion of the falsework foundation; and
- b) Upon completion of the construction of the falsework and formwork for which Working Drawings are submitted.

The placement of concrete shall not proceed until the Contract Administrator has issued a MTO form PH-CC-702, Notice to Proceed.

919.07.06 Removal of Formwork, Falsework, and Temporary Supports

All formwork and falsework shall be removed, and removals shall not damage the concrete. If the top of a pile used for falsework is 1.2 m below the finished grade or ground level, or is at least 0.6 m below a streambed, a request may be made in writing to the Contract Administrator to leave it in place.

The method and sequence of removal of the formwork and falsework shall be such that it permits the concrete to take up the stresses gradually.

Falsework shall not be removed from post-tensioned structures until the post-tensioning is completed.

When a component is not post-tensioned, falsework may be removed after the concrete has attained a minimum strength of 20 MPa.

Formwork shall not be removed until the concrete has attained a minimum strength of 20 MPa, except for the following:

- a) Formwork for structure concrete barrier wall, concrete parapet wall, curb and sidewalk on the deck shall be removed within 24 hours after completion of the concrete placement; and

- b) Vertical formwork for approach slabs, deck fascia, and footings may be removed 24 hours or more after concrete placement.

Following the removal of formwork, curing must be applied and maintained according to the Contract Documents. Early loading of structural concrete must be as specified in the Contract Documents.

Where insulation is used, the side forms may be slackened off 24 hours after concrete placement to help control temperature.

Removal of temporary supports shall be as specified in the Contract Documents.

919.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

919.10 BASIS OF PAYMENT

919.10.01 Formwork and Falsework

The Contract price for the concrete tender item directly associated with formwork and falsework shall include full compensation for all labour, Equipment, and Material to do the work.

919.10.02 Temporary Support - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the Work.

TABLE 1
Concrete Face and Plywood Properties

Size of Permitted Abrupt or Gradual Irregularities in Formed Surfaces				
Class of Concrete Surface	A	B	C	D
Tolerance	3 mm	6 mm	13 mm	25 mm
Standard for Test	Tested according to the Surface Tolerance clause of OPSS 904 except that the length of measure for the straight edge shall be 1.5 m.			
Minimum Plywood Face Veneer Grade for Class of Formed Surface (Typical)				
Douglas Fir	B	C face	C face	C
Canadian Softwood	B	C face	C face	C
Poplar	B	Select	Select	C



**CONSTRUCTION SPECIFICATION FOR DECK JOINT ASSEMBLIES,
PREFORMED SEALS, JOINT FILLERS,
AND JOINT SEALING COMPOUNDS - STRUCTURES**

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920.10	BASIS OF PAYMENT

920.01 SCOPE

This specification covers the requirements for the installation and modification of deck joint assemblies and the placing of preformed seals, joint fillers, and joint sealing compounds.

920.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
OPSS 928	Structure Rehabilitation-Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation-Concrete Patches, Refacing, and Overlays

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
OPSS 1204	Polyvinyl Chloride Waterstops
OPSS 1210	Deck Joint Assemblies
OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1302	Water
OPSS 1308	Joint Filler In Concrete
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Laboratory Testing Manual:

LS-407 Method of Test for Compressive Strength of Moulded Cylinders

CSA Standards

W47.1-09 (R2014)	Certification of Companies for Fusion Welding of Steel
W59-18	Welded Steel Construction (Metal Arc Welding)
W186-M1990 (R2012)	Welding of Reinforcing bars in Reinforced Concrete Construction

920.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Armouring Angle means the expansion joint angle at the gap.

Bearing means a structural device that transmits load while permitting translation or rotation or both.

Blockout means a cavity created to permit the installation of deck joint assemblies.

Elastomer means a compound containing virgin polychloroprene (neoprene).

Joint Seal means ethyl vinyl acetate foam.

Joint Sealing Compound means a hot applied material, which is not preformed, used to seal a joint.

Nosing Angle means the angle that forms the outside edges of the blockout.

Preformed Seal means an extruded elastomer that, when retained in recesses in the deck joint assembly, prevents the passage of water and other materials.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

Trial Installation means an installation designated by the Owner for the purpose of proving the performance of a particular joint system.

Upturn means an upward vertical change in direction of the seal at the gutter lines.

920.04 DESIGN AND SUBMISSION REQUIREMENTS

920.04.01 Submission Requirements

920.04.01.01 Notice of Manufacturer

Within 30 Days of the Contract award, the name and address of the manufacturer of the deck joint assembly shall be submitted in writing to the Contract Administrator.

920.04.01.02 Deck Joint Assembly Working Drawings

920.04.01.02.01 General

Prior to commencement of fabrication of the deck joint assembly, one hardcopy set and one electronic PDF copy of deck joint assembly Working Drawings, shall be submitted to the Contract Administrator for information purposes. An Engineer shall affix their seal and signature on the Working Drawings verifying that the drawings are consistent with the Contract Documents and product drawings.

A sealed and signed copy of these drawings shall be kept at the manufacturing plant during the joint assembly fabrication and at the site prior to and during installation of the deck joint assembly.

920.04.01.02.02 Modular Expansion Joints

In addition to the general requirements for modular expansion joints, the deck joint assembly Working Drawings shall also bear the seal and signature of a design-checking Engineer. The deck joint assembly manufacturer shall submit the approved product drawings along with the Working Drawings.

The product drawings shall specify all material properties, dimensions, connection attachments, injection hose system, splices, fasteners and accessories, and the individual alphanumeric identification numbers. The product drawings for modular joints shall bear the seal and signature of an Engineer.

920.04.01.02.03 Drawing Content

The deck joint assembly Working Drawings shall clearly indicate the following:

- a) Material properties.
- b) Dimensions, including total joint length, skew angles, crossfalls (measured along skew angle), and overall lengths between all breakpoints.
- c) Connection attachments.
- d) Injection hose system components and name of approved injection company.
- e) Shop, field, and stage construction splices when applicable.
- f) Fasteners and accessories.
- g) Installation details.
- h) Individual alphanumeric identification number for each stage of installation.
- i) Handling procedures including lifting points.
- j) Manufacturer's installation procedure

- k) Turn-of-nut procedure specified in the Contract Documents for achieving the required bolt pretension.
- l) For modular joints, the stiffness of the mechanism shall be shown on the Working Drawings.

920.04.01.02.04 Deck Joint Assembly Modification

In addition to the requirements of the previous clause, the deck joint assembly Working Drawings shall show all connection details between the new and the existing deck joint assemblies and all other modifications.

920.04.01.03 Field Dimensions

Prior to the commencement of fabrication of the deck joint assembly, a drawing showing the actual joint dimensions at the existing deck joint assembly locations shall be submitted to the Contract Administrator.

920.04.01.04 Cold Weather Protection for Epoxy Injection

Seven Days prior to the commencement of epoxy injection of the deck joint assembly in cold weather, a description of the method to be used to control the concrete temperature shall be submitted to the Contract Administrator. The submission shall be accompanied by samples of insulation when requested by the Contract Administrator. The description shall contain the following information:

- a) Weather conditions for which the description applies.
- b) Type of insulation, metric R value, and number of layers to be used.
- c) Description of housing and heating.
- d) Method of protection employed to effectively maintain the concrete temperature above 5 °C in the expansion joint blockout during the injection and continuously for a period of 48 hours after epoxy injection.

920.04.01.05 Inspection After the Fabrication of Expansion Joints

A Manufacturer's Certificate of Conformance and a Request to Proceed shall be submitted to the Contract Administrator upon completion of the fabrication of the expansion joint and prior to shipping from the plant.

The expansion joint shall not be delivered from the plant until the Contract Administrator has received the Manufacturer's Certificate of Conformance, Request to Proceed, and issued a Notice to Proceed.

920.04.01.06 Concrete Mix Design

A mix design shall be submitted according to OPSS 1350 for concrete in deck joint assemblies.

920.05 MATERIALS

920.05.01 Anti-seize Compound

Anti-seize compound shall be according to OPSS 1210.

920.05.02 Concrete

Concrete in which the deck joint assemblies are embedded shall be according to the Materials section of OPSS 1350, except that for sliding plate and modular deck joint assemblies the nominal maximum size of coarse aggregate for concrete shall be 13.2 mm.

920.05.03 Deck Joint Assemblies

Deck joint assemblies shall be according to OPSS 1210.

920.05.04 Granular A

Granular A shall be according to OPSS 1010.

920.05.05 Joint Fillers

Joint fillers shall be according to OPSS 1308.

920.05.06 Joint Sealing Compounds

Joint sealing compounds shall be according to OPSS 1212.

920.05.07 Lubricant

The lubricant shall be water soluble, non-adhesive, and non-staining. Lubricants used between the steel components and preformed seals shall not be deleterious to the joint materials or the surrounding concrete.

920.05.08 Preformed Seals

Preformed seals shall be according to OPSS 1210. Preformed seals shall have a manufacture date less than two years at the time of installation.

920.05.09 Water

Water used for curing shall be according to OPSS 1302.

920.05.10 Waterstops

Waterstops shall be according to OPSS 1204.

920.07 CONSTRUCTION

920.07.01 Operational Constraints

During construction, joints shall be protected from chloride ingress during winter weather, extending from November 1 to April 15, by the installation of a temporary joint seal meeting the requirements of this specification.

920.07.02 Installation of Deck Joint Assemblies

920.07.02.01 General

Concrete work shall be according to OPSS 904, except as specified herein.

The plastic concrete shall be sampled and tested for slump, plastic air content and temperature according to the Materials Sampling and Testing section of OPSS 1350.

Deck joint assemblies shall be installed according to the deck joint assembly Working Drawings. When a deck joint assembly requires an expansion joint drainage system, it shall be installed as specified in the Contract Documents.

Any damage to the galvanic corrosion protection coating system, including surface areas of field welds, shall be repaired with two coats of brush applied zinc-rich touch-up coating applied according to the coating manufacturer's recommendations.

The threaded portion of the bolts and the underside of bolt heads shall be liberally coated with anti-seize compound immediately prior to installation.

The bolts that have been fully tensioned and require removal after final installation shall not be reused to fasten the clamping bars.

For modular expansion joint installations, the manufacturer's representative shall be present on site during the installation to ensure proper installation. The representative shall review the modular joint after it is placed and prior to concreting.

920.07.02.01 Traffic Restrictions

Traffic, including construction traffic, shall not be permitted on any part of each stage of the deck joint assembly until all of the following conditions are met:

- a) Concrete has attained a minimum compressive strength of 25 MPa. Early strength determination of concrete compressive strength shall be according to OPSS 904.
- b) Epoxy injection has been completed.
- c) Epoxy has cured for a minimum of 24 hours.
- d) For cold weather, epoxy has cured for 48 hours after epoxy injection or the curing time as specified in the manufacturer's data sheet, whichever is longer.
- e) For Type A joints, the clamping bars have been installed.

920.07.02.02 Protection

The deck joint assembly shall be lifted by nylon slings placed at the lifting points indicated on the deck joint assembly Working Drawings.

During storage, the deck joint assembly shall be protected from dirt and deleterious materials and stored so that distortion cannot occur. The deck joint assembly shall be supported on wood blocking spaced a maximum of 2 m apart.

Preformed seals storage and handling requirements shall be according to the manufacturer's recommendations.

920.07.02.03 Splicing

The location and number of field and stage construction splices and method of splicing of metal components shall be as detailed on the deck joint assembly Working Drawings. For new construction, where the length of the expansion joint is greater than 15 m and a splice is required, a splice shall be located at a lane demarcation line near the centreline of the structure.

Field splicing of modular joints shall not be permitted.

The preformed seal shall be continuous with no splices.

920.07.02.04 Welding

Field welding of structural steel shall be according to CSA W59 by a company certified to CSA W47.1, Division 1 or 2. Any welding of reinforcing steel shall meet CSA W186 requirements.

920.07.02.05 Drilling and Preparation of Holes

The edge of drilled holes shall not be permitted within 70 mm of a concrete edge.

920.07.02.06 Placing

920.07.02.06.01 General Requirements

The deck joint assemblies shall be placed as specified in the Contract Documents.

The deck shall be waterproofed according to OPSS 914.

Concrete faces of the blockout shall be abrasive blast cleaned according to OPSS 929. Any existing reinforcing steel to be retained as part of a rehabilitation shall also be abrasive blast cleaned according to OPSS 929.

Immediately prior to placing concrete, top setting devices shall be adjusted to give the setting width as specified in the Working Drawings.

Setting devices shall be tightened and the deck joint assembly secured at the correct width, line and grade by welding the loop anchors and stud anchors to the steel reinforcement at a spacing of approximately 500 mm on centre. Any welding of reinforcing steel shall meet CSA W186 requirements.

Concrete shall be placed in the blockout, no later than 48 hours after the blockout surfaces have been abrasive blast cleaned. All concrete surfaces to receive concrete shall be maintained in a wet condition for a period of one hour prior to placing any new concrete. Immediately prior to wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air. Prior to placing concrete, excess water shall be removed from the surface using compressed air.

Concrete shall be placed and consolidated to minimize voids under the deck joint assembly and shall be hand-finished with a wooden float. All steel surfaces that are going to be in contact with the preformed seal shall be protected during concrete placement.

Exposed faces of the structural steel shapes shall be cleaned to remove any concrete and deleterious material.

The setting devices shall be flame cut at the gap between two to four hours after concrete placement. The setting device boltholes for all nosing angles, as well as for the armouring angles, of the joints shall be drilled to a depth of 20 mm, air blast cleaned, and filled with epoxy. All dust, debris, water, and any other foreign materials must be removed from boltholes immediately prior to filling it with epoxy.

920.07.02.06.02 Joint Installation After Asphalt Paving

When specified in the Contract Documents, concrete shall be removed to prepare the blockout. Where new barrier or parapet walls are to be constructed, bulkheads shall be used to form blockouts. Steel reinforcement shall be placed in the blockout, as specified in the Contract Documents.

Prior to filling the blockout, the expansion joint gap shall be plugged to support the material placed in the blockout. The method used to plug the gap shall accommodate the anticipated movement of the structure and retain the blockout material until the joint is to be placed. Granular A shall be used to fill the blockout and then be compacted to 100% of the maximum dry density according to OPSS 501. Granular A shall be placed as follows:

- a) When only construction vehicles and equipment are going to use the bridge and cross over the blockout prior to asphalt paving, the Granular A shall be placed from the top of the plug up to a height that is level with the top of the adjacent concrete.
- b) When traffic is to be maintained on the bridge and cross over the blockout prior to asphalt paving, the Granular A shall be capped with 50 mm of cold mix or hot mix asphalt placed level with the top of the adjacent concrete. The top surface of the asphalt shall be maintained smooth and level with adjacent concrete and shall not ravel.

Prior to asphalt paving, the limits of the blockout shall be accurately marked and the markings shall be visible after paving so that the joint limits may be accurately identified.

The paving operation shall be continuous over the area from 20 m beyond the approach slab, across the bridge to 20 m beyond the end of approach slab of the opposite end. The asphalt pavement at the limits of blockout shall be sawcut full depth and the asphalt above the blockout shall be removed.

The saw-cut asphalt edges shall be adequately protected for the full depth of asphalt. Wood angles with a minimum thickness of 19 mm shall be considered a minimum requirement.

All the material used to fill the blockout and to plug the expansion gap, including any supports or bracing, shall be removed to the depth of the bearing seat. Asphalt residue shall be cleaned from the steel reinforcement.

Reinforcing steel in the blockout shall be checked to ensure that it is not damaged. Damaged reinforcing steel shall be removed from the blockout and replaced with new reinforcing steel.

The deck joint assembly shall be placed in the blockout 3 mm below the elevation of asphalt pavement and in the position specified in the deck joint assembly Working Drawings.

After installation of the deck joint assemblies, a 20 mm wide groove shall be saw cut for the full depth of asphalt adjacent to each steel-nosing angle. If the previously saw cut face is undamaged and within 5 mm of the specified location, the groove may be formed. The grooves shall be cleaned, dried, and filled with hot poured rubberized joint sealing compound according to OPSS 914.

920.07.02.06.03 Joint Installation Prior to Asphalt Paving

Concrete shall be removed to prepare the blockout, as required. The blockout shall be formed to the lines and grades specified in the Contract Documents. Where new barrier or parapet walls are to be constructed, bulkheads shall be used to form blockouts. The dimensions of the blockout in the barrier or parapet wall shall not be greater than those of the blockout in the deck and ballast wall, except for the modular joints in structures. Steel reinforcement shall be placed as specified in the Contract Documents.

The top of formwork shall be set such that the top of the deck joint assembly is placed at the proposed top-of-asphalt elevations.

The joint assembly shall be placed in the blockout at the correct elevation and location.

Waterproofing membrane shall extend 50 mm up the vertical face of the nosing angle of the deck joint assembly.

The final top of asphalt elevation immediately adjacent to the deck joint assemblies shall be 5 mm higher than the assembly, and shall taper to 0 mm over a distance of 1.0 m.

920.07.02.07 Concrete Curing

Curing of concrete for Type A and C deck joint assemblies shall be according to OPSS 904.

Curing of concrete for sliding plate and modular deck joint assemblies shall be according to OPSS 904 with the exception that the moist curing period shall be seven Days.

920.07.02.08 Epoxy Injection

920.07.02.08.01 General

Epoxy shall be injected into the injection hose system once concrete in the expansion joint blockouts has reached a minimum compressive strength of 25 MPa and curing of concrete has been completed. Early strength determination of concrete compressive strength shall be according to OPSS 904.

The epoxy shall be kept at a temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ prior to its use.

The concrete surfaces shall be clean and dry prior to epoxy injection.

920.07.02.08.02 Injection Method

Only the supplier of the expansion joint system or an agent approved by the supplier shall inject the epoxy used in the injection hose system.

Epoxy shall be mixed and pressure injected according to the manufacturer's specifications.

Injection shall start at the injection fitting at one end of a 2 m section of hose to initially fill the hose and continue until the epoxy discharges from the other injection fitting of the same section. Injection shall then alternate at both fittings of the same section until the epoxy emanates from the voids in the concrete or at the interface between the steel angles and concrete or both. The injection fittings shall then be plugged.

If the epoxy injection pressure is held at 50 kPa for at least 60 seconds without having epoxy discharge from the other injection fitting, the section shall be considered sufficiently injected.

The above procedure shall be repeated in each section of hose until the full length of the expansion joint system has been filled with epoxy. The top surface of the blockout shall be thoroughly cleaned to remove any excess epoxy prior to hardening.

After the epoxy has set, all adapters and injection fittings shall be removed and the ends of each hose shall be filled with epoxy.

The deck joint assembly shall be checked for voids remaining under the angles. Holes shall be drilled in angles where voids are detected and voids and boltholes shall be filled with epoxy.

920.07.02.08.03 Cold Weather Epoxy Injection Requirements

Epoxy injection shall not be performed without protection when the ambient air temperature at the time of injection is below 10 °C or is likely to fall below 5 °C within 24 hours immediately following the epoxy injection.

When the epoxy injection is to be performed under cold weather conditions, the temperature of the concrete in the expansion joint blockout shall be a minimum of 10 °C prior to the commencement of the injection. The temperature shall be maintained at a minimum of 10 °C for a period of 24 hours after injection or the curing time as specified in the manufacturer's data sheet.

920.07.03 Modification of Deck Joint Assemblies

The requirements of the Installation of Deck Joint Assemblies subsection shall apply.

Where a new joint assembly is to be welded to existing hardware, the surface of the existing hardware that is going to be in contact with the new joint assembly shall be abrasive blast cleaned according to OPSS 929.

920.07.04 Repair of Existing Deck Joints

Repair of existing deck joint assemblies shall be according to the Installation of Deck Joint Assemblies and the Modification of Deck Joint Assemblies subsections and as specified in the Contract Documents.

When required, repairs to existing concrete within the blockout shall be as directed by the Contract Administrator. Concrete removal and repairs shall be according to OPSS 928 and OPSS 930.

920.07.05 Field Installation of Preformed Seals and Bolted Components

Preformed seals shall be installed with lubricant in one continuous piece.

Prior to installation of the preformed seal, all steel surfaces in contact with the preformed seal shall be cleaned and the gap completely clear for its full length and width to the depth of the bearing seat. The preformed seal and bolted components shall be installed according to the deck joint assembly Working Drawings. Adhesives and sealants shall not be used.

920.07.06 Placing Joint Fillers

Joint fillers shall be firmly fixed in position before any concrete is placed so that their final position in the concrete remains as shown in the Contract Documents and are true to line and grade.

920.07.07 Placing Joint Sealing Compounds

920.07.07.01 Preparation of Joint

Concrete at all joints shall be sound, clean, dry, and free of all dust, debris, and deleterious material.

920.07.07.02 Placing Hot Poured Rubberized Asphalt Joint Sealing Compounds

Hot poured rubberized asphalt joint sealing compound shall be installed according to OPSS 914 except that the temperature of the air and the materials that is going to be in contact with the sealing compound shall be 2 °C or greater at the time of installation.

920.07.08 Trial Installations

Only deck joint assemblies pre-approved for trial installation by the Owner shall be used. The installation procedures shall be according to the manufacturer's detailed instructions, the Contract Documents, and this specification.

920.07.09 Corrective Work

All defects or deficiencies identified in the Acceptance of Deck Joint Assembly subsection shall be repaired according to the requirements of this specification and to the satisfaction of the Contract Administrator.

920.07.10 Sampling for Quality Assurance Testing

920.07.10.01 Preformed Seal

Preformed seal samples shall be taken from the extra length of preformed seal supplied for each joint delivered to the Working Area.

The extra 1 m length of preformed seal shall be cut and supplied according to OPSS 1210, in the presence of the Contract Administrator. The sample must be stamped with the name of the manufacturer, product identification, the lot and the date of manufacture.

From time of sampling and through shipping, the seal shall be stored at a temperature between 10 and 50 °C and shall not be exposed to ultraviolet rays. The seal shall be placed in an opaque container or bag in the presence of the Contract Administrator and sealed and labeled immediately. The label shall have the fabrication company name, seal type, Contract number, lot, and location clearly marked.

The seal shall be delivered by the Contract Administrator to:

Head, Concrete Section
145 Sir William Hearst Avenue, Room 15
Downsview, Ontario, M3M 0B6

920.07.10.02 Concrete Compressive Strength, Air Void System and Rapid Chloride Permeability

Cylinders shall be cast, cured and transported for compressive strength, air void system and rapid chloride permeability. Testing shall be performed by the Owner according to the Materials Sampling and Testing section of OPSS 1350 with the following exceptions and additions:

- a) A lot shall be all the concrete placed in the expansion joints in one bridge in one day.
- b) One set of three 100 mm diameter x 200 mm long cylinders shall be cast for acceptance testing of 28-day compressive strength for each lot. Every time a set of acceptance cylinders is cast, a second set of cylinders shall be cast for referee testing purposes.
- c) One 100 mm diameter x 200 mm long cylinder shall be cast for evaluation of air void system parameters for each lot.
- d) One 100 mm diameter x 200 mm long cylinder shall be cast for acceptance testing of rapid chloride permeability for each lot. Every time an acceptance cylinder is cast, a second cylinder shall be cast for referee testing purposes.

920.07.11 Expansion Joint Water Test Preparation

After the epoxy has set and before acceptance, the joint shall be water tested. The Contract Administrator shall evaluate the expansion joint water test. The joint shall be tested over its entire length where there are no upturns. Where there are upturns, the joint shall be tested between the gutter lines. The water shall be continuously ponded for a minimum of one hour, maintaining a minimum depth of 25 mm along the tested length and a minimum depth of 100 mm above the deck joint assembly at the gutter lines. For superelevated decks, only the lower gutter line requires the testing at a depth of 100 mm. The width shall extend 50 mm beyond the concrete dams on both sides of the deck joint assembly. When the staging of traffic is required, the joint shall be tested in overlapping sections.

The air, concrete, and deck joint assembly temperature shall be 2 °C or higher at time of testing. The water test and any related corrective work shall be completed prior to any seasonal shutdowns. Where this is not feasible, a proposal detailing an alternative solution shall be submitted to the Contractor Administrator for approval.

For expansion joints installed at the ends of approach slabs, the expansion joint water test shall not be required.

920.07.12 Inspection After Installation of the Expansion Joints

A Request to Proceed shall be submitted to the Contract Administrator after the installation of the expansion joint.

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

920.07.13 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

920.08 QUALITY ASSURANCE

920.08.01 Acceptance of the Preformed Seal

Each preformed seal sample shall be tested according to Table 1 of OPSS 1210 by the Owner. Preformed seals shall be acceptable if the sample tested meets the requirements of OPSS 1210. Unacceptable preformed seals shall be removed and replaced at no additional cost to the Owner. Preformed seals with a date of manufacture of more than two years earlier than the date of sampling shall not be accepted.

A defective seal constitutes grounds for rejection of other seals from the same lot identified by the marking on the seal, within the same Contract.

920.08.01.01 Referee testing

A written request may be made for referee testing of any sample within five Business Days of receiving notification of rejection of the seal. The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in rejection of the seal, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

920.08.02 Acceptance of Concrete Compressive Strength

Compressive strength shall be determined according to LS-407.

The compressive strength result of a lot shall be the average of the set of three acceptance cylinders representing the lot, rounded to one decimal place.

The individual test results shall be forwarded to the Contractor, as they become available.

Concrete compressive strength for the lot shall be considered acceptable when it meets all of the following:

- a) The average compressive strength tests shall be equal to or greater than the specified strength.
- b) No individual strength test shall be more than 4.0 MPa below the specified strength.

Unacceptable lots shall be removed and replaced.

920.08.02.01 Referee Testing

Referee testing and referee testing cost for concrete compressive strength shall be according to OPSS 1350.

920.08.03 Acceptance of Air Void System in Hardened Concrete

Acceptance of air void system, including referee testing, shall be according to OPSS 1350 with the following exceptions:

- a) The lot size shall be according to this specification.
- b) One cylinder is tested per lot rather than cores. All references to cores in the Acceptance of Air Void System in Hardened Concrete of OPSS 1350 are replaced by cylinder.

920.08.04 Acceptance of Rapid Chloride Permeability

Acceptance of rapid chloride permeability, including referee testing, shall be according to OPSS 1350 with the following exceptions:

- a) The lot size shall be according to this specification.
- b) One cylinder is tested per lot rather than cores. All references to cores in the Acceptance of Rapid Chloride Permeability of OPSS 1350 are replaced by cylinder.

920.08.05 Acceptance of Expansion Joint Water Test

The deck joint assembly shall be acceptable if there is no leakage of water. Leakage of water through the deck joint assembly during this test, including the interface between the preformed seal and the seal retainers, concrete to steel interfaces, and the concrete construction joints, shall constitute failure of the deck joint assembly.

If such failure occurs, the deck joint assembly is to be repaired or replaced and the water test repeated. The method of repair shall be submitted in writing to the Contract Administrator for review prior to commencement of repair work.

920.08.06 Acceptance of Deck Joint Assembly

On completion of the deck joint assembly installation, the assembly shall be free of the following defects or deficiencies:

- a) Defective preformed seals.

- b) Cracks wider than 0.3 mm and voids in concrete end dams.
- c) Defective coating.
- d) Seal not completely held in retainer.
- e) Turn-of-nut procedure for bolt installation not followed.
- f) Defective, loose, or missing structural components and welds.
- g) A line parallel to the centreline of the structure joining the tops of all steel components of the deck joint assembly that deviates from a line parallel to the pavement profile between nosing angles by more than 3 mm, at any location along the length of the expansion joint.
- h) For modular joints, at any location along the length of the deck joint assembly, the relative difference in the opening between the steel retainers exceeds the narrowest width by 6 mm. This dimension shall be measured at the level of the road surface, perpendicular to the centreline of the expansion joint, and at the inner faces of the retainers.
- i) Any portion of the deck joint assembly is extending above the finished road surface.

For expansion joints installed at the ends of approach slabs, joints will be accepted based on visual acceptance by the Contract Administrator to verify seal integrity and retention.

920.10 BASIS OF PAYMENT

920.10.01 Deck Joint Assemblies, Installation - Item Deck Joint Assemblies, Modification - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

920.10.02 Repair of Existing Deck Joints - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When the repairs are not specified in the Contract Documents, payment for the cost of repairing existing deck joints and of repairing concrete prior to the installation of deck joint assemblies or preformed seals in existing structures shall be administered as a Change in the Work.

920.10.03 Repairs of Defects and Deficiencies

Repair of defects or deficiencies identified during the inspection for acceptance of deck joint assemblies shall be completed with no additional cost to the Owner.

920.10.04 Preformed Seals, Joint Fillers, and Joint Sealing Compounds

Payment for the tender items in which preformed seals, joint fillers, and joint sealing compounds are placed shall include full compensation for all labour, Equipment, and Material to do the work of placing these materials.



CONSTRUCTION SPECIFICATION FOR JACKING OF BRIDGE SUPERSTRUCTURE

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921.01 SCOPE

This specification covers the requirements for raising and lowering a bridge superstructure by using hydraulic jacks.

921.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 906	Structural Steel for Bridges
OPSS 919	Formwork and Falsework
OPSS 922	Installation of Bearings

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

ASTM International

A563M-15	Standard Specification for Carbon and Alloy Steel Nuts
F3125M-15a	Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 830MPa and 1040MPa Minimum Tensile Strength [Metric]
F436M-16	Standard Specification for Hardened Steel Washers

921.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Jacking Design Engineer means the Engineer retained by the Contractor who performs the design of the jacking system and related work.

Jacking Design Checking Engineer means the Engineer retained by the Contractor who performs the design check of the jacking design Engineer's work.

Jacking System means all components required to perform the lifting and temporary support of the bridge superstructure. This includes but is not limited to; jacks, hydraulic hoses and fluid, valves, sensors, jacking systems, shims, temporary support systems, and all related appurtenances.

Survey means precise and detailed measurements and elevations taken, recorded, documented and certified by an Ontario Land Surveyor or an Engineer.

921.04 DESIGN AND SUBMISSION REQUIREMENTS

921.04.01 Design Requirements

921.04.01.01 General

A detailed jacking system shall be designed and provided to do the work by a jacking design Engineer and checked by a jacking design checking Engineer, unless a detailed jacking system is provided in the Contract Documents. The jacking design Engineer and jacking design checking Engineer shall have knowledge in the design of bridge jacking systems, and proven experience in recent projects of similar complexity. Both Engineers shall be capable of certifying that the provided jacking equipment and jacking methodologies will facilitate the jacking and lowering of the bridge shall be according to the Contract Documents.

When specific requirements for the jacking system are provided in the Contract Documents, they shall be incorporated into the design of the jacking system.

When jacking locations are provided in the Contract Documents, they shall be incorporated into the design of the Contractor's proposed jacking system and shall not be changed.

Where the replacement of bearings is specified in the Contract Documents, the design shall consider the possible difference in bearings size between the new and the original and ensure that the placement of the temporary supports does not interfere with the proper placing of bearings.

The design shall account for the structural work and condition of the structure at the time of jacking, and the stages that may interfere with temporary supports or jacking locations. It shall consider any deterioration and/or removals prior to and during the duration of the jacking and remedial work. The design of temporary supports shall account for articulation of the superstructure including thermal movements, as well as any potential slip in supports. Jack and support locations shall account for conflicts between structural work and temporary works designed by the contractor.

The amount of pre-loading to be applied to the jacks prior to the start of displacement controlled jacking shall be specified. The pre-loading amount shall be no less than 15% of the specified jacking load and shall be sufficient to account for decompression of bearings, gaps between shims (if used) and any other geometric imperfections in the proposed jacking system.

Temporary supports, including shims and blocking, used to support the jacks shall be designed for no less than 150% of the jacking loads specified on the Contract Drawings.

921.04.01.02 Jacking Corbels

The design of temporary jacking corbels anchored into substructure elements shall consider the non-uniform distribution of load between anchors when the system is not pre-tensioned and relies on tension or the combined bearing and shear resistance of the anchors.

921.04.01.02 Temporary Supports

Temporary Supports shall be designed according to OPSS 919 and the requirements of this specification.

921.04.02 Submission Requirements

921.04.02.01 Jacking Drawings and Calculations

Three sets of the jacking drawings and calculations and a digital PDF format copy shall be submitted to the Contract Administrator seven Days prior to the commencement of the jacking operations, for information purposes only. Submissions shall bear the seals and signatures of the jacking design Engineer and the jacking design checking Engineer.

The jacking drawings and calculations shall include the following:

- a) Jacking methodology and sequence.
- b) Location, number, type and capacity of the jacks to be used.
- c) Description of the control system, complete with all design, schematics and equipment to be used.
- d) Location and material to be used for temporary blocking and shimming.
- e) Proposed pre-loading to be applied to jacks.
- f) Schematic showing the configuration of all jacks, stop valves, gauges, manifolds and hydraulic pumps.
- g) Calibration certificates for all jacks, gauges, and lifting/lowering controller, issued within 12 months from when the equipment is to be used.
- h) Full details of the temporary support system including forces to be transmitted and method of transferring the loads to the substructure or founding strata, including considerations for thermal expansion and contraction.
- i) Restrictions on traffic and construction traffic.

A copy of the signed and sealed jacking drawings shall be kept at the site during jacking setup and operations.

921.04.02.02 Revised Submissions

When jacking design considerations or field conditions necessitate amendments to the jacking drawings, revised jacking drawings shall be submitted according to the Jacking Drawings and Calculations clause.

921.05 MATERIALS

921.05.01 General

Temporary supports shall be structural steel or concrete according to OPSS 919.

When jacks with locking collars are used as temporary supports, they shall be unmodified and as supplied by the manufacturer.

921.05.02 Mechanical and/or Adhesive Anchors

Mechanical and/or adhesive anchors shall be suitable for dynamic loads and shall be installed according to the manufacturer's recommendations.

921.05.03 Grout

Grout used for the jacking system that will remain as part of the permanent structure shall be cement based, non-shrink, non-staining, and shall be supplied from a source named on the ministry's DSM. Grout shall have a minimum 7-day compressive strength of 35 MPa.

921.06 EQUIPMENT

921.06.01 Synchronized Jacking System

A synchronized jacking system shall consist of either a Programmable Logic Controller (PLC) controlled system or a volumetric controlled system. The system shall be capable of adjusting pressures and hydraulic volumes in order to achieve a uniform lift and/or lowering to a tolerance of less than or equal to 1.5 mm from the leading to lagging cylinders.

921.06.01.01 Programmable Logic Controlled Jacking System

A PLC controlled system shall include a central unit which continuously monitors the relative and absolute position of each individual jacking point.

921.06.01.02 Volumetric Controlled Jacking System

A volumetric controlled jacking system shall be fully calibrated and designed to precisely deliver the same volume of hydraulic oil to each individual jack at the same time. The same make and model of jacks shall be used at all locations.

921.06.02 Displacement Sensors

The synchronized jacking system shall display real-time data for each jack location showing vertical displacement and hydraulic pressure for monitoring purposes during the jacking operation. The data shall be automatically recorded at one second intervals during active lifting and lowering operations in a data log file for the entire duration of the jacking/lowering operation(s) and only shall cease after the bridge is firmly on the temporary supports or permanent bearings. The data interval may be increased to 10 seconds when the bridge is resting on the pressurized hydraulic component of the system, and not being actively lifted or lowered.

Digital displacement sensors or linear transducers shall be installed at all locations where a jack is placed. Multiple jacks may be represented by a single displacement sensor when all of the following conditions are met:

- a) All jack centrelines are within 1000 mm of each other.
- b) Each jack in the group is in contact with the same structural element.
- c) The structural element is continuous between all jacks within a group, and not separated by any structural discontinuities or abrupt changes in stiffness (such as a bolted connection).
- d) All jacks within a group receive an equal pressure for programmable logic controlled jacking systems, or the same amount of hydraulic fluid for volumetric controlled jacking systems.

Digital displacement sensors or linear transducers shall be accurate to 0.1 mm to monitor displacements. The displacement sensors can be either integrated into the jacking system or independently monitored such that displacement sensors, stroke sensors or calibrated volumetric control system is capable of achieving the relative lift/lowering tolerances specified in the Contract Documents. For jacks supported on temporary fixtures (such as jacking corbels), independent displacement sensors shall be used, and measurements shall be made relative to a fixed location on the adjacent bearing seat.

A data log file shall be submitted to the Contract Administrator within seven days of any jacking operation in Microsoft Excel format (or approved equivalent). Data log file format is to be in a table with individual columns representing each displacement sensor reading in millimetres, hydraulic pressure applied to the jack (or group of jacks), and applied force at each jack (or group of jacks). Data for applied force may be provided using applied pressure to each jack and the area of the jack's piston. Individual rows shall represent the time in Hr:Min:Sec format.

921.07 CONSTRUCTION

921.07.01 Pre-Condition Surveys

Prior to the start of any work related to the jacking operation, field measurements shall be taken of all components of the existing structure that might impact the installation of the jacking system. The jacking design Engineer and the jacking design checking Engineer shall determine whether any adjustments to the jacking system based on the field measurements. When adjustments to the jacking drawings and calculations are required, the jacking drawings and calculations shall be resubmitted to the Contract Administrator along with a request for approval.

Measurements of the underside of deck or girders at bearing locations prior to jacking the structure shall be made taken relative to an adjacent fixed point on the substructure which will not move during construction. This shall include a minimum of one local fixed marking on the abutment or pier immediately adjacent to each lift point and bearing location. This marking must be located such that it will not be moved or compromised by the Work. Measurements to the underside of each girder and lifting point shall be made relative to the corresponding fixed marking, which shall be recorded accurate to 1 mm.

Measurements shall be submitted to the Contract Administrator prior to jacking.

921.07.01.01 Detailed Survey

A detailed, geodetic survey of the deck top is not required prior to jacking, unless specified in the Contract Documents.

921.07.02 Structural Steel

All structural steel fabrication, delivery and erection shall be according to OPSS 906.

921.07.03 Formwork and Falsework

All formwork and falsework shall be according to OPSS 919.

921.07.04 Installation of Bearings

When jacking is required for the installation, replacement or adjustment of bearings, the requirements shall be according to OPSS 922.

921.07.05 Jacking

921.07.05.01 General

All end components of the bridge deck, such as expansion joints and railing systems, shall be free to move vertically prior to jacking. Bolts securing the handrail posts to the parapet walls, if present, shall be loosened to permit jacking without damaging the handrails.

Upon completion of the fabrication and installation of the components of the temporary works and prior to jacking, the jacking design Engineer or jacking design checking Engineer shall conduct an inspection to verify that the fabrication and installation of the temporary works has been carried out according to the jacking drawings.

Traffic shall not be permitted on or below the bridge during the jacking operation, unless specified in the Contract Documents.

921.07.05.02 Jacking Points and Loads

Jacks shall only be placed at the jacking points specified in the Contract Documents. Jacks with a rated capacity of no less than 150% of the jacking loads specified on the Contract Drawings shall be used.

At no point shall the applied jacking loads exceed 200% of the jacking loads specified on the Contract Drawings.

921.07.05.03 Inspection Prior to the Commencement of the Jacking Operation

A Certificate of Conformance shall be submitted to the Contract Administrator prior to commencing each jacking operation.

921.07.05.04 Jacking Operations

The Contract Administrator shall be informed in writing at least three Days prior to the commencement of the jacking operations.

The lifting or lowering of the entire width of the structure shall be carried out in one uniform and synchronized operation using a synchronized jacking system. At no time during the lifting or lowering of the structure, except during pre-loading of the system, shall the elevation difference between any displacement sensor exceed 1.5 mm.

Jacking operations shall be carried out under the direct supervision of the jacking design Engineer or the jacking design checking Engineer. Prior to the commencement of jacking operations, the accuracy of all transducer read-outs, relative to manual measurements shall be demonstrated to the Contract Administrator.

The lift and/or lowering at each jacking point shall be monitored continuously during the jacking operation from a centralized location by remote sensors or calibrated jacking system. The maximum lift for all jacking points shall be as specified in the Contract Documents. The minimum lift shall be 3 mm above the bearings once decompressed.

921.07.05.05 Temporary Supports

The bridge superstructure shall not be supported on pressurized hydraulic jacks for a period longer than permitted on the jacking drawings and shall never exceed 12 hours.

When the required lift for all jacking points has been achieved and the bearings have been released, temporary supports (such as blocking and shimming) shall be placed to support the bridge. The jacks shall then be lowered in one synchronized operation while maintaining the maximum allowable difference between any two jacking points of 1.5 mm.

The jacking loads shall be transferred to temporary supports prior to bearing removal, bearing seat reconstruction, or other related bearing replacement work.

Temporary supports shall be located at the jacking points or as specified in the Contract Documents.

The superstructure shall not be left on temporary supports for more than 30 Days or as specified in the Contract Documents.

921.07.05.05.01 Post-Jacking Survey

Immediately after the structure has been placed on temporary supports and prior to the bearing seats being reconstructed (if applicable), the underside of the superstructure that will be in contact with the new bearings shall be surveyed. The survey shall include the four corners in contact with the bearings and at least one point in the middle of the bearing area. Data from the survey shall be forwarded to the Contract Administrator to determine if adjustments to the design are required.

921.07.05.06 Lowering of the Superstructure

Where jacking of the superstructure is accompanied by rehabilitation of bearing seats, the superstructure may be jacked again for the removal of the temporary supports only after the concrete in the bearing seats has reached 75% of its design strength. The jacks shall then be lowered in one synchronized operation, while maintaining the maximum allowable difference between any two jacking points of 1.5 mm, and the superstructure shall be placed onto the bearings.

921.07.05.06.01 Bearing Contact

The bearings shall have uniform and full contact at top and bottom. The requirements for bearing full contact shall be according to OPSS 922. The jacking system shall remain in place until full contact of bearings is achieved.

921.07.05.07 Reinstatement of Structure and Components

The bridge deck and girders shall be reinstated to the original elevations unless new elevations are specified in the Contract Documents or as otherwise directed by the Contract Administrator.

When bearings are replaced, a final continuous and smooth riding surface across all joints, approaches, and adjacent spans shall be provided with a tolerance of 3 mm across each joint. The Contract Administrator shall be notified when existing conditions, information in the Contract Documents, or specific components will affect the ability to meet this requirement for further clarification or instruction.

Anchor holes shall be filled with non-shrink grout finished flush with the surrounding concrete. No metal components of the jacking system shall be embedded permanently in concrete with less than 40 mm of cover.

All expansion joint and handrail components removed or loosened to facilitate jacking shall be reinstated.

921.07.06 Inspection After Completion of the Jacking Operation

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of each jacking operation.

921.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

921.10 BASIS OF PAYMENT

921.10.01 Jacking of Superstructure - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Materials to do the work.



CONSTRUCTION SPECIFICATION FOR INSTALLATION OF BEARINGS

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922.01 SCOPE

This specification covers the construction requirements for the installation of bearings.

922.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 921	Jacking of Bridge Superstructure
OPSS 1202	Bearings - Elastomeric Plain and Steel Laminated
OPSS 1203	Bearings - Rotational and Sliding Surface

CSA Standards

A3004-C2	Test Method for Determination of Compressive Strengths*
	* Part of A3000 Cementitious Materials Compendium
S6-19	Canadian Highway Bridge Design Code

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

MTO Forms:

PH-CC-701 Request to Proceed
PH-CC-702 Notice to Proceed

922.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Anchor means a device employed to secure a bearing to the structure or to restrict movement of the structure or both.

Bearing means a structural device that transmits load while permitting translation or rotation or both.

Superstructure means all parts of a bridge above the bearings.

922.04 DESIGN AND SUBMISSION REQUIREMENTS

922.04.01 Design Requirements

922.04.01.01 Jacking

When jacking is not specified in the Contract Documents, design requirements shall be in accordance with OPSS 921 with the following additional requirements:

- a) Detailed calculation of all anticipated jacking and temporary support loads, and member resistances, shall be performed in accordance with CSA S6.
- b) The calculated jacking and temporary support loads shall reflect the actual loads that will be present on the bridge during jacking and temporary support, including all anticipated construction dead and live loads.
- c) Jacking loads shall be calculated for the jacking operation at serviceability limit states, and when the bridge is on temporary supports at ultimate limit states.

922.04.02 Submission Requirements

922.04.02.01 Layout and Installation Drawings

922.04.02.01.01 General

At least seven Days prior to commencement of bearing installation, one hardcopy and one electronic PDF copy of bearing layout and installation Working Drawings shall be submitted to the Contract Administrator for information purposes only. An Engineer's seal and signature shall be affixed on the bearing layout and installation Working Drawings verifying that they are consistent with the Contract Documents.

A copy of the bearing layout and installation Working Drawings shall be kept on site prior to and during the installation of the bearings.

922.04.02.01.02 Elastomeric Bearings

The layout and installation Working Drawings for elastomeric bearings shall clearly indicate the following:

- a) Bearing layout and orientation.
- b) Dimensions and details of the bearings.
- c) Details of the top or bottom plate, or both, including anchorages or dowels or both.
- d) Installation details.
- e) Load resistance at serviceability and ultimate limit states, including maximum compressive permanent and total loads.
- f) Individual alphanumeric identification of each bearing and lot identification.

922.04.02.01.03 Rotational and Sliding Surface Bearings

The layout and installation Working Drawings for rotational and sliding surface bearings shall clearly indicate the following:

- a) Bearing layout and orientation.
- b) Top and bottom plate details, including anchorages.
- c) Installation details.
- d) Method of attachment of bearings to the top and bottom plates.
- e) Bearing identification letter and numbers.

922.04.02.02 Jacking

When jacking is not specified in the Contract Documents, submission requirements shall be in accordance with OPSS 921 with the following additional requirements:

- a) Submissions shall be made at least seven Days in advance of the planned jacking operation for approval.
- b) The jacking drawings shall clearly show the anticipated loads during the jacking operation at serviceability limit states, and while the bridge is on temporary supports at ultimate limit states.
- c) Dimensioned locations of all jacking points shall be clearly shown in an elevation view across the entire substructure, and in a section view of each substructure location cut from elevation at a minimum.
- d) Jacking loads shall be clearly shown for each individual jacking point and shall represent the actual loads anticipated at each location.
- e) The maximum allowable lift shall be specified on the jacking drawing.

922.05 MATERIALS

922.05.01 Bearings

Bearings shall be according to OPSS 1202 or OPSS 1203 and as specified in the Contract Documents.

922.05.02 Grout

Grout for installation of rotational and sliding surface bearings or anchors shall be cement based, non-shrink, non-staining, and shall be supplied from a source named on the ministry's DSM. Grout shall have a minimum 7-Day compressive strength of 35 MPa.

922.07 CONSTRUCTION

922.07.01 General

The bearings shall be protected from damage, distortion, excessive heat, and deleterious matter during the handling, transportation, storage, and installation.

The bearings shall not be disassembled without the permission of the bearing supplier. The bearing supplier's representative shall be present during disassembly and reassembly.

Upon completion of the structure, the top and bottom surfaces of the bearings shall be in full contact with the structure.

Where pintles are specified in the Contract Documents, they shall engage the steel plate of the bearings through the entire thickness of that plate.

When elastomeric bearings are replaced on an existing structure, the top and bottom of the bearings shall be in full contact with the structure. Work required to achieve full contact shall be as specified in the Contract Documents. If the work as specified in the Contract Documents does not achieve full contact of the bearings, the Contract Administrator shall be notified and the work shall proceed only when directed.

922.07.02 Bearing Seats

The bearing seats shall be finished to an elevation as specified in the Contract Documents and shall be finished level or as specified in the Contract Documents.

For elastomeric bearings, the finish of the concrete surface shall be smooth and not vary greater than 1 mm along a straightedge placed in any direction across an area that extends at least 25 mm beyond the outside limits of the bearing. For other types of bearings, deviation along the straightedge shall not vary greater than 3 mm.

Any concrete surface area prepared by grinding shall not allow water to pond in the area. For elastomeric bearings, the bearing seat areas prepared by grinding shall have a finish equivalent to a trowel finish. All surface areas shall be inspected and deemed acceptable by the Contract Administrator prior to installation of bearings.

922.07.03 Installation of Anchors

The diameter, length, and material of the anchor and the diameter and depth of the anchor hole shall be as specified in the Contract Documents.

Holes for anchors shall be formed into abutments and pier caps prior to casting concrete. Coring for installation of bearing anchors is not permitted, unless specified elsewhere in the Contract Documents. If sleeves are used as forms, they shall be removed prior to installation of anchors.

When coring of the bearing seats to receive anchors is specified in the Contract Documents, coring shall be done without damaging or cutting the steel reinforcement by using either a concrete covermeter or a concrete scanner (such as a ground penetrating radar unit) to locate the steel reinforcement in advance. Where permitted, coring shall not commence earlier than three weeks prior to bearing installation.

The holes shall be protected against entry of moisture and shall be completely filled with grout, when the anchors are installed.

922.07.04 Grouting

Where the anchors for rotational and sliding surface bearings require core drilling or preformed holes, the bearings shall be bedded over their entire area on grout that does not contain any voids. The use of permanent shims to achieve the theoretical elevation at the top of the bearing shall not be allowed.

Grouting operations shall be according to the manufacturer's recommendations, with the following exceptions:

- a) The temperature of the air, concrete, and bearings shall not be less than 10 °C at the time of grouting and shall be maintained at not less than 10 °C for a minimum of 96 hours after grout is placed.
- b) The thickness of the grout bedding for rotational and sliding surface bearings shall be 12 mm ± 3 mm.

The substrate shall be roughened by bushhammering, cleaned, and prewetted prior to grouting. Transfer of superstructure load to the bearings shall not be allowed until the grout has reached a minimum strength of 30 MPa.

The grout material shall be mixed, handled, and cured according to the manufacturer's instructions.

Grout is not permitted in contact with elastomeric bearings.

922.07.05 Alignment and Elevation Tolerances

Bearings shall be set level to within a 500H:1V slope in any direction. The top of the bearing shall be set at the theoretical elevation specified in the Contract Documents, within the following tolerances:

Concrete deck and precast I-type girders	± 5 mm
Steel plate girders	0 to + 3.0 mm
Steel and precast concrete box girders	0 to + 2.0 mm

The longitudinal and transverse centrelines of the bearings shall be installed within ± 10 mm of the position specified in the Contract Documents. The centreline of the bearing along the direction of movement shall be parallel to the direction of movement of the bridge at that bearing location within 0.02 radians of the value specified in the Contract Documents.

922.07.06 Temporary Attachments

Temporary clamping devices shall be used to maintain correct orientation and setting and to prevent movement or separation of the bearing components during the handling, transportation, and installation. The clamping devices shall not be used for lifting or suspending the bearings. Clamping devices shall be removed after each bearing is in its final position, with all permanent connections made, and after all grout and concrete in contact with the bearing have been placed.

922.07.07 Jacking

Jacking shall be in accordance with OPSS 921.

922.07.07.01 General

All jacking and temporary support components shall have sufficient strength and stability for the entire duration that they are in use. All jacking surfaces shall be level.

Repairs shall be performed to the existing structure prior to jacking if necessary, so that jacking and temporary support bearing surfaces are sound and competent. Concrete shall reach a minimum strength of 75% of the specified 28-day compressive strength prior to loading.

Jacks may be fitted with appropriate locking collars to function as temporary supports.

922.07.07.02 Adjusting or Resetting Bearings

When jacking is required in order to adjust or reset the bearings, the structure shall be jacked the minimum amount required to allow the bearings to be adjusted.

For girder type bridges, all girders at each abutment or pier shall be jacked simultaneously if the amount of total lift required to adjust or reset the bearings exceeds 3.0 mm and a concrete deck is present.

Each girder may be individually jacked to adjust or reset the bearings if:

- a) The total lift required is less than or equal to 3.0 mm and a concrete deck is present; or,
- b) The total lift required is less than or equal to 5.0 mm and a concrete deck is not present.

The total lift amount shall include the amount to decompress the bearings plus the additional amount to lift the girders enough to do the bearing adjustment or reset.

For all other bridge types, the entire superstructure shall be uniformly lifted across the entire width of the abutment or pier.

922.07.08 Positive Attachment of Elastomeric Bearing Strips

Where positive attachment is specified for elastomeric bearing strips on ballast walls, wing walls, elastomer shall be attached with stainless steel concrete nails spaced at 400 mm or epoxy adhesive.

922.07.09 Sampling for Quality Assurance Testing

922.07.09.01 Sampling of Bearings

After the bearings have been fabricated, the Contract Administrator shall be notified in writing of the identification and availability of the bearings.

When continuous strip bearings have been specified for precast boxes placed side-by-side, each strip bearing shall be supplied at least 600 mm longer than required. A sample, 600 mm in length, shall be cut in the field from one end of each strip bearing and supplied for testing.

Elastomeric bearings beyond the number of bearings specified for installation shall be supplied as specified in the Contract Documents. Lot size shall be as specified elsewhere in the Contract Documents.

All bearings shall be available for sampling either at the project site or at a location acceptable to the Contract Administrator. Sample bearings for testing purposes shall be randomly selected by the Contract Administrator from the lot. When there is more than one lot containing bearings with the same dimensions, the Contract Administrator shall group the bearings based on sequential dates of manufacture. The Contract Administrator shall advise in writing which bearings have been selected for testing from each lot, and the identification of all other bearings within the lot.

Elastomeric bearings sampled for testing, and a copy of the bearing layout and installation Working Drawings according to OPSS 1202, shall be delivered to:

Head, Concrete Section
145 Sir William Hearst Avenue, Room 15
Downsview, Ontario, M3M 0B6

Bearings weighing more than 30 kg shall be delivered on a wooden pallet which can be lifted by a forklift.

922.07.09.02 Sampling of Approach Slab Bearings and Ballast Wall Bearings

Elastomers delivered to the site shall exceed the required length to allow for a 1 m labelled test sample to be taken from the approach slab or ballast wall elastomers on each structure.

Elastomers shall be delivered, along with a transmittal form to:

Head, Concrete Section
145 Sir William Hearst Avenue, Room 15
Downsview, Ontario, M3M 0B6

922.07.09.03 Grout Sampling

One set of three compressive strength cubes shall be cast for each day of production of grout. Casting of cubes shall be according to CSA A3004-C2. For early strength testing, additional cubes shall be cast. Cubes for compressive strength testing shall be delivered, with a transmittal form, to the Regional Quality Assurance Laboratory.

922.07.10 Inspection after Installation of the Bearings

Inspection after installation of the bearings shall be according to the Contract Documents.

920.07.13 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

922.08 QUALITY ASSURANCE

922.08.01 Acceptance of Bearings

Acceptance of bearings shall be on a lot basis. The number, type, and size of elastomeric bearing samples to be selected for destructive testing shall be as specified in the Contract Documents.

The acceptance of bearings shall be according to the requirements of this section. If the bearing tested does not meet the requirements of this section, all bearings from the lot are unacceptable and shall not be included in the Work. Unacceptable bearings that have been included in the Work shall be removed and replaced at no additional cost to the Owner. Repairs to elastomeric bearings are not permitted.

Bearings supplied as replacements for rejected bearings shall be sampled, tested, and accepted on the same basis as the original bearings.

An allowance of 60 days shall be made for the Owner's testing program from the time of submission of elastomeric bearings and Working Drawings, according to this specification.

922.08.02 Acceptance of Approach Slab Bearings and Ballast Wall Bearings

Acceptance of bearings shall be on a lot basis. For testing of approach slab bearing and ballast wall bearing elastomers, a lot shall be all the bearings on a structure.

The acceptance of bearings shall be according to the requirements of OPSS 1202. For each lot, one 1 m sample of elastomer shall be tested according to OPSS 1202. If the bearing tested does not meet the requirements of this specification, all bearings from the lot shall be considered unacceptable but with the agreement of the Owner may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated based on individual lots and applied according to the Basis of Payment section of this specification.

922.08.03 Acceptance of Grout Compressive Strength

One set of three cubes shall be tested for 7-Day compressive strength according to CSA A3004-C2. Grout shall be acceptable if the average 7-Day compressive strength of the set of three cubes is greater than or equal to 35 MPa. Unacceptable grout shall be removed and replaced at no additional cost to the Owner.

922.09 MEASUREMENT FOR PAYMENT

922.09.01 Bearings – Elastomeric, Laminated Bearings – Rotational

For measurement purposes, a count shall be made of the number of the bearings installed.

922.10 BASIS OF PAYMENT

922.10.01 Bearings – Elastomeric, Plain – Item Bearings – Elastomeric, Laminated - Item Bearings – Rotational - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the Work.

Payment at the Contract price shall include full compensation for any additional bearings supplied for destructive testing.

For structural rehabilitation, when repairs to the existing bearing seat or soffit above the bearing areas is required prior to the installation of the new bearings to ensure full contact is achieved, and if the work is not specified in the Contract Documents, payment for such work shall be administered as a Change in the Work.

922.10.02 Payment Adjustment for Bearings

922.10.02.01 Elastomeric Bearings with Steel Laminates

When the elastomer cover to each of the embedded steel plates in the test sample is within the tolerances of the specifications, a payment adjustment factor of 1.00 shall be applied to the Contract price for the bearings location represented by the sample. Bearings that do not meet tolerances are rejectable and shall be removed and replaced at no additional cost to the Owner.

When the elastomer cover to any or all of the embedded steel plates in the test sample is within the payment adjustment range shown in Table 1 and/or Table 2, and a request is made that the Owner accept the bearings in the lot represented by the sample as is, the cover payment adjustment factor equal to 0.5, shall apply to the lot. In the case where both Table 1 and Table 2 indicate a cover payment adjustment factor of 0.5, the payment adjustment factor of 0.5 applies.

When multiple test samples are represented by the tender item, the payment adjustment shall apply to the total plan area of laminated elastomeric bearings represented by the sample, divided by the total plan area of all laminated elastomeric bearings represented by the tender item.

When the average top or bottom elastomer cover to the embedded steel plates in the test sample exceeds the tolerance specified in the Contract Documents and exceeds 70% of the average effective elastomer thickness of internal layers, or when the average thickness of individual layers of elastomer exceeds the tolerance specified in the Contract Documents, a request may be made that the Owner accept the bearings if they meet the design requirements. The bearing supplier shall update the bearing design on the shop drawings for the as-built configuration and shall evaluate the bearing for the design loads based on the as-built geometry.

922.10.02.02 Approach Slab and Ballast Wall Bearings

The payment adjustment for each unacceptable lot of approach slab and ballast wall bearings shall be minus \$5,000.

TABLE 1
Payment Adjustment Factors for Elastomer Cover to Embedded Steel Plates – Low Cover
at Top and Bottom and Low Cover at Sides

		Minimum Top and Bottom Cover, mm		
		< 3.0	3.0 to 3.5	> 3.5
Minimum Side Cover, mm	< 4.0	Rejectable	Rejectable	Rejectable
	4.0 to 4.5	Rejectable	Rejectable, a request may be made to have bearings within this range accepted with a payment adjustment factor of 0.5	Rejectable, a request may be made to have bearings within this range accepted with a payment adjustment factor of 0.5
	> 4.5	Rejectable	Rejectable, a request may be made to have bearings within this range accepted with a payment adjustment factor of 0.5	Acceptable

TABLE 2
Payment Adjustment Factors for Elastomer Cover to Embedded Steel Plates – Low Cover
at Top and Bottom and High Cover at Sides

		Minimum Top and Bottom Cover, mm		
		< 3.0	3.0 to 3.5	> 3.5
Maximum Side Cover, mm	≤ 12.0	Rejectable	Rejectable, a request may be made to have bearings within this range accepted with a payment adjustment factor of 0.5	Acceptable
	> 12.0 to ≤ 15.0	Rejectable	Rejectable, a request may be made to have bearings within this range accepted with a payment adjustment factor of 0.5	Rejectable, a request may be made to have bearings within this range accepted with a payment adjustment factor of 0.5
	> 15.0	Rejectable	Rejectable	Rejectable



CONSTRUCTION SPECIFICATION FOR STRUCTURE REHABILITATION-CONCRETE REMOVAL

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APPENDICES

928-A	Commentary

928.01 SCOPE

This specification covers the requirements for the removal of concrete from existing structures, except by means of pressurized water, hydrodemolition, in order to facilitate structure rehabilitation.

928.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

928.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

928.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 905 Steel Reinforcement for Concrete

CSA Standards

CAN/CSA S6-06 Canadian Highway Bridge Design Code

928.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certificate of Conformance means a document issued by the Quality Verification Engineer confirming that the specified components of the Work are in general conformance with the requirements of the Contract Documents.

Concrete Crusher means a piece of equipment fitted with a hydraulic attachment, such as a scissor type jaw, used for the removal of concrete.

Concrete Removal - Full Depth means concrete removals that typically apply to full or partial length removals of entire thickness of curbs, sidewalks, medians, wingwalls, concrete barrier walls and parapet walls, ballast walls, and approach slabs. This also applies to localized removals extending the full thickness of slab decks and culverts.

Concrete Removal - Partial Depth, Type A means concrete removals that typically apply to the top surface of decks, including removals over round voids in post tensioned structures; sidewalks; curbs; and culvert and tunnel floor slabs and the top and inside faces of concrete barrier and parapet walls.

Concrete Removal - Partial Depth, Type B means concrete removals that typically apply to deck soffit and fascia of bridge decks, soffit of the top slab of culverts and tunnels, girders, diaphragms, and outside face of concrete barrier walls and parapet walls.

Concrete Removal - Partial Depth, Type C means concrete removals other than the ones specified for Concrete Removal - Partial Depth, Type A and Type B, and typically apply to abutments, wingwalls, pier columns and caps, bearing seats, retaining walls, and vertical walls of culverts and tunnels.

Concrete Removal Sequence means a specified order of concrete removals within a stage to ensure structural adequacy, stability, and integrity throughout construction.

Concrete Removal - Structural Component means concrete removals that typically apply to full or partial length removals of entire thickness of decks, girders, diaphragms, pier columns, and pier caps that have an impact on the structural adequacy, stability, and integrity of a structure.

Engineer means a professional engineer licensed by the Professional Engineers Ontario to practice in the Province of Ontario.

Layer - Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat - Reinforcing Steel means two layers of reinforcing steel, in different directions, tied together.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Reinforcing Steel means deformed steel bars used in the reinforcing of concrete and includes splice bars.

Scarifying means the removal of concrete from the top surface of a structure, to a specified depth achieved by the milling action of cutting teeth fitted to a rotating head.

Steel Reinforcement means a general term that includes reinforcing steel bars, splice bars, welded steel wire fabric, and prestressing tendons.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway, or any part thereof or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

928.04 DESIGN AND SUBMISSION REQUIREMENTS

928.04.01 General

The Contractor shall meet all design and submission requirements from other authorities, as specified in the Contract Documents. The requirements of these authorities and the Owner shall be satisfied before commencement of concrete removals.

928.04.02 Design Requirements

The structural design and evaluation shall be carried out according to CAN/CSA S6.

The design assumptions for structural design and evaluation shall accurately represent the condition of the structure during construction, including the effect of concrete removals on load distribution and member resistance, support location and restraints, construction loads and construction staging, and shall be based on the existing structure drawings.

The weights of construction equipment shall be based on the manufacturer's specifications. The minimum dynamic load allowance for rig-mounted breakers and concrete crushers shall be 0.4. The load factors for construction live loads shall be the same as for highway live loads.

928.04.03 Submission Requirements

928.04.03.01 Access to Work Areas, Platforms, and Scaffolding

When access to work areas, work platforms, and scaffolding are to be provided, the Contractor shall submit to the Contract Administrator detailed drawings, for information purposes, prior to the installation.

928.04.03.02 Working Drawings

The Contractor shall submit 3 sets of Working Drawings to the Contract Administrator at least 7 Days prior to the commencement of the concrete removals, for concrete removal, complete deck and concrete removal, structural component, for information purposes only. The Contractor shall have a copy of the Working Drawings on site at all times while the work is being carried out.

All Working Drawings shall contain the following:

- a) Layout and description of concrete removal sequences and temporary supports.
- b) Clearances at existing and proposed structures.
- c) The locations, loadings, and detailed descriptions of heavy equipment and vehicles to be supported on existing structures.
- d) Seal and signature of the design Engineer and design check Engineer employed or retained by the Contractor, and a statement certifying that based on the existing drawings of the structure that the serviceability limit state and ultimate limit state requirements of CAN/CSA S6 are satisfied when any one or more of the following are proposed by the Contractor:
 - i. Existing structures supporting rig-mounted breakers, concrete crushers, cranes, any other heavy equipment, and vehicles that would induce higher load effects than normal traffic on a structure.
 - ii. Removal sequence different from the one specified in the Contract Documents or when the Contract Documents do not specify a removal sequence.
- e) Identify stages of work that require interim inspection by the Quality Verification Engineer (QVE) for the safe execution of concrete removal, such as:
 - i. Installation of temporary support.
 - ii. Installation of temporary protection for traffic, pedestrians, and property.
 - iii. Structural strengthening or modification.
 - iv. Removal of existing dead load or earth pressure, or both.

928.04.03.03 Concrete Removal Equipment

The Contractor shall submit identification of equipment and the manufacturer's published specifications for all concrete removal equipment to be used to the Contract Administrator, at least 7 Days prior to the commencement of the concrete removal operation.

928.04.03.04 Saw Cutting Details

When it is intended to cut full thickness through a concrete component by the use of sawing equipment, the Contractor shall submit saw cutting details to the Contract Administrator, at least 7 Days prior to the intended commencement of the saw cutting operation. The details shall include the following:

- a) Depth and location of sawcuts.
- b) Method used to prevent any contact with components that are to remain in place.
- c) Method of collecting and managing the effluent from the saw cutting operation.

928.04.03.05 Traffic and Pedestrian Protection

Unless otherwise specified in the Contract Documents, the Contractor shall submit a description of the traffic and pedestrian protection plan to the Contract Administrator, at least 7 Days prior to the commencement of the concrete removal operations.

928.06 EQUIPMENT

928.06.01 Air Hammers

Air hammers shall be hand-held and meet the following requirements:

- a) Chipping hammers shall have a maximum weight of 9.0 kg prior to any handle modification and a maximum piston stroke of 102 mm.
- b) Jack hammers shall have a maximum weight of 14.0 kg.
- c) All hammers shall have the manufacturer's name and part or model number engraved on them by the manufacturer. All information must be clearly legible.

The manufacturer's published specifications shall be the sole basis for determining weight and piston stroke.

928.06.02 Rig-Mounted Breakers

Rig-mounted breakers using pneumatically driven equipment shall only be fitted with amoil point and produce a maximum energy of 1,000 Joules per blow as per manufacturer's specification.

928.06.03 Sawing Equipment

The sawing equipment shall be capable of sawing the concrete along the lines and to the depths specified in the Contract Documents.

928.06.04 Scarifiers

Equipment used for scarifying shall be capable of removing a minimum of 6 mm of concrete from the top surface of the structure in one pass.

The maximum weight of a scarifier used on bridge decks shall not exceed 26 tonnes.

928.06.05 Straight Edges

Two commercially made metal straight edges, 1.5 m and 3 m in length, shall be supplied.

928.07 CONSTRUCTION

928.07.01 General

Concrete shall be removed to the depth and demarcated boundaries as specified in the Contract Documents or as directed by the Contract Administrator.

Upon completion of the concrete removals in the demarcated areas, the Contractor shall notify the Contract Administrator for inspection of the removal areas. Additional areas of concrete removal identified by the Contract Administrator shall be removed as directed by the Contract Administrator.

928.07.02 Access to Work Area, Work Platform, and Scaffolding

Adequate access shall be provided to the work area, work platform, and scaffolding as required, for the following:

- a) Concrete surveys by the Contract Administrator.
- b) Inspection of work and measurement of the quantities by the Contract Administrator.
- c) Quality Assurance and acceptance inspections by the Owner.
- d) Performance of the Contractor's work, including concrete removals.

928.07.03 Concrete Surveys

928.07.03.01 General

The Contractor shall schedule operations so as to ensure there is no interference with the concrete surveys.

928.07.03.02 Covermeter Survey

The Contractor shall allow the Contract Administrator to carry out a bridge deck covermeter survey for all asphalt-covered decks when concrete removals from the top surface of the deck are specified in the Contract Documents.

The Contractor shall notify the Contract Administrator 24 hours prior to the commencement of the scarifying operation.

The covermeter survey shall be carried out as follows:

- a) When the deck is specified to be patched, complete the survey after the waterproofing is completely removed from the top surface of the deck.
- b) When an overlay is specified in the Contract Documents, complete the survey after the first pass of the scarifying equipment.

928.07.03.03 Concrete Removal Surveys

928.07.03.03.01 General

The Contractor shall submit a written notification to the Contract Administrator to carry out all applicable concrete removal surveys. The notification shall state that the Contractor has completed the work specified in the Work Requirements clause for the concrete removal surveys specified and has installed all accesses to the work area, including work platforms and scaffolding required by the Contract Administrator to carry out the surveys.

When the location and extent of removals are not completely defined in the Contract Documents, the Contract Administrator shall carry out one or both of the following concrete removal surveys as part of determining and demarcating the actual location and extent of removals:

a) Visual and Delamination Survey

A visual and delamination survey shall be carried out for all concrete removals.

When a structure has an existing overlay that is not to be completely removed, the Contract Administrator shall carry out the delamination survey twice. The first survey shall be carried out on the top surface of the entire overlay. The second survey shall be carried out on the top surface of the original deck within the removal area, after the existing overlay has been removed.

When a structure has an existing overlay that is to be completely removed, the Contract Administrator shall carry out the delamination survey after the overlay is completely removed.

b) Corrosion Potential Survey (Half-Cell)

A corrosion potential survey shall be carried out on all surfaces when concrete is to be removed based on corrosion potential criteria when specified in the Contract Documents.

When full depth removals are specified in the Contract Documents, the concrete removal surveys on the top of the deck and soffit shall be completed to determine and demarcate the full depth concrete removal areas.

Concrete removals shall not proceed until all the applicable concrete surveys have been completed, reviewed, and written permission to proceed has been given by the Contract Administrator.

928.07.03.03.02 Work Requirements

Prior to the concrete removal surveys, the Contractor shall carry out all applicable work as follows:

- a) Scarifying - Complete the scarifying operations.
- b) Refacing with Uniform Concrete Removal - Complete the uniform removal of concrete.
- c) Removal of Waterproofing, Asphalt, and Coatings - All existing waterproofing membrane, asphalt, and coatings shall be removed in such a way to prevent damage to the existing concrete surface.
- d) Concrete Removal by Corrosion Potential - The Contract Administrator shall select two widely separated locations for each portion of the structure when the reinforcing steel is continuous. The reinforcing steel within these locations shall be exposed for a length of 150 mm and a clearance of 25 mm all around the bar.

Immediately prior to the commencement of the concrete removal surveys, all equipment shall be removed and all debris and standing water cleared from the surfaces to be surveyed.

928.07.03.03 Time Requirements

The time required by the Contract Administrator to complete the concrete removal surveys, including review of the surveys by the Owner, shall be as specified in Table 1 and shall commence upon receipt of the Contractor's written notification to carry out the concrete removal surveys. When the area of a structure exceeds the maximum area surveyed for the time period shown, the time period specified in Table 1 shall be extended on the basis of prorating the area, rounded up to the nearest Business Day.

The maximum time period required to complete the concrete surveys does not include any days of inclement weather or days when the air temperature is below 5 °C.

928.07.04 Scarifying

928.07.04.01 General

The portion of the structure to be scarified and the depth of scarifying shall be according to the Contract Documents.

Prior to scarifying, all sand and debris shall be removed from the top surface of the structure to be scarified. The maximum depth of scarifying in any one pass of the scarifying equipment shall be 10 mm. After the scarifying operation, areas of the structure not scarified to the specified depth shall be re-scarified until the specified depth is achieved.

When the specified depth of scarifying is greater than 10 mm, the Contractor shall allow the Contract Administrator a 24-hour period to complete the covermeter survey prior to commencing the second pass of the scarifying.

The portion of the curb face, barrier or parapet wall, and all existing concrete surfaces that have not been scarified against which new concrete is to be placed shall be uniformly roughened by means of scabbling, chipping hammer, or bushhammering. A surface profile of 5 mm ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All material resulting from the scarifying operation shall be removed from the deck immediately after each pass of the scarifying equipment.

928.07.04.02 Protection of Reinforcing Steel

The Contractor shall immediately notify the Contract Administrator of any exposed reinforcing steel visible on the concrete surface prior to and at any time during the scarifying operation. Operations shall be adjusted to avoid contacting the reinforcing steel with the scarifying equipment.

The Contract Administrator shall demarcate an area around any exposed reinforcing steel. The concrete shall be removed from within the demarcated area to the depth specified for the adjacent scarifying area using chipping hammers or as directed by the Contract Administrator.

Exposed reinforcing steel shall not be cut, removed, or damaged.

928.07.05 Reinforcing Steel in Concrete Removal Areas

When the cutting, bending, and removal of reinforcing steel is specified in the Contract Documents, the work shall be done as part of concrete removals. The cutting and bending of reinforcing steel shall be according to OPSS 905.

When the area of concrete removal with exposed reinforcing steel exceeds 2 m², the reinforcing steel shall be retied at every second intersection point and shall be supported to maintain the steel mat in its original location. Supports shall be placed as required and tied securely to the reinforcing steel according to OPSS 905.

928.07.06 Equipment Restrictions

928.07.06.01 General

Only equipment specified shall be permitted for the removal of concrete.

Construction equipment shall be permitted on the structure provided that all of the following conditions are met:

- a) Contamination by oil or other deleterious substances shall be prevented. Contaminated concrete shall be removed according to the procedures specified in the Concrete Removal - Partial Depth Type A, B, and C clause.
- b) Vehicles, runways, and equipment other than hand held equipment shall not be supported by reinforcing steel.
- c) Heavy vehicles such as ready mix concrete trucks or dump trucks shall not be permitted on any portion of the deck, within a span, once concrete removals within the deck have commenced in that span.

928.07.06.02 Concrete Removal - Partial Depth Types A, B, and C

Only chipping hammers shall be used for all partial depth concrete removals.

928.07.06.03 Concrete Removal - Complete Deck, Deck Joint Assemblies, Full Depth, and Structural Component

928.07.06.03.01 Sawing Equipment

The use of sawing equipment, except for perimeter treatments of concrete removal areas shall not be permitted for the removal of concrete:

- a) Within the lap length of reinforcing steel to remain in place.
- b) Within 100 mm from the edges and faces of structural steel members and concrete components to remain in place.

Prior to making sawcuts in a concrete deck close to the areas of existing structural steel members and other components that are to remain, the concrete surface shall be delineated by a qualified surveyor to locate the underlying edges and the faces of structural steel members and other components so not to damage the structural steel members and other components while saw cutting the concrete as specified.

928.07.06.03.02 Chipping Hammers

The use of chipping hammers shall be permitted in all areas of concrete removal.

928.07.06.03.03 Jack Hammers

The use of jack hammers shall not be permitted for the removal of concrete:

- a) For partial depth removals.
- b) Within 100 mm from concrete to remain in place.
- c) Within 25 mm of any reinforcing steel to remain in place.
- d) Within 100 mm from the edges and faces of structural steel members to remain in place.

928.07.06.03.04 Rig-Mounted Breakers

The use of rig-mounted breakers shall not be permitted for the removal of concrete:

- a) In concrete barrier and parapet walls, and deck slabs supported by concrete girders, unless the girders are to be removed.
- b) In concrete barrier and parapet walls supported by steel beams, unless the deck slab is to be removed.
- c) Within the deck joint assembly.
- d) Located within a distance from concrete to remain in place equal to the sum of 600 mm and the specified lap length of reinforcing steel to remain in place.
- e) Within 600 mm from the edge and faces of structural steel members including shear studs to remain in place.

928.07.06.03.05 Concrete Crusher

The use of a concrete crusher shall not be permitted for the removal of concrete:

- a) Within 2 m of concrete to remain in place.
- b) Within 1 m of reinforcing steel to remain in place.
- c) Within 300 mm from the edge and faces of structural steel members, including shear studs to remain in place.

928.07.07 Concrete Removal

928.07.07.01 General

Concrete removal shall not be permitted within 1 m of newly placed concrete until the newly placed concrete has attained a compressive strength of 20 MPa.

Concrete shall be removed in such a manner to prevent damage to the concrete to remain in place and debonding of reinforcing steel beyond the demarcated removal area. Reinforcing steel, prestressing tendons, shear connectors, structural steel, Utilities, and all other components that are to remain in place shall not be damaged or loosened. Concrete debris shall be removed from the concrete removal area on an ongoing basis.

928.07.07.02 Concrete Removal - Partial Depth Types A, B, and C

928.07.07.02.01 Perimeter Treatment of Concrete Removal Areas

The perimeter treatment of a partial depth concrete removal area shall be prepared according to the rehabilitation method to be used as follows:

- a) Concrete Overlay or Refacing - The perimeter of the removal area shall have a 1H:1V sloped face for the full depth of the removal area. The perimeter shall not be sawcut.
- b) Shotcrete - Prior to carrying out concrete removal operations, the perimeter of the removal area shall be sawn to a depth of 10 mm or to the depth of the reinforcing steel, whichever is less. The perimeter of the removal area shall have a face perpendicular to the original concrete surface for the specified depth of the removal area.
- c) Concrete Patches - Prior to carrying out concrete removal operations, the perimeter of the removal area shall be sawn to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less. The perimeter of the removal area shall have a face perpendicular to the original concrete surface for the specified depth of the removal area.

928.07.07.02.02 Depth of Concrete Removal Areas

For existing concrete overlays to be patched, concrete shall be removed to the top surface of the original deck in the demarcated areas to allow the Contract Administrator to conduct a second delamination survey.

Concrete removal shall extend below the reinforcing steel within the boundaries demarcated by the Contract Administrator in the following areas:

- a) The entire area of spalls and delaminations.
- b) The areas of concrete components when corrosion potential of the reinforcing steel is more negative than minus 0.35 volts, as determined by the corrosion potential survey.
- c) All areas of exposed reinforcing steel.

Concrete in these areas shall be removed to a uniform depth of 25 mm behind the first layer of reinforcing steel.

Concrete surrounding the second layer of reinforcing steel shall also be removed locally to provide a minimum clearance of 25 mm all around the reinforcing steel.

Concrete removal beyond the second layer of reinforcing steel shall be carried out only when directed by the Contract Administrator.

For all other concrete removals demarcated by the Contract Administrator, including scaling and honeycombing, concrete shall be removed as follows:

- a) To sound concrete, when an overlay or refacing is specified in the Contract Documents.
- b) To sound concrete for a uniform depth of at least 50 mm, when an overlay or refacing is not specified in the Contract Documents.

928.07.07.03 Concrete Removal - Complete Deck, Full Depth, and Structural Component

Prior to carrying out concrete removals, the perimeter of the demarcated removal area shall be sawn to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less, except for localized full depth repairs in the deck.

Prior to carrying out the concrete removals for localized full depth repairs in the deck, the perimeter of the removal area on the top surface of the deck shall be sawn to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less. After concrete removals from the top of the deck are completed, the perimeter of the removal area along the soffit shall be squared off by saw cutting to a depth of 25 mm or to the depth of the reinforcing steel, whichever is less. The concrete removals shall be completed from the soffit using chipping hammers.

928.07.07.04 Concrete Removal - Deck Joint Assemblies

The existing deck joint assemblies including joint filler materials and surrounding concrete shall be removed according to the requirements of this specification and the Contract Documents.

928.07.08 Remedial Work

The Contract Administrator shall be notified immediately in writing if any of the following work related defects are present along with an explanation of the cause and extent of the defect:

- a) Damage to concrete beyond demarcated removal areas.
- b) Damage to concrete not specified for removal and damage to reinforcing steel to remain in place.
- c) Damage to structural steel and other components that are to remain in place.
- d) Contaminated concrete.
- e) Work that does not conform to the requirements of the Contract Documents.

All work related defects shall be repaired. A proposal for the remedial work to correct defects shall be submitted to the Contract Administrator for review. The Contractor shall not proceed with repairs until approval of the proposal has been received.

Repairs shall be made to the approval of the Contract Administrator.

928.07.09 Certificate of Conformance

A Certificate of Conformance shall be submitted by the Contractor upon completion of the designated concrete removal for each structural component and complete deck. The certificate shall be sealed, signed, and dated by the Quality Verification Engineer. The certificate shall state that the Work has been carried out in general conformance with the Working Drawings and the Contract Documents.

928.07.10 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

928.08 QUALITY ASSURANCE

928.08.01 General

After the concrete removals are completed in the areas designated for removal, the work shall be inspected by the Contract Administrator to:

- a) determine and demarcate any additional removals within and along the perimeter of the demarcated areas.
- b) verify that the concrete has been removed to the depth and dimensions specified in the Contract Documents or as approved by the Contract Administrator.
- c) identify any work related defects in the work.

All work related defects and deficiencies shall be corrected as outlined in the Remedial Work subsection.

928.08.02 Acceptance

The following work related defects are unacceptable and shall be subject to remedial work:

- a) Damage to concrete beyond demarcated removal areas.
- b) Damage to concrete not specified for removal and damage to reinforcing steel to remain in place.
- c) Damage to structural steel and other components.
- d) Contaminated concrete.
- e) Work that does not conform to the requirements of the Contract Documents.

928.09 MEASUREMENT FOR PAYMENT

928.09.01 Actual Measurement

928.09.01.01 Scarifying

Measurement of scarifying shall be by area in square metres of the structure surface area to be scarified.

Measurement shall not be made of the roughened portions of curb faces, concrete barrier and parapet walls or of areas that require a second scarifying due to the Contractor's method of operation.

The total area shall be calculated to the nearest 0.1 m².

928.09.01.02 Concrete Removal - Partial Depth Types A, B, and C

928.09.01.02.01 General

Measurement of partial depth concrete removal shall be by area or volume as specified in the Contract Documents.

928.09.01.02.02 By Area

Measurement shall be of the area of concrete removed in square metres.

The total area shall be calculated to the nearest 0.1 m².

928.09.01.02.03 By Volume

Measurement for payment shall be of the volume of concrete removed for the depth specified or to the depth approved by the Contract Administrator.

Material removed locally 25 mm around the second layer of reinforcing steel shall not be measured. However, if the Contract Documents specify a uniform removal below the second layer of reinforcing steel, measurement for payment shall be of the volume of concrete removed to the specified depth.

After concrete removal is completed, verification of concrete removal depths shall be completed by the Contract Administrator on a grid system that best describes the profile at the particular area.

Measurement shall be taken by placing a straight edge across the removal area and measuring the distance from the straight edge to the top of the remaining concrete surface, as follows:

- a) A minimum of three measurements for each removal area less than or equal to 1.0 m².
- b) A minimum of ten measurements for every square metre for each removal area greater than 1.0 m².

The depths for each removal area shall be measured and averaged to the nearest millimetre.

The total volume shall be calculated to the nearest 0.1 m³.

928.09.01.03 Concrete Removal - Full Depth

Measurement of the full depth concrete removal shall be by volume in cubic metres. Alternatively, full depth concrete removal may be a lump sum item.

The total volume shall be calculated to the nearest 0.1 m³.

928.10 BASIS OF PAYMENT

928.10.01 Scarifying - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

When exposed reinforcing steel necessitates concrete being removed from within the demarcated areas to the depth specified for the adjacent scarifying using chipping hammers, such work shall be paid as Extra Work.

928.10.02 Access to Work Area, Work Platform, and Scaffolding - Item **Concrete Removal - Complete Deck - Item** **Concrete Removal - Deck Joint Assemblies - Item** **Concrete Removal - Full Depth - Item** **Concrete Removal - Partial Depth Type A - Item** **Concrete Removal - Partial Depth Type B - Item** **Concrete Removal - Partial Depth Type C - Item** **Concrete Removal - Structural Component - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

When the Contract does not contain a separate tender item for access to the work area, work platform and scaffolding, the Contract price for the concrete removal items shall include full compensation for all labour, Equipment, and Material to provide access to work area, work platform, and scaffolding.

Payment for the appropriate tender item Concrete Removal - Partial Depth Type A, Concrete Removal - Partial Depth Type B, or Concrete Removal - Partial Depth Type C or any combination of the three shall include full compensation for all labour, Equipment, and Material to remove concrete locally around the second layer of reinforcing steel to provide a minimum 25 mm clearance around the reinforcing steel.

When the replacement of corrosion damaged reinforcing steel is required, such work shall be paid as Extra Work.

Work related defects repaired as remedial work shall be completed at no extra cost to the Owner.

TABLE 1
Time Requirements for Concrete Removal Surveys

Concrete Component	Maximum Area Surveyed Per Time Period m²	Time Period Business Days
Bridge deck surface, including sidewalks, concrete barrier, and parapet walls.	3,000	3
Bridge deck soffit, including fascias.	1,500	3
Abutments, wingwalls, and retaining walls.	1,000	2
Piers	500	2
Culverts	500	2

Appendix 928-A, April 2012
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

OPSS.PROV 929
NOVEMBER 2017
(Formerly OPSS 929, April 2012)

Note: The PROV published in November 2017 replaces OPSS 929 COMMON, April 2012 with no technical content changes.

**CONSTRUCTION SPECIFICATION FOR
ABRASIVE BLAST CLEANING - CONCRETE CONSTRUCTION**

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929.01 SCOPE

This specification covers the requirements for abrasive blast cleaning of concrete surfaces and reinforcing steel.

929.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

ASTM International

D 4285-83 (R2006) Standard Test Method for Indicating Oil or Water in Compressed Air

The Society for Protective Coatings (SSPC)

VIS 1-2002 Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

Joint Publications of the Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE)

SSPC-SP 6/NACE No. 3-2007 Commercial Blast Cleaning

929.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Abrasive means a solid substance capable of grinding or wearing down.

Fiber Reinforced Polymer (FRP) Reinforcement means a structural reinforcing bar made from glass fibers or carbon fibers held in a polymeric resin matrix binder. FRP includes dowels, reinforcing bars and grids.

Layer, Reinforcing Steel means two or more reinforcing bars placed in a plane parallel to a concrete face.

Mat, Reinforcing Steel means transverse and longitudinal layers of reinforcing steel tied together.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

929.06 EQUIPMENT

929.06.01 Air Compressor

The air compressor for abrasive blast cleaning shall be capable of delivering material at a pressure of 620 kPa. The air pressure shall be measured in the delivery system at a distance not greater than 3 m from the nozzle end.

The compressed air shall be clean, dry, and free of oil residue when tested according to ASTM D 4285.

Nozzles used for abrasive blast cleaning shall have a minimum diameter of 8 mm and the size shall be indicated on the nozzle.

Hoses used for abrasive blast cleaning shall have an internal diameter not less than 40 mm.

929.07 CONSTRUCTION

929.07.01 General

Abrasive blast cleaning shall only be permitted when the concrete and reinforcing steel are surface dry.

Areas and components not designated for abrasive blast cleaning shall be protected from adjacent abrasive blast cleaning operations.

All new epoxy coated reinforcing steel and any FRP reinforcement in the vicinity of the abrasive blast cleaning operations shall be protected from damage.

Adequate access to the work area shall be provided to facilitate the work and for any inspection or measurement required by the Contract Administrator.

929.07.02 Abrasive Blast Cleaning of Reinforcing Steel

Abrasive blast cleaning of existing reinforcing steel applies to both epoxy coated and uncoated reinforcing steel.

All existing epoxy coated reinforcing steel within a concrete removal area shall be abrasive blast cleaned to remove the epoxy coating. Reinstatement of the epoxy coating on the existing reinforcing steel is not required.

The full circumference of the existing exposed reinforcing steel shall be abrasive blast cleaned to a commercial blast cleaned finish according to SSPC-SP 6/NACE No. 3, and the blast cleaned steel surfaces shall be according to the applicable visual standards specified in SSPC-VIS 1.

When silica sand is used as the abrasive material, the subsequent placement of concrete or shotcrete shall be done within 72 hours or the reinforcing steel shall be reblasted. When other types of abrasive materials are used, the subsequent placement of concrete or shotcrete shall be done within 36 hours or the reinforcing steel shall be reblasted.

929.07.03 Abrasive Blast Cleaning of Structural Steel in Contact with Concrete

All surfaces of existing structural steel against which new concrete is to be placed for the rehabilitation of a concrete structure component shall be abrasive blast cleaned to a commercial blast cleaned finish according to SSPC-SP6/NACE No. 3, and the blast cleaned steel surfaces shall be according to the applicable visual standards specified in SSPC-VIS 1.

The abrasive blast cleaning of structural steel shall be done immediately prior to placing coated reinforcing steel or FRP reinforcement.

Enclosure shall be provided during abrasive blast cleaning of structural steel to prevent escape of dust from the immediate work area into the natural environment, live traffic, waterways, and beyond the right-of-way.

929.07.04 Abrasive Blast Cleaning of Concrete Surfaces

929.07.04.01 General

All new and existing concrete surfaces against which new concrete is to be placed shall be abrasive blast cleaned.

The abrasive blast cleaning shall be of an extent to expose and clean the coarse aggregate and remove all dirt, laitance, and hardened concrete slurry. Any oil or grease on the surface of the concrete shall be removed using hand tools.

The abrasive blast cleaning of concrete surfaces shall be carried out not more than 48 hours prior to the placement of concrete against them.

Immediately after abrasive blast cleaning is completed, the surface shall be checked by the Contract Administrator for fractured concrete or loose aggregate. This material shall be removed using hand tools.

929.07.04.02 Concrete Surfaces for Overlays

Abrasive blast cleaning shall proceed by delineating an area of the deck not exceeding 10 m² and completing abrasive blast cleaning within the delineated area prior to proceeding to the adjacent areas of the deck surface.

When the concrete overlay is to be placed over cathodic protection anode mesh, the abrasive blast cleaning shall be completed prior to installing the mesh in that area.

Except when anode mesh is used, areas of concrete that are abrasive blast cleaned for the subsequent treatment of concrete overlay, shall have the overlay applied within 36 hours or shall be reblasted.

929.07.05 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

929.08 QUALITY ASSURANCE

928.08.01 General

After abrasive blast cleaning is completed, the abrasive blast cleaned concrete surfaces, reinforcing steel, and structural steel shall be examined by the Contract Administrator to verify that the requirements of this specification have been met.

929.09 MEASUREMENT FOR PAYMENT

929.09.01 Actual Measurement

929.09.01.01 Abrasive Blast Cleaning of Reinforcing Steel

Measurement for payment shall be of the area of concrete removed in square metres where reinforcing steel bars are exposed. When the removal exposes more than one mat of reinforcing steel, the measured area shall be for each mat of exposed bars that are to remain in place. There shall be no measurement for abrasive blast cleaning of reinforcing steel in volume of concrete that was not designated for concrete removal by the Contract Administrator.

When only one reinforcing steel bar is exposed in the area of concrete removal, the area shall be calculated based on the width of 200 mm by the length of the exposed reinforcing steel bar.

The total area shall be calculated to the nearest 0.1 m².

929.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

929.10 BASIS OF PAYMENT

929.10.01 Abrasive Blast Cleaning for Overlays - Item Abrasive Blast Cleaning of Reinforcing Steel - Item Abrasive Blast Cleaning of Structural Steel in Contact with Concrete - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour,

Equipment, and Material to do the Work.

Abrasive blast cleaning of reinforcing steel applies to abrasive blast cleaning of existing reinforcing steel that is either epoxy coated or uncoated reinforcing steel.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the abrasive blast cleaning items requiring the access shall include full compensation for all labour, Equipment, and Material to provide such access.



**CONSTRUCTION SPECIFICATION FOR
STRUCTURE REHABILITATION - CONCRETE PATCHES,
REFACING, AND OVERLAYS**

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APPENDICES

930-A	Commentary

930.01 SCOPE

This specification covers the requirements for concrete structure rehabilitation, including; concrete patches, concrete refacing, normal concrete overlays, and silica fume concrete overlays.

930.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

930.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

930.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Construction

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specification, Material

OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Structure Rehabilitation Manual

MTO Laboratory Testing Manual:

LS-430	Method of Test for Bond Strength by Tensile Load
LS-435	Method of Test for Linear Shrinkage of Concrete
LS-601	Materials Finer than 75 µm Sieve in Mineral Aggregates by Washing
LS-607	Determination of Percent Crushed Particles in Processed Coarse Aggregate

MTO Forms:

PH-CC-736	Notification of Placement of Concrete

CSA Standards

A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing*
C22.2 No. 211.2-M1984 (1992)	Rigid PVC (Un-plasticized) Conduit
G30.5-M1983 (R1998)	Welded Steel Wire Fabric for Concrete Reinforcement

* [Part of A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

A 53/A 53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A 123/A 123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A 153 - 09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
D 4285-83-(R2006)	Method for Indicating Oil or Water in Compressed Air

930.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Concrete Patches, Formed Surfaces means concrete patches where at least one face of the patch requires formwork.

Concrete Patches, Unformed Surfaces means concrete patches located in the top surface of decks, sidewalks, and curbs where no formwork is required.

Concrete Refacing means concrete refacing where at least one of the surfaces of a component is entirely overlaid with concrete. Concrete refacing typically applies to pier columns, pier caps, abutments, vertical walls of culverts and tunnels, concrete barrier, and parapet walls.

Form and Pump Placement Method means a method of placing concrete by pumping directly into formwork through injection ports.

Hot Weather means those conditions when the air temperature is at or above 28 °C. It is also considered to exist when the air temperature is at or is likely to rise above 28 °C within 24 hours after concrete placement. Temperature refers to shade temperature.

Injection Port means a mechanical device with a manual shut-off that is attached to the formwork and connected to the discharge line of a pump to facilitate delivery of concrete directly into the formwork.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Self-Consolidating Concrete (SCC) means a highly flowable yet stable concrete that can spread readily into place, fill the formwork, and encapsulate the reinforcement without any mechanical consolidation or vibration and without undergoing segregation or excessive bleeding. It may be designed for high strength and durability in addition to flow characteristics.

Segregation means visible separation of the mortar and coarse aggregate particles in the plastic concrete resulting in concrete that is not uniform in appearance or proportions.

Silica Fume Concrete means concrete which includes silica fume and may in addition include other supplementary cementing materials having specified rapid chloride permeability at 28 to 32 Days of 1,000 coulombs or less.

Structure means any bridge, culvert, tunnel, retaining wall, wharf, dock, guideway, or any part thereof or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

930.04 DESIGN AND SUBMISSION REQUIREMENTS

930.04.01 Design Requirements

930.04.01.01 Formwork and Falsework

Design submission shall be according to OPSS 919 with the following additional requirements:

- a) Working Drawings for soffit repairs shall be designed and sealed by an Engineer.
- b) Formwork and falsework for soffit repairs subjected to live traffic vibrations on the deck shall be designed for an additional dynamic load allowance of 50% the weight of plastic concrete being supported.

Timber formwork and falsework for soffit repairs shall be designed using permanent load duration factors and shall accommodate additional pressure due to pumping of repair concrete.

930.04.02 Submission Requirements

930.04.02.01 Notification of Placement of Concrete

Prior to each placing operation, form PH-CC-736, accompanied by all supporting documentation as indicated on the form shall be submitted to the Contract Administrator.

930.04.02.02 Cold Weather Protection

930.04.02.02.01 General

A description of the methods to be used to control the concrete temperature and temperature difference in cold weather shall be submitted to the Contract Administrator 3 Days prior to the commencement of concrete production. Cold weather is considered to exist when the air temperature is at or below 10 °C. It is also considered to exist when the air temperature is at or is likely to fall below 10 °C within 96 hours after concrete placement. Temperature refers to shade temperature. The submission shall be according to the Temperature Control Plans clause of OPSS 904.

930.04.02.02.02 Temperature Records

Datalogger temperature records and a record of any actions taken to maintain control of temperature and temperature difference shall be submitted to the Contract Administrator at the end of each Business Day during the temperature monitoring period. At the end of the temperature monitoring period, a complete temperature record shall be submitted to the Contract Administrator.

930.04.02.03 Concrete Mix Design

Concrete mix design submissions shall be according to OPSS 1350, with the additional requirement that test data for linear shrinkage shall be required and submitted within 40 Days of the mix design submission.

930.04.02.04 Hot Weather Concreting

A description of the methods to be used to control the concrete temperature shall be submitted to the Contract Administrator 3 Days prior to the commencement of concrete production in hot weather.

930.04.02.05 Placement Methods

When the form and pump placement method is specified in the Contract Documents or self-consolidating concrete is used, 4 copies of the details of the placement method shall be submitted to the Contract Administrator at least 3 Days prior to commencement of the work. The details shall include methodology and equipment to be used and shall bear the seal and signature of an Engineer.

930.04.02.06 Formwork and Falsework

Working Drawings for soffit repairs shall be submitted to the Contract Administrator 3 Days prior to the commencement of formwork and falsework installation, for information purposes only.

930.05 MATERIALS

930.05.01 General

The following materials shall be according to OPSS 904:

- a) Burlap.
- b) Insulation material.
- c) Moisture vapour barrier.

If a bonding agent is used, it shall be compatible with the repair material.

930.05.02 Anchors

Anchors for the attachment of the welded steel wire fabric to the concrete surface shall be galvanized according to ASTM A 153 and be of adequate length and strength to resist a pull-out force of 1.0 kN.

930.05.03 Concrete

The concrete shall be according to OPSS 1350 with the following modifications:

- a) The minimum specified 28-Day compressive strength shall be 30 MPa, except for silica fume overlays which shall be 40 MPa.
- b) Coarse aggregates for overlays shall consist of a minimum of 60% crushed particles when tested according to MTO LS-607 and shall have 1.00% by mass maximum passing the 75 µm sieve when tested according to MTO LS-601. Coarse aggregate for overlays that form the bridge deck riding surface shall be composed of at least 80% siliceous rocks and minerals.
- c) Linear shrinkage test data for each mix design shall be submitted for information purposes. Testing shall be carried out in accordance with LS 435 and specimens may be cast at the ready mixed plant or at the site. Laboratory testing shall be carried out by a laboratory who has participated in an MTO correlation program for linear shrinkage.

- d) For concrete patches where the longest dimension, width or length, of individual patches is less than 400 mm, a proposal may be submitted to the Contract Administrator for approval to use a proprietary patching material. The patching material shall be mixed, handled, and cured according to the manufacturer's instructions.
- e) SCC will be considered on an individual project basis for patches and refacing subject to the Contract Administrator's approval. If permitted for use, SCC shall be according to the ministry's current specification for SCC. A copy of the specification can be obtained from the Ministry's Material Engineering and Research Office, 1201 Wilson Avenue, Downsview, M3M 1J8.

930.05.04 Drainage Tubes

Rigid polyvinyl chloride (PVC) drainage tubes shall be according to CSA C22.2 No. 211.2. Galvanized steel drainage tubes shall be according to ASTM A53/A53M and galvanizing shall be according to ASTM A 123.

930.05.05 Forms

Forms shall be according to OPSS 919, with the exception that all forms shall be medium density overlay plywood.

930.05.06 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry's list of concrete patching materials.

930.05.07 Tie Wire

Tie wire shall be according to OPSS 905.

930.05.08 Welded Steel Wire Fabric

Welded steel wire fabric shall be welded galvanized steel and shall be according to CSA G30.5. Galvanizing shall be according to ASTM A 123.

930.05.09 Water

Water used for curing, fog-misting of concrete, pre-soaking of burlap, and bonding agent shall be according to OPSS 1302.

930.06 EQUIPMENT

930.06.01 General

The following equipment shall be according to OPSS 904:

- a) Bridge deck finishing machine, screed rails, screed rail chairs, and work bridges used for overlays.
- b) Consolidating equipment.
- c) Hand finishing tools.
- d) Straight edges.

930.06.02 Buggies

Buggies used for transporting and placing the concrete may be hand operated or motorized. Motorized concrete buggies shall have a capacity no greater than 0.5 m³.

930.06.03 Compressor - Air Blasting

The compressed air shall be clean, dry, and free from oil residue and other contaminants when tested according to ASTM D 4285.

930.06.04 Fog Misting Equipment

Fog misting equipment shall be provided for the curing of the silica fume concrete overlays. Hand held fogging wands shall be used.

A fogging system mounted on the finishing machine may also be used, provided it does not result in dripping or accumulation of water on the concrete surface.

930.06.05 Form and Pump Placement Method Equipment

When the form and pump placement method is specified in the Contract Documents, the pump shall be a positive displacement type pump and shall be capable of delivering adequate volumes of concrete to maintain a continuous placement.

930.06.06 Sawing Equipment - Overlays

The sawing equipment shall be self-propelled and capable of sawing the concrete overlay full depth in one pass.

930.07 CONSTRUCTION

930.07.01 General

Typical locations and areas of repair are as shown on the Contract Drawings; however, the actual locations and extent of repair shall be as determined during the layout of the repair areas according to OPSS 928 and as directed by the Contract Administrator.

930.07.02 Operational Constraints

The Contract Administrator shall be notified of the intent to place the overlay, concrete patches, or concrete refacing 1 Business Day prior to the commencement of the placing operation. The work shall not proceed until the concrete surface preparation has been completed and form PH-CC-736 has been received and signed by the Contract Administrator.

Construction equipment shall be permitted on the bridge deck or other concrete components, provided that:

- a) Contamination by oil or other deleterious substances is prevented.
- b) Equipment vehicles and runways are not supported by steel reinforcement.
- c) Only the finishing machine and buggies used to place concrete are allowed on the abrasive blast cleaned portions of the deck or other concrete components. No other vehicles or equipment, including concrete ready mix trucks shall be permitted.

- d) Heavy vehicles such as concrete ready mix trucks or dump trucks shall not be permitted on any portion of the deck, within a span, once concrete removals within the deck have commenced in that span.

No construction vehicles, equipment, or traffic, with the exception of sawcutting equipment shall be permitted on the finished surface of the overlay, patches, and on deck surface directly over soffit patches or refacing until the curing and cold weather protection period has been completed and a minimum compressive strength of 25 MPa has been attained.

Prior to seasonal shutdown, operations shall be scheduled in such a manner to ensure that overlays, concrete patches, and concrete refacing are completed in all areas where concrete removal has commenced. No steel reinforcement shall be left exposed during seasonal shutdown.

**930.07.03 Normal Concrete Overlay
 Silica Fume Concrete Overlay**

930.07.03.01 Minimum Thickness of Overlay

The thickness of the overlay shall be according to the requirements of the Contract Drawings with no areas less than 45 mm in thickness.

930.07.03.02 Surface Preparation

All concrete surfaces against which new concrete is to be placed shall be clean, sound and free from loose or unsound fragments, coatings and any other foreign substances or debris, and shall be sufficiently rough to ensure that a full bond is developed with the new concrete.

A bonding agent may be used. The Contract Administrator shall be notified in writing whether a bonding agent is to be used and, if so, the bonding agent shall be identified.

The portion of curb face, barrier wall or parapet wall, and all existing concrete surfaces which have not been scarified, against which new concrete is to be placed, shall be uniformly roughened by means of scabbling, chipping, or bush hammering. A surface profile of 5 ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All concrete surfaces and steel reinforcement to receive the overlay shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface by using compressed air, except where anode mesh is to be used.

When anode mesh is required, the concrete surface shall be pressure washed with water using a pressure not less than 10 MPa with the anode mesh in place. The pressure washing shall take place immediately prior to pre-wetting. All debris resulting from drilling of anchor holes and other accumulated dirt adhering to the anode or concrete surfaces shall be removed.

All concrete surfaces to receive an overlay shall be pre-wetted and continuously maintained in a wet condition for a minimum period of 6 hours immediately prior to the application of the concrete overlay or bonding agent when used. Excess water shall be removed from the surface using compressed air immediately prior to the application of the bonding agent or concrete overlay.

930.07.03.03 Placing of Screed Rails

Supports for the screed rails shall be installed outside the area to be overlaid or waterproofed. The screed rails shall be continued beyond the deck, at each end, to a length that will enable the finishing machine to be driven beyond the end of deck.

930.07.03.04**Dry Run**

A dry run shall be made to verify that the minimum thickness of the overlay can be achieved, in the presence of the Contract Administrator, prior to each placing operation.

The Contract Administrator shall be notified at least 1 Business Day in advance of a dry run. When the dry run indicates that an unsatisfactory thickness will result, the screed rails shall be adjusted in order to obtain the minimum thickness and the dry run repeated in the area of screed rail adjustment.

For silica fume concrete overlays, the ability to successfully fog mist shall be demonstrated to the Contract Administrator at the time of the dry run. The same equipment and process shall be used to fog mist the overlay.

930.07.03.05**Placing of Concrete**

The placing of concrete shall be according to OPSS 904 with the following modifications:

- a) Concrete shall not be placed when the ambient air temperature or existing concrete surface temperature is below 10 °C or likely to fall below 10 °C, or is above 30 °C or likely to rise above 30 °C throughout the duration of the concrete placing operation.

Prior to placing new concrete, it shall be demonstrated to the Contract Administrator that the substrate temperatures meet the Contract requirements, by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

- b) Concrete shall not be placed adjacent to any new concrete less than 48 hours old. If the ambient air temperature falls below 10 °C within the first 48 hours after placement of concrete, the 48 hour time requirement shall be extended to 96 hours.

In addition, for staged overlay construction, concrete shall not be placed adjacent to any new concrete having a compressive strength less than 20 MPa.

- c) All concrete overlay 3 m or wider shall be placed with bridge deck finishing equipment.
- d) Any concrete or bonding agent deposited in areas other than the intended point of discharge shall be removed immediately.
- e) Unless otherwise specified in the Contract Documents, concrete for partial depth removal areas shall be placed at the same time as the overlay. Concrete for full depth removal areas shall be placed prior to placing the overlay and left with a rough surface finish.
- f) Cold joints shall not be permitted.

930.07.03.06**Construction Joints**

Construction joints shall be permitted only where shown in the Contract Drawings or in the case of unexpected interruptions during the placing operation, as directed by the Contract Administrator.

All construction joints shall be formed using bulkheads. The height of the bulkhead shall match the thickness of the overlay.

The edge and face created by the bulkhead shall be a clean vertical face free from any defects such as honeycombing or spalls. If the construction joint formed by the bulkhead is deemed unacceptable by the Contract Administrator, a new construction joint shall be created by sawcutting back to a limit where the quality of concrete is acceptable to the Contract Administrator.

930.07.03.07 Surface Finish

The surface finish shall be according to OPSS 904.

930.07.03.08 Surface Tolerance

The surface tolerance shall be according to OPSS 904.

930.07.03.09 Surface Texture

Where the surface of the overlay forms the driving surface of the bridge deck, the surface shall be given a texture with a wire broom or comb having a single row of tines. The required texture shall be transverse grooves which may vary from 1.5 mm width at 15 mm centres to 4.5 mm width at 20 mm centres with a groove depth varying from 3.0 mm to 4.5 mm. The texture shall extend uniformly to within 300 mm of the curb or barrier wall or parapet wall.

930.07.03.10 Curing

Normal concrete overlay shall be cured according to the requirements for Curing with Burlap and Water clause of OPSS 904 for a minimum curing period of 4 Days, except that for concrete subjected anytime to cold weather during the first 96 hours after concrete placement, the curing period shall be extended to 7 Days.

Silica fume concrete overlay shall be cured according to the requirements for high performance concrete (HPC) of OPSS 904 for a minimum curing period of 7 Days.

Where waterproofing is to be applied to an overlay following curing with burlap and water, the overlay shall be air dried for at least 72 hours prior to the application of waterproofing.

930.07.04 Concrete Patches, Formed Surface Concrete Patches, Unformed Surface Concrete Patches, Form and Pump Concrete Refacing Concrete Refacing, Form and Pump

930.07.04.01 Surface Preparation

All concrete surfaces against which new concrete is to be placed shall be clean, sound and free from loose or unsound fragments, coatings, and any other foreign substances or debris and shall be sufficiently rough to ensure that a full bond is developed with the new concrete.

A bonding agent may be used. The Contract Administrator shall be notified in writing whether a bonding agent is to be used and, if so, the bonding agent shall be identified.

All existing concrete surfaces against which new concrete is to be placed shall be uniformly roughened by means of scabbling, chipping, or bush hammering. A surface profile of 5 ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All concrete surfaces and steel reinforcement to receive new concrete shall be abrasive blast cleaned according to OPSS 929.

Immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface of the repair area by using compressed air.

The surface of the existing concrete shall be pre-wetted and continuously maintained in a wet condition for a period of 6 hours immediately prior to placing any new concrete. Prior to placing concrete, excess water shall be removed from the surface using compressed air.

930.07.04.02**Placement of Welded Steel Wire Fabric**

When welded steel wire fabric is specified in the Contract Documents, it shall not be installed until after the concrete surface and exposed steel reinforcement in the repair area have been abrasive blast cleaned. The welded steel wire fabric shall not be abrasive blast cleaned at any time.

Where there is no exposed steel reinforcement, the wire fabric shall be fastened to the concrete with anchors placed no further than 600 mm apart, in a grid pattern.

Where steel reinforcement is exposed, the wire fabric shall be securely fastened to the steel reinforcement by tie wires placed no further than 600 mm apart, in a grid pattern. When the exposed steel reinforcement is not capable of providing rigid support for the wire fabric, anchors shall be used to support the wire fabric.

The wire fabric shall be installed flat, tight, and at the locations shown in the Contract Drawings using spacers and anchors. The edges of adjoining wire fabric shall overlap by two-wire spacing plus 100 mm. The wire fabric shall be kept clean of any contamination that could reduce the bond of the repair material to the wire surface.

930.07.04.03**Installation of Anchors and Dowels**

Holes for anchors and dowels shall be drilled into the concrete at the location and spacing as specified in the Contract Documents. They shall be installed in such a way as to not cause delamination or other damage to the surrounding concrete. Each anchor used to fasten the welded steel wire fabric into the concrete shall be installed to resist a pull out force of at least 1.0 kN at either sides of the concrete interface.

930.07.04.04**Formwork and Falsework**

The erection and removal of formwork and falsework shall be according to OPSS 919 and it shall be designed to retain the concrete and withstand the placement pressures. The formwork shall be placed to provide the specified cover to steel reinforcement or welded steel wire fabric, or both, as specified in the Contract Documents. When this results in over-building of the existing concrete surface, a 1H:1V slope shall be provided to meet the existing surface at the edges of the repair area. The perimeter of the formwork shall be sealed to be grout-tight. Vent holes shall be installed at the highest locations.

930.07.04.05**Placing of Concrete**

The placing of concrete shall be according to OPSS 904 with the following modifications:

- a) Concrete shall not be placed when the ambient air temperature or existing concrete surface temperature is below 10 °C or likely to fall below 10 °C or is above 30 °C or likely to rise above 30 °C throughout the duration of the concrete placing operation.

Prior to placing new concrete, it shall be demonstrated to the Contract Administrator that the substrate temperatures meet the Contract requirements by measuring and recording the substrate temperatures using a contact thermometer or infrared thermometer.

- b) Concrete shall not be placed adjacent to any new concrete less than 48 hours old. If the ambient air temperature falls below 10 °C within the first 48 hours after placement of concrete, the 48 hour time requirement shall be extended to 96 hours.
- c) For form and pump method, the port arrangement and pumping procedures shall be designed to ensure that requirements of this specification are met.
- d) Cold joints shall not be permitted.

930.07.04.06 Construction Joints

Construction joints in concrete shall be permitted at the locations shown on the Contract Drawings and shall be according to OPSS 904. Any additional construction joints required to suit the construction operation and to meet the specified crack control criteria shall be subject to approval by the Contract Administrator.

930.07.04.07 Surface Finish

The surface finish shall be according to OPSS 904.

930.07.04.08 Surface Tolerance

The surface tolerance shall be according to OPSS 904.

930.07.04.09 Curing

930.07.04.09.01 General

Normal concrete shall be cured for a minimum period of 4 Days, except that for concrete subjected anytime to cold weather during the first 96 hours after concrete placement the curing period shall be extended to 7 Days.

930.07.04.09.02 Unformed Surfaces

Concrete shall be cured for the full duration of the curing period according to the Curing with Burlap and Water clause in OPSS 904. The burlap and the moisture vapour barrier shall then be removed and the concrete permitted to air dry for not less than 72 hours prior to any application of tack coat for waterproofing, where applicable.

930.07.04.09.03 Formed Surfaces

930.07.04.09.03.01 General

All exposed concrete surfaces of formed components shall be cured as specified in the Unformed Surfaces clause.

930.07.04.09.03.02 Concrete Patches, Formed Surface Concrete Patches, Form and Pump

Curing shall be according to the following:

- a) If the formwork is left in place for the duration of the curing period, no additional curing shall be required.
- b) Where the formwork is to be removed within the specified curing period, curing shall be applied as specified in the Unformed Surfaces clause, curing shall be applied immediately after removal of the formwork and remain in place until the end of the curing period. Under no circumstance shall the concrete be left uncured for more than 2 hours during the removal of formwork.

930.07.04.09.03.03 Concrete Refacing Concrete Refacing, Form and Pump

Burlap and water shall be applied immediately to the top of all exposed concrete surfaces, within 2 to 4 m of the finishing operation. The burlap shall be soaked for 24 hours prior to placing and shall be kept continuously wet by means of an operating soaker hose placed along the top of the component being refaced. The soaker hose shall be placed immediately after the concrete has set and its operation shall not cause fines to be washed out.

Forms for all surfaces, except soffit for structural components, shall be removed within 16 to 24 hours of concrete placement, unless the Contractor is unable to remove the forms due to structural concerns. All concrete surfaces shall be immediately covered with wet burlap and moisture vapour barrier for the remainder of the minimum curing period according to the requirements of Curing with Burlap and Water clause in OPSS 904. Under no circumstance shall the concrete be left uncured for more than 2 hours during the removal of the formwork.

Forms for soffit of structural components including decks, pier caps, beams, and arch ribs shall not be removed until the full curing time has elapsed.

930.07.05 Cold Weather Protection

930.07.05.01 General

Concrete shall be protected during cold weather. The protection system shall be designed for the worst conditions that can be reasonably anticipated from local weather records, forecasts, site conditions, and past experience for the time period during which the protection is required.

Regardless of ambient air temperature, overlays shall be moist cured with burlap and water at all times. During cold weather, burlap shall be prevented from freezing.

930.07.05.02 Control of Temperature and Temperature Difference

During cold weather, the temperature of the concrete shall be monitored and controlled according to the Control of Temperature and Temperature Difference subsection in OPSS 904, with the following exceptions:

- a) Thermocouple wires shall be embedded near the concrete surface in a minimum of 4 locations for each Day of concrete placement, as directed by the Contract Administrator. Thermocouples for monitoring ambient air temperature shall be installed in the shade close to the surface of the concrete at a minimum frequency of 1 thermocouple for each Day of placement.
- b) For cold weather conditions, protection of concrete shall, at a minimum, be as shown in Table 1. Protective measures shall be increased based on consideration of the specific type of rehabilitation in order to comply with the specified temperature constraints, as required.
- c) The cold weather protection shall be gradually removed or reduced in such a manner that the maximum allowable drop of concrete temperature for each 24 hour period as shown in Table 1 is not exceeded. The protection shall not be totally removed nor shall the concrete be fully exposed to the air until the average concrete temperature is within 10 °C of the air temperature.

930.07.06 Material Sampling and Testing

930.07.06.01 Plastic Concrete Testing

The sampling and testing of the plastic concrete for slump, air content, and temperature shall be according to OPSS 1350 with the exception that the minimum frequency of testing shall be one test from each load of concrete. Results shall be recorded and shall be submitted to the Contract Administrator, upon request.

930.07.06.02 Early Strength Determination

Where early loading of concrete is proposed or anticipated, sets of cylinders for testing for early strength determination shall be prepared according to OPSS 904.

930.07.06.03 Samples for Compressive Strength, Air Void System Parameters and Rapid Chloride Permeability - Acceptance Testing

The Contractor shall be responsible for sampling and transportation of samples for acceptance testing of compressive strength, air void system, and rapid chloride permeability by the Owner according to OPSS 1350.

930.07.06.03.01 Samples for Acceptance Testing Where Rehabilitation Involves the Use of Anode Mesh Cathodic Protection

Cylinders for acceptance testing of compressive strength shall be according to OPSS 1350.

Where anode mesh is used, cores shall not be required and cylinders shall be cast for determination of air void system and rapid chloride permeability. One cylinder shall be made for determination of air void system parameters to represent each 300 m² of surface area of overlay and for each 100 m² of surface area of patches and refacing placed.

For silica fume overlays, two additional cylinders shall be made for determination of rapid chloride permeability to represent each 300 m² of surface area of overlay placed. One cylinder shall be used for acceptance testing and the remaining cylinder shall be retained for referee testing.

The cylinders shall be 100 mm diameter x 200 mm long and shall be made, field cured, and transported according to the Test Cylinders clause in OPSS 1350.

930.07.06.04 Tensile Bond Strength

The following shall be marked to facilitate the selection of testing locations and avoid damage to the embedded materials due to coring:

- a) For rehabilitation involving use of anode mesh cathodic protection in overlay, the locations of anode distribution bars, wiring, and embedded hardware.
- b) For rehabilitation involving use of glass fiber reinforced polymer (GFRP) reinforcing, the reinforcing bar locations.

Application of tack coat, where applicable, shall not be carried out until the testing of tensile bond strength is completed.

930.07.06.05 Filling of Core Holes

Filling of core holes shall be according to OPSS 1350.

930.07.07 Remedial Work

Remedial work shall be carried out as shown in Table 2.

Treatment for deck with waterproofing and paving shall not begin until the specified curing period and the air drying period has elapsed. For all other exposed components, the treatment shall not begin until a minimum period of 28 Days has elapsed after placement of concrete.

Repair of cracks shall be according to OPSS 932. Alternatively, a proposal for repair may be submitted to the Contract Administrator for review to show that the repair method and material shall be able to restore the structural integrity of the concrete across the cracks. The inspection and monitoring of cracks shall continue up to the date of waterproofing or completion of the Work, whichever is later.

The application of tack coat for waterproofing shall not proceed until all defects have been addressed and remedial work accepted by the Contract Administrator.

930.07.08 Modification of Deck Drains

Modification of deck drains shall be made prior to waterproofing the deck.

930.07.09 Drainage Tubes in Deck

Installation of drainage tubes shall be made prior to waterproofing the deck.

930.07.10 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

930.08 QUALITY ASSURANCE

930.08.01 Testing - Tensile Bond Strength

The Contract Administrator shall use a covermeter to locate steel reinforcement prior to testing in order to avoid coring through the steel and shall perform the sampling and testing of cores from overlays, concrete patches, and concrete refacing to determine tensile bond strength.

A lot shall consist of the total quantity of concrete patches, concrete refacing, or overlay for each item, except for the following where tensile bond shall not be measured:

- a) When the total measured area of concrete patches on a structure is less than 20 m².
- b) When the total area of concrete refacing on a structure is less than 20 m².
- c) In circular columns with spiral reinforcement.

Each lot shall be divided into sublots as follows:

- a) Sublots for overlays shall be approximately equal in size and not greater than 300 m². Separate sublots are required for each overlay placement.
- b) Sublots for concrete patches shall not be combined with areas of concrete refacing for determining sublots. Sublots shall be approximately equal in size and not greater than 100 m². Work on different structures shall not be combined in the same subplot.
- c) Soffit repairs shall be a separate subplot and a subplot shall not be greater than 100 m².

The tensile bond strength testing shall be carried out on 3 in-situ cores taken within 1 m of each other for each subplot. The core locations shall be randomly selected by the Contract Administrator. Additional testing shall not be permitted.

The cores shall be obtained by the Contract Administrator according to CSA A23.2-14C. Cores shall be 100 mm in diameter and extend into the parent concrete to the depth as specified in LS-430. The testing shall be according to LS-430 and shall be carried out when the concrete is 7 to 10 Days of age. The equipment used to measure the tensile bond strength shall be equipped with a maximum load indicator.

If a core comes loose during coring operation, another core shall be obtained within 300 mm of the original core location.

If failure occurs in the epoxy adhesive and the specified strength of 1.0 MPa has not been reached, the test shall be repeated within 300 mm of the original core location. If a failure occurs fully within the parent concrete, this shall be considered a valid result, unless the Contractor has been directed to leave unsound concrete in place. Retesting is not required when the specified strength of 1.0 MPa has been achieved

Individual test results shall be forwarded to the Contractor, as they become available.

930.08.02 Inspection After Curing

The Contract Administrator shall inspect the Work to determine if the completed work contains any of the following defects:

- a) Areas of debonding.
- b) Honeycombed areas, spalls, and cold joints.
- c) Cracks requiring remedial work as shown in Table 2.

930.08.03 Acceptance

930.08.03.01 Concrete Compressive Strength, Air Void System in Hardened Concrete or Rapid Chloride Permeability for Silica Fume Overlays

Acceptance, referee testing and referee testing cost of concrete compressive strength, air void system in hardened concrete, and rapid chloride permeability for silica fume overlays shall be according to OPSS 1350.

930.08.03.02 Tensile Bond Strength

For a subplot to be acceptable, the average tensile bond strength of the subplot shall be a minimum of 1.0 MPa. Sublots with average tensile bond strength less than 1.0 MPa and more than or equal to 0.8 MPa shall be accepted with payment reduction. The payment reduction factor (Pr_i) for the tensile bond strength testing for each subplot shall be calculated based on the following equation:

$$Pr_i = 1.25 (1 - B)$$

Where:

B = The average tensile bond strength (MPa) for each subplot. For the purpose of calculating the payment reduction factor, a value of 1.0 MPa shall be used for B when the average tensile bond strength is greater than 1.0 MPa.

i = Sublot number

The payment reduction, Pr , for the lot is calculated by one of the following equations:

For the concrete patches, concrete refacing, place concrete overlay, and place silica fume concrete overlay items, the following equation shall be used:

$$Pr = \text{Tender Unit Price} \times [(Pr_1 \times LQ_1) + (Pr_2 \times LQ_2) \dots (Pr_n \times LQ_n)]$$

Where:

Pr_i = The payment reduction for subplot i

LQ_i = Quantity for subplot i (m^3)

n = The total number of sublots

For the finish and cure concrete overlay and finish and cure silica fume concrete overlay items, the following equation shall be used:

$$Pr = \frac{\text{Lump Sum} \times [(Pr_1 \times SA_1) + (Pr_2 \times SA_2) \dots (Pr_n \times SA_n)]}{SA_T}$$

Where:

Pri = The payment reduction for subplot i

SA_i = Surface area for subplot i (m²)

SA_T = Total surface area of the lot (m²)

n = The total number of sublots

For the purpose of calculating the payment reduction for concrete overlays, the Pr shall be applied to both place concrete overlay and finish and cure concrete overlay items.

For the purpose of calculating the payment reduction for silica fume concrete overlays, the Pr shall be applied to both place silica fume concrete overlay and finish and cure silica fume concrete overlays items.

930.08.03.03 Acceptance at the Completion of Work

The Contract Administrator shall reject all or a portion of the subplot based on:

- a) The presence of debonding, honeycombed areas, spalls and cold joints.
- b) Cracks as shown in Table 2.
- c) Average tensile bond strength less than 0.8 MPa.
- d) Any work that does not meet the requirements of this specification and the acceptance requirements of OPSS 1350.
- e) Unsatisfactory completion of remedial work associated with surface tolerance, surface finish, cracks, or any other deficiencies.

930.08.03.04 Performance During General Warranty Period

In addition to the acceptance requirements stated herein, concrete in the structure shall meet the requirements as shown in Table 2 during and up to the end of the general warranty period.

930.09 MEASUREMENT FOR PAYMENT

930.09.01 General

For all types of overlays, there shall be no measurement for the following:

- a) Concrete produced in excess of that required for the placing operation.
- b) Quantity of bonding agent.

For construction joints in overlay that do not meet the requirements specified in this specification and is deemed unacceptable by the Contract Administrator, the portion of overlay removed shall be deducted from the volume indicated on the delivery ticket.

No measurement shall be made for areas of new overlays, concrete patches, and concrete refacing that were removed according to the requirements of the Remedial Work subsection.

930.09.02 Actual Measurement

**930.09.02.01 Place Concrete Overlay
Place Silica Fume Concrete Overlay**

Measurement shall be by the volume of concrete placed, including concrete placed in partial depth removals, in cubic metres by delivery ticket. Deductions shall be made for the following:

- a) Concrete produced in excess of that required for the placing operation.
- b) The portion of the overlay that is sawcut back and removed at the construction joint.
- c) The portion of concrete removals not approved by the Contract Administrator.

The total volume shall be calculated to the nearest cubic metre.

**930.09.02.02 Concrete Patches, Formed Surface
Concrete Patches, Unformed Surface
Concrete Patches, Form and Pump
Concrete Refacing
Concrete Refacing, Form and Pump**

930.09.02.02.01 By Volume

Measurement shall be by the volume of concrete placed in cubic metres.

The volumes shall be calculated by multiplying each area to be patched by the average depth. Depths shall be taken on a grid system to best describe the profile at the particular area. The Contract Administrator, in the presence of the Contractor, shall take a minimum of 3 measurements for each removal area or 10 for every m², after concrete removal is completed by placing a straight edge across the removal area and measuring the depth from the straight edge to the concrete.

The depths shall be measured and averaged to the nearest millimetre.

No measurement shall be made for concrete required to fill localized areas behind the second layer of steel reinforcement.

The total volume shall be calculated to the nearest 0.1 m³.

930.09.02.03 Modification of Deck Drains

For measurement purposes, a count shall be made of the number of deck drains modified.

930.09.02.04 Drainage Tubes in Deck

For measurement purposes, a count shall be made of the number of drainage tubes placed.

930.09.03 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

930.10**BASIS OF PAYMENT****930.10.01**

Modification of Deck Drains - Item
Drainage Tubes in Deck - Item
Place Concrete Overlay - Item
Place Silica Fume Concrete Overlay - Item
Finish and Cure Concrete Overlay - Item
Finish and Cure Silica Fume Concrete Overlay - Item
Concrete Patches, Formed Surface - Item
Concrete Patches, Unformed Surface - Item
Concrete Patches, Form and Pump - Item
Concrete Refacing - Item
Concrete Refacing, Form and Pump - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work, subject to payment adjustments as specified in the Contract Documents. Payment at the Contract price for the above tender items shall also include abrasive blast cleaning of the concrete surface for concrete patches and concrete refacing. Payment for abrasive blast cleaning of steel reinforcement and the concrete surface to receive an overlay shall be administered according to OPSS 929.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the concrete patching and concrete refacing items shall include full compensation for all labour, Equipment, and Material to do the work, including provision of access.

No payment shall be made for normal concrete, silica fume concrete or self-consolidating concrete or both required to patch, reface, or overlay areas of concrete removal where the removal was not approved by the Contract Administrator.

TABLE 1
Minimum Cold Weather Protective Measures

Anticipated Minimum Air Temperature °C	Protective Measure
+10 to +6	PM2
+5 to 0	PM3
-1 to -5	PM4
-6 and lower	PM5
Maximum Allowable Drop in Concrete Temperature / 24 hours	15 °C
PM2 - Protective Measure - Cover concrete with insulation having an R-Value of 0.67 ** PM3 - Protective Measure - Cover concrete with insulation having an R-Value of 1.33 ** PM4 - Protective Measure - Cover concrete with insulation having an R-Value of 2.00 ** PM5 - Protective Measure - House and heat according to the Housing and Heating clause of OPSS 904. ** Note: All R-Values are metric. The conversion factor from metric to imperial unit is: Metric R value x 5.678 = Imperial R value	

Table 2
Performance Requirements at Time of Construction and During Warranty Period

	Test Method	Performance Requirements	Consequence of Non-Conformance
Concrete Surface Scaling	Visual inspection and assessment of severity of-scaling according to Figures 1 to 6.	At the end of the warranty period, there shall be no medium or severe scaling and total area of light scaling shall be no more than 5% of the component.	Areas of medium and severe scaling shall be removed and replaced full depth. For light scaling greater than 5% of the component, the Contractor shall submit a repair proposal for approval by the ministry.
Concrete Delamination or Debonding	As described in the Structure Rehabilitation Manual.	Delaminated or debonded areas shall not be present.	Remove and replace.
Cracks	Visual inspection and measurement by means of crack comparator. Width of crack is measured at the widest point of the crack, not average width of crack. Cracks in overlays and patches to be waterproofed shall be measured after the air drying period.	For overlays and patches to be waterproofed and paved, width of cracks shall be less than 0.50 mm and linear measurement of cracks greater than 0.50 mm within 1 m ² shall be less than 2 m.	Repair cracks greater than 0.50 mm in width according to OPSS 932, unless the linear measurement of cracks greater than or equal to 0.50 mm per m ² exceeds 2 m. If the linear measurement of cracks greater than 0.50 mm in width exceeds 2 m per m ² , remove and replace.
		For exposed overlays, refacing and patches, width of cracks shall be less than 0.30 mm and linear measurement of cracks greater than 0.30 mm within 1 m ² shall be less than 2 m.	Repair cracks greater than 0.30 mm in width according to OPSS 932, unless the linear measurement of cracks greater than or equal to 0.30 mm per m ² exceeds 2 m. If the linear measurement of cracks greater than 0.30 mm in width exceeds 2 m per m ² , remove and replace.
Spalls, Exposed Reinforcement, Honey-Combing, and Other Observed Unanticipated Defects and Deterioration	Visual inspection.	Spalls, exposed reinforcement, honey-combing, or other observed defects and deterioration shall not be present at the end of the warranty period.	Remove and replace.
Note: A. Where the area failing to meet the performance requirement is a large proportion of the repair area, the entire repair shall be removed and replaced.			

FIGURE 1
Example of Light Scaling



FIGURE 2
Example of Light Scaling



FIGURE 3
Example of Medium Scaling



FIGURE 4
Example of Medium Scaling



FIGURE 5
Example of Severe Scaling



FIGURE 6
Example of Severe Scaling



Appendix 930-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
STRUCTURE REHABILITATION - SHOTCRETE**

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931.01 SCOPE

This specification covers the requirements for concrete structure rehabilitation using shotcrete.

931.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction:

OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 932	Crack Repair - Concrete

Ontario Provincial Standard Specifications, Material:

OPSS 1002	Aggregates - Concrete
OPSS 1301	Cementing Materials

OPSS 1302	Water
OPSS 1303	Admixtures for Concrete
OPSS 1306	Burlap
OPSS 1315	White Pigmented Curing Compounds for Concrete
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete

Ontario Ministry of Transportation Publications

Structure Rehabilitation Manual

MTO Laboratory Testing Manual:

LS-430	Method of Test for Bond Strength by Tensile Load
LS-433	Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Penetration

MTO Forms:

PH-CC-433A	Concrete Mix Design Submission Form A
PH-CC-701	Request to Proceed
PH-CC-702	Notice to Proceed

CSA Standards

A23.1:19/A23.2:19	Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practice for Concrete*
A23.2-14C	Obtaining and Testing Drilled Cores for Compressive Strength Testing
A3001	Cementitious Materials for Use in Concrete**
	* [Part of A23.1:19/A23.2:19 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]
	** [Part of A3000-18 - Cementitious Materials Compendium]

ASTM International

A153 / A153M - 16a	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A1022 / A1022M - 16b	Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
A1064 / A1064M - 18a	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
D4285-83(2018)	Method of Indicating Oil or Water in Compressed Air

931.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cold Weather means those conditions when the air temperature is less than or equal to 10°C. It is also considered to exist when the air temperature is at or is likely to be less than 10°C within 96 hours after concrete placement. Temperature refers to shade temperature.

Dry Mix Shotcrete means the dry materials are prebagged and mixed and placed into a stream of compressed air. Material is carried by the compressed air through a delivery hose to the nozzle where water is added. Water is added to the mixture as it is jetted from the nozzle.

Hot Weather means those conditions when the air temperature is greater than or equal to 28°C. It is also considered to exist when the air temperature is at or is likely to be greater than 28°C within 24 hours after concrete placement. Temperature refers to shade temperature.

Nozzleman means the qualified worker on the shotcrete crew who has obtained ministry approval for Shotcrete Nozzleman Certification who manipulates the nozzle, controls consistency and controls final disposition of the material.

Rehabilitation means any modification, alteration, or improvement to a structure or its components that is designed to correct defects or deficiencies.

Structure means any bridge, structural culvert, tunnel, retaining wall, wharf, dock, guide way or any part thereof or other reinforced concrete component designed to carry loads.

Saturated Surface Dry means concrete is fully saturated without free standing water.

Wet Mix Shotcrete means shotcrete in which all of the materials, including water, are mixed before introduction into the delivery hose. Compressed air is introduced to the material flow at the nozzle.

931.04 DESIGN AND SUBMISSION REQUIREMENTS

931.04.01 Submission Requirements

931.04.01.01 Mix Design for Dry Mix Shotcrete

A minimum of seven Days prior to the application of shotcrete, the mix design including sources of all materials and the name of the supplier for the pre-bagged dry mix shotcrete shall be submitted to the Contract Administrator.

In addition, the following information shall be submitted with the mix design:

- a) A certificate from the cement supplier stating that the cement is certified to be free from early stiffening tendencies.
- b) Performance test data from the manufacturer of the prebagged material, where testing was carried out by a laboratory independent of the manufacturer, or test data from another MTO Contract, verifying that the pre-bagged material is capable of meeting the requirements of this specification.

The certificate and supporting test data shall be current within 12 months at the time the mix design is submitted to the Contract Administrator.

931.04.01.02 Mix Design for Wet Mix Shotcrete

The wet mix shotcrete shall be designed to meet the requirements of this specification. The mix design shall be submitted according to the Mix Design clause of OPSS 1350.

Documentation verifying certification of the concrete production facility by the Ready Mixed Concrete Association of Ontario (RMCAO) shall be submitted with the completed MTO form PH-CC-433A (Form A).

931.04.01.03 Shotcrete Equipment

A minimum of seven Days prior to the application of shotcrete, the following information shall be submitted to the Contract Administrator:

- a) Equipment type and capacity
- b) Nozzle type and size
- c) Continuous feed predampener details, if the dry mix process is used

931.04.01.04 Nozzleman

A minimum of seven Days prior to the commencement of the shotcreting operation, the names of the nozzle men and proof of their qualification with photo identification shall be submitted to the Contract Administrator.

931.04.01.05 Cold Weather Protection

In cold weather, a temperature control plan shall be submitted to the Contract Administrator a minimum of seven Days prior to the application of shotcrete. The submission shall be according to the Temperature Control Plans clause of OPSS 904.

When requested by the Contract Administrator, samples of insulation materials shall also be submitted.

931.04.01.06 Hot Weather Shotcreting

In hot weather, a plan describing the methods to be used to control the shotcrete temperature shall be submitted to the Contract Administrator a minimum of seven Days prior to the application of shotcrete.

931.04.01.07 Curing

A minimum of seven Days prior to the application of shotcrete, a description of the methods to be used for fog-misting and curing the shotcrete, including equipment and procedures to be used, shall be submitted to the Contract Administrator.

931.05 MATERIALS

931.05.01 Admixtures

Admixtures shall be according to OPSS 1303.

931.05.02 Aggregates

Aggregates shall be according to OPSS 1002.

931.05.03 Anchors

Anchors for the attachment of the welded steel wire reinforcement to the concrete surface shall be galvanized according to ASTM A153 and shall be of adequate length and strength to resist a pull-out force of 1.0 kN. When stainless welded steel wire reinforcement is used, anchors and tie wires shall be made of the same type of stainless steel.

931.05.04 Burlap

Burlap shall be according to OPSS 1306.

931.05.05 Cementing Material

Cementing materials shall be according to OPSS 1301 and CSA A3001.

931.05.06 Curing Compound

Curing compound shall be according to OPSS 1315.

931.05.07 Formwork

Formwork shall be according to OPSS 919.

931.05.08 Proprietary Patching Materials

Proprietary patching materials shall be from the Owner's prequalified product list. The list of proprietary patching materials shall be obtained from the Contract Administrator.

931.05.09 Shotcrete**931.05.09.01 General**

Shotcrete shall have a minimum 28-day compressive strength of 35 MPa and maximum rapid chloride permeability less than or equal to 1000 coulombs, when tested at the age of 28-32 Days. The shotcrete mix shall contain 8% silica fume by mass of total cementing materials. Fibres shall not be used in the shotcrete.

Dry mix shotcrete shall be used, unless otherwise specified in the Contract Documents.

931.05.09.02 Additional Requirements for Dry Mix Shotcrete

For dry mix shotcrete, the shotcrete mix shall be supplied pre-bagged and unopened. Each bag shall be stamped with the following:

- a) name of the manufacturer
- b) mix identification
- c) manufacturer's batch number
- d) date of packaging

The pre-bagged mix shall contain cementing materials and aggregates. The bags shall be maintained in a dry condition up to the time of use and shall be stored within a temperature range of 10°C to 30°C. Material from bags that contain lumps of hydrated shotcrete or appear to be frozen or otherwise damaged shall not be used in the work. The pre-bagged mix shall be used within the six months of date of packaging.

931.05.09.03 Additional Requirements for Wet Mix Shotcrete

Silica fume shall be added to the concrete mix in the form of a blended cement containing silica fume.

931.05.10 Tie Wire

Tie wire shall be according to OPSS 905.

931.05.11 Water

Water used for production, fog-misting, curing and pre-soaking of burlap shall be according to OPSS 1302.

931.05.12 Welded Steel Wire Reinforcement

The welded steel wire reinforcement shall be welded galvanized or stainless steel according to OPSS 1440. Dimensions shall be 51 mm x 51 mm, W 5.5 x W 5.5. Galvanized steel wire shall be according to ASTM A1064. Stainless steel wire reinforcement shall be in according to ASTM A1022.

931.06 EQUIPMENT

931.06.01 Compressor - Air Blasting

The compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free from oil and other contaminants according to ASTM D4285.

931.06.02 Fog Misting Equipment

Fog misting equipment for the curing of shotcrete shall be according to OPSS 904.

931.06.03 Hand Finishing Equipment

Where hand finishing is required, only magnesium, wood or sponge rubber floats shall be used.

931.06.04 Mixers

931.06.04.01 Dry Mix Process

A continuous feed predampener shall be used, except for shotcrete which contains an accelerator. The predampening equipment shall be capable of bringing the dry bagged material to a consistent and suitable moisture content and shall operate at sufficient capacity to allow work to proceed without delays.

The delivery equipment shall be capable of discharging the mixture into the delivery hose at a rate sufficient to ensure a continuous smooth stream of uniformly mixed shotcrete mixture being delivered to the nozzle, at the velocity required to ensure maximum consolidation and full encapsulation of the reinforcement.

The discharge nozzle shall be equipped with a manually operated water injection system, for directing an even distribution of liquid through the mixture, with uniform appearance and consistency of shotcrete throughout to ensure that the water is thoroughly mixed with the other materials.

931.06.04.02 Wet Mix Process

Truck mixers shall be according to the Delivery Equipment subsection of OPSS 1350. The shotcrete delivery equipment shall be capable of delivering the pre-mixed materials accurately, uniformly and continuously through the delivery hose, at the velocity required to ensure maximum consolidation and full encapsulation of the reinforcement.

931.06.05 Straight Edge

The straight edge shall be 1.0 m long, commercially made and metal.

931.07 CONSTRUCTION

931.07.01 General

Locations and extent of repair shall be as determined during the layout of repair areas according to OPSS 928 and as directed by the Contract Administrator.

931.07.02 Operational Constraints

The Contract Administrator shall be notified of the intent to apply shotcrete three Business Days prior to the commencement of the shotcreting operation.

A Request to Proceed shall be submitted to the Contract Administrator at the completion of the surface preparation operation and prior to the commencement of the application of shotcrete.

The application of shotcrete shall not proceed until a Noticed to Proceed has been received from the Contract Administrator.

Prior to the application of shotcrete, protection for traffic from overspray and any rebound shall be in place.

No shotcrete shall be placed until all curing materials have been delivered to the site, and, in cold weather, all cold weather protection materials have been delivered to the site.

Shotcreting shall not be carried out when the air temperature or existing concrete surface temperature is less than 10°C or is likely to be less than 10°C, or is greater than 30°C or likely to be greater than 30°C throughout the duration of the shotcreting operation unless protection is provided in accordance with the Contractor's submitted plan.

Prior to shotcreting, the Contractor shall demonstrate to the Contract Administrator that the substrate temperatures meet the Contract requirements by measuring the substrate temperatures using a contact thermometer, and recording them.

Shotcrete shall not be placed against frozen surfaces. All surfaces against which shotcrete is to be placed shall be free of standing water. Shotcrete shall be protected from contact with rain or snow.

The air in contact with the repaired surfaces shall be maintained at temperatures greater than 10°C for a minimum of 96 hours after the application of shotcrete. Unvented heaters shall not be used.

Shotcreting operations shall be suspended during weather conditions that may adversely affect the quality of the work. This includes but is not limited to wind causing segregation of ingredients, rain or snow.

Prior to seasonal shutdown, operations shall be scheduled in such a manner as to ensure that the shotcreting operations are completed in all areas where concrete removal has commenced. No reinforcing steel shall be left exposed during seasonal shutdown.

931.07.03 Surface Preparation

All concrete surfaces against which shotcrete is to be placed shall be clean, solid and free from loose or unsound fragments, coatings and any other foreign substances or debris, and shall be sufficiently rough to ensure that a full bond is developed with the new shotcrete.

All existing concrete surfaces to be covered by shotcrete shall be uniformly roughened by means of scabbling, chipping or bush hammering. A surface profile of 5 ± 2 mm shall be achieved by exposing the aggregates across the entire surface.

All concrete surfaces, including areas 50 mm beyond the perimeter of the removal area, and existing reinforcing steel to receive shotcrete shall be abrasive blast cleaned according to OPSS 929 prior to installation of welded galvanized steel wire reinforcement or stainless steel wire reinforcement.

Abrasive blast cleaned areas shall have shotcrete applied within 36 hours of abrasive blasting or shall be reblasted. In areas requiring reblasting, the welded galvanized steel wire reinforcement shall be removed prior to abrasive blast cleaning and shall be reinstalled after cleaning. When stainless steel wire reinforcement is used, it may be left in place during abrasive blast cleaning.

Following abrasive blast cleaning and immediately prior to pre-wetting the concrete surface, all dust and loose material shall be removed from the prepared surface of the repair area by using compressed air.

The concrete surface to receive shotcrete shall be maintained in a continuously wet condition for a period of at least two hours prior to the application of the shotcrete. Immediately prior to the placement of shotcrete, the concrete surface to receive shotcrete shall be brought to a saturated surface dry condition, with excess water removed from the surface using compressed air.

931.07.04 Placement of Welded Steel Wire Reinforcement

When welded steel wire reinforcement is specified in the Contract Documents, it shall not be installed until after the concrete surface and exposed reinforcing steel in the repair area has been abrasive blast cleaned. Welded steel wire reinforcement shall not be used in repair areas on which a cathodic protection system is to be installed.

The welded steel wire reinforcement shall be installed flat, tight and in the locations shown in the Contract Documents and in all repair areas greater than 0.1 m² that have a minimum dimension of 200 mm, using spacers and anchors or fastening to exposed reinforcing steel. The wire reinforcement shall be securely fastened to the exposed reinforcing steel by ties placed no greater than 300 mm apart, in a grid pattern.

When the exposed reinforcing steel is not capable of providing rigid support for the welded steel wire reinforcement or when the spacing of the reinforcement is greater than 300 mm, anchors shall be used to support the welded steel wire reinforcement. Anchors shall be placed no greater than 300 mm apart in a grid pattern. The clearance between the reinforcement and the existing concrete shall be greater than or equal to 20 mm. The edges of adjoining welded steel wire reinforcement sheets shall be overlapped by one wire spacing plus 50 mm.

The welded steel wire reinforcement shall be kept clean of any substance that may reduce the bond of the shotcrete to the wire surface.

931.07.05 MTO Nozzleman Certification Program

Shotcreting shall be carried out by a nozzleman who has successfully participated in the MTO Shotcrete Nozzleman Certification Program that is valid for the current construction season. Notwithstanding this prequalification, the nozzleman shall be replaced when in the opinion of the Contract Administrator; acceptable quality of work is not achieved or is not maintained.

931.07.06 Mixing and Delivery of Wet Mix Shotcrete

Wet mix shotcrete shall be mixed and delivered according to the Mixing Time and Mixing Rate, and Delivery subsections of OPSS 1350.

931.07.07 Placing

Prior to the application of shotcrete, all structural components and appurtenances not receiving shotcrete shall be protected from the shotcreting operation. Repair areas being prepared to receive shotcrete shall also be protected from contamination, rebound, overspray or anything that would inhibit the bond of the shotcrete.

Where practical, shotcrete shall be placed without the use of formwork. When the requirements of this specification cannot otherwise be met, formwork may be used and shall be according to OPSS 919. Formwork, where used, shall be adequately braced against excessive vibration and constructed to permit the escape of air and rebound material during the shotcreting operation.

During the application of shotcrete, a steady continuous flow of shotcrete shall be maintained.

For dry mix shotcrete, any predampened mixture which is not utilized within 30 minutes, shall be rejected and shall not be incorporated into the work. When wet mix shotcrete is transported to the site by means of agitating or mixing equipment, discharge of the concrete shall be completed within 1.5 hours after introduction of the mixing water to the cement and aggregates, except when the air temperature is greater than 28°C and the concrete temperature is greater than 25°C, the concrete shall be discharged within one hour after the introduction of the mixing water. Use of retarders does not change the specified concrete discharge time.

The total required depth of shotcrete shall be placed within the same Day.

Shotcrete shall be applied such that there is no sagging or separation of the material in place.

All rebound and overspray material shall be removed from the repair area as the work proceeds. Rebound, overspray or waste material shall not be worked back into the shotcrete or salvaged and re-used. The concrete surface surrounding the repair area shall be cleaned immediately after the application of shotcrete using suitable hand tools.

When shotcrete in a repair area cannot be applied in a single operation or delays are experienced, moist curing by means of continuous fog mist shall be applied immediately according to the Curing Subsection. If the previous layer has hardened, the surface of the shotcrete shall be thoroughly cleaned of any laitance, loose material, overspray or other material that may compromise the bond of subsequent layers by wire brushing and wetted prior to application of an additional layer of shotcrete.

The shotcrete shall be placed level with the original concrete surface to provide a minimum of greater than or equal to 50 mm cover to the welded steel wire reinforcement or reinforcing steel unless otherwise specified in the Contract Drawings. Areas where the minimum cover requirements cannot be achieved shall be identified to the Contract Administrator.

At the end of the shotcreting operation, the shotcrete shall be terminated at a 1:1 slope. Before placing an adjacent section, this sloped portion shall be thoroughly cleaned by wire brushing or abrasive blasting to remove any laitance and then wetted.

931.07.08 Finishing

Unless otherwise specified in the Contract Documents, when the final layer of shotcrete has attained its initial set, the surface of the shotcrete shall be finished with hand finishing equipment.

When tested with a 1.0 m long straight edge, the maximum gap between the straight edge and any point on the surface shall be 6 mm.

931.07.09 Curing

Shotcrete shall be moist cured for a minimum period of four Days followed by three Days of curing with curing compound. Curing for at least the first 24 hours of the curing period shall be by fog mist.

Application of fog mist shall begin immediately after application of the final layer of shotcrete or, where hand finishing is specified, immediately after finishing of the shotcrete.

For the remainder of the moist curing period, for vertical applications, moist curing shall be by means of fog mist or wet burlap and for overhead applications the moist curing shall be by means of fog mist.

When wet burlap is used, the burlap shall be placed in a manner that will ensure that it is in full contact with the surface of the shotcrete for the full duration of the curing period. Curing with burlap and water shall be according to OPSS 904.

Immediately after removal of moist curing, the shotcrete surface shall be coated with a curing compound according to OPSS 904. Once the curing period is complete, curing compound shall be removed completely. The method of removal shall be by abrasive blast cleaning and it shall not result in any damage to the shotcrete surface. The removal process shall meet all environmental constraints as specified in the Contract Documents.

931.07.10 Cold Weather Protection

931.07.10.01 General

Shotcrete shall be protected during cold weather using the method submitted to and accepted by the Contract Administrator. Shotcrete work cannot commence until the Contract Administrator has reviewed and accepted the method submitted.

931.07.10.02 Control of Temperature

During cold weather, for a minimum period of seven Days following the shotcrete operation, the temperature of the shotcrete shall be monitored and controlled to ensure that the temperature is not less than 10°C. Measures shall be taken to ensure that the shotcrete temperature remains within the acceptable limits.

During cold weather, thermocouples, wires and unalterable digital temperature indicators with an accuracy of $\pm 1.5^{\circ}\text{C}$ shall be supplied to monitor the ambient air temperature and shotcrete temperature. The digital temperature indicators shall be left in place or provided upon request to the Contract Administrator to facilitate additional readings for verification purposes. A set of two thermocouples shall be embedded at a minimum of two locations for each day of shotcreting, as directed by the Contract Administrator. At each location one thermocouple shall be embedded at approximately the centre of the shotcrete application, and the second shall be placed within 10 mm of the surface of the shotcrete.

For cold weather conditions, protection of concrete shall be according to Table 1, as a minimum.

931.07.10.03 Cold Weather Temperature Records

Recording of ambient air temperature and shotcrete temperature shall begin at the start of placement. The ambient air and shotcrete temperature shall be recorded automatically at intervals no greater than one hour until the end of the monitoring period. The monitoring period shall be seven Days. Shotcrete and ambient air temperature readings shall be monitored and verified every 6 hours, or more frequently, for the first three Days and every 12 hours for the remainder of the monitoring period. The Contractor shall take necessary action to maintain the temperature within the specified limits.

The Contract Administrator shall be provided with the necessary access to the location and equipment to verify temperature readings.

Temperature records shall be forwarded to the Contract Administrator at the end of each day. At the end of the cold weather protection period, a complete temperature record consisting of a summary of the recorded temperatures and a graphical plot of temperature versus time shall be submitted to the Contract Administrator.

931.07.11 Sampling for Acceptance Testing of 28-Day Compressive Strength and Rapid Chloride Permeability

931.07.11.01 General

Core samples for acceptance testing of 28-Day compressive strength and rapid chloride permeability shall be removed from the shotcrete repairs at locations randomly selected by the Contract Administrator. Core samples shall be obtained for acceptance testing in the presence of the Contract Administrator.

The lot size, subplot size and number of cores per subplot shall be according to the Quality Assurance section.

931.07.11.02 Coring

Coring shall be carried out according to CSA A23.2-14C when the concrete is between 7 to 10 Days of age. Cores for compressive strength testing shall be 75 mm in diameter and a minimum of 100 mm long. Cores for rapid chloride permeability shall be 100 mm in diameter and a minimum of 75 mm long.

To avoid cutting reinforcing steel, all reinforcing steel in the area shall be located, using a covermeter, prior to taking any cores. Cores for compressive strength testing may contain welded steel wire reinforcement but shall not contain reinforcing steel. Cores for rapid chloride permeability testing shall not contain welded steel wire reinforcement or reinforcing steel.

The Contract number, lot number, subplot number, exact location of each individual core, date of shotcrete placement, and date of extraction shall be marked legibly on each core with durable ink immediately after removal.

Cores shall be placed in a plastic bag, sealed to prevent loss of moisture and provided to the Contract Administrator along with Form A of the concrete mix design and the form on which the field data for the cores is recorded, for testing by the Owner.

The filling of core holes shall be according to OPSS 1350.

931.07.12 Cracks

The Contractor shall inspect all concrete to identify and document any cracks including, their location, width, and density. The results of the inspection shall be reported to the Contract Administrator.

Based on criteria in the Field Inspection of Completed Work subsection, the Contractor shall identify areas requiring repair or replacement and shall identify the limits of such repair or replacement. This information shall be provided to the Contract Administrator along with a proposal for remedial action to be taken. No repairs shall proceed until the proposal has been accepted by the Contract Administrator in writing. Repair of cracks shall be according to OPSS 932 and shall be completed after the curing period has elapsed.

931.07.13 Management of Excess Materials

Management of excess material shall be according to the Contract Documents.

931.08 QUALITY ASSURANCE

931.08.01 Acceptance of Shotcrete

Shotcrete shall be acceptable if all of the requirements of this specification are met, including:

- a) Tensile bond strength
- b) 28-Day compressive strength
- c) Rapid chloride permeability, and
- d) There are no defects detected by inspection according to the Field Inspection subsection.

Unacceptable lots or sublots shall be deemed rejectable.

The replacement shotcrete for lots or sublots shall be evaluated for acceptance on the same basis as the original lots or sublots.

931.08.02 Field Inspection

931.08.02.01 Field Inspection Prior To and During Application

The Contract Administrator will inspect the plastic shotcrete during the application process and will reject all or a portion of the work based on the presence of one or more of the defects identified below:

- a) Failure to achieve specified surface profile
- b) Inadequate abrasive blast cleaning or failure to remove all dust and loose material prior to pre-wetting
- c) Failure to meet 36 hour window between abrasive blast cleaning and application of shotcrete
- d) Failure to adequately prewet or achieve a saturated surface dry condition of the concrete substrate prior to application of the shotcrete
- e) Failure to properly control and remove build-up of shotcrete overspray and rebound
- f) Incomplete consolidation around reinforcing steel, mesh and anchors
- g) Excessive shotcrete rebound
- h) Incorporation of sand lenses, excessive voids, delaminations, sags and sloughing
- i) Failure to apply shotcrete to the required line, grade and tolerance

If plastic shotcrete is rejected by the Contract Administrator, the work shall stop and all necessary measures to correct deficiencies shall be taken while the shotcrete is in the plastic state.

931.08.02.02 Field Inspection of Completed Work

The Contract Administrator will inspect the completed work and will reject all or a portion of the work based on the presence of one or more of the defects identified below:

- a) Debonding or hollow-sounding areas
- b) Porous or rebound material visible in cores or in the field
- c) Areas which have sagged visible in cores or in the field
- d) Cracks with a width greater than 0.3 mm where the linear measurement of the crack is 2 m or greater per square meter area

Cracks greater than or equal to 0.3 mm in width shall be repaired according to this specification, if the linear measurement of the crack per square metre is less than 2 m.

931.08.03 Acceptance of Tensile Bond Strength, 28-Day Compressive Strength, and Rapid Chloride Permeability

931.08.03.01 Lot Size

A lot shall consist of the total quantity of shotcrete in the Contract Documents. Each lot will be divided into sublots of approximately equal size and no greater than 100 m². Separate sublots are required for vertical and overhead repairs. Separate sublots are required for individual structures.

The Contract Administrator will determine the subplot size after discussion with the Contractor and prior to the commencement of the shotcreting operation.

Testing for tensile bond strength, 28-Day compressive strength and rapid chloride permeability will not be required on a structure when the total measured vertical area of shotcrete on a structure is less than 20 m² or, total measured horizontal area of shotcrete on a structure is less than 20 m² or, for shotcrete on circular columns with spiral reinforcement.

931.08.03.02 Acceptance of Tensile Bond Strength

931.08.03.02.01 Basis of Acceptance of Tensile Bond Strength

The tensile bond strength of a subplot shall be considered acceptable when it meets all of the following:

- a) The average of the three tensile bond strength tests shall be greater than or equal to 1.0 MPa
- b) Each individual tensile bond strength test shall be equal to or greater than 0.6 MPa

Sublots with an average tensile bond greater than or equal to 0.8 MPa and less than 1.0 MPa shall be considered unacceptable but, with the agreement of the Owner, may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated and applied according to the Basis of Payment section.

Sublots with an average tensile bond strength less than 0.8 MPa or an individual tensile bond strength less than 0.6 MPa shall be rejected.

931.08.03.02.02 Acceptance Testing of Tensile Bond Strength

Tensile bond strength shall be tested by the Owner according to LS-430 when the concrete is 7 to 10 Days of age. Tensile bond strength testing shall be carried out on three in-situ cores taken within 1 m of each other for each subplot. The core locations shall be randomly selected by the Contract Administrator. If a core comes loose during coring operation, another core shall be obtained within 300 mm of the original core location.

Individual test results shall be forwarded to the Contractor, as they become available.

931.08.03.03 Acceptance of 28-Day Compressive Strength

931.08.03.03.01 Acceptance Testing of 28-Day Compressive Strength

For each subplot, one set of three cores shall be taken to determine the 28-Day compressive strength. The 28-day compressive strength shall be determined according to CSA A 23.2-14C on moisture conditioned cores.

The 28-Day compressive strength of a subplot shall be considered acceptable when it meets the following requirements:

- a) The average of the three 28-Day compressive strength tests shall be greater than or equal to 35 MPa.
- b) No individual compressive strength test shall be less than 4.0 MPa below the specified strength.

Sublots with an average compressive strength greater than or equal to 31 MPa and less than 35 MPa shall be considered unacceptable but, with the agreement of the Owner, may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated and applied according to the Basis of Payment section. Sublots with a compressive strength test less than 31 MPa shall be removed and replaced.

931.08.03.03.02 Referee Testing of 28-Day Compressive Strength

Referee testing for a subplot may only be invoked by the Contractor within five Business Days of receiving the test results for that subplot.

Referee testing shall be carried out according to the test method specified in the Acceptance Testing of 28-Day Compressive Strength subsection.

The referee laboratory shall be designated by the Owner based on the applicable roster. Referee test results shall be forwarded to the Contractor as they become available.

Referee testing of 28-day compressive strength for a subplot shall be done on a new set of three cores removed by the Contractor within 24 hours of invoking the referee testing. Cores for referee testing for each disputed subplot shall be taken in the presence of the Contract Administrator at a location no more than 1 m from the location that each of the disputed acceptance cores were removed. The core size, and core extraction shall be according to the Coring clause.

If the difference between the referee test result and the acceptance test result is less than or equal to the confirmation value, then the acceptance test result is confirmed, and the acceptance test result shall be used in the determination of acceptance and payment for the concrete. If the difference between the referee test result and the acceptance test result is greater than the confirmation value, the acceptance test result is not confirmed, and the acceptance test result shall be disregarded and not used in the determination of acceptance and payment.

The confirmation value for confirming the acceptance test result shall be the greater of 10% of the specified strength or 10% of the strength of the acceptance cores, expressed to one decimal place.

When acceptance results are eliminated from the analysis as a result of the referee process, the concrete shall be assessed based on the available strength results for the subplot.

The cost of referee testing shall be as specified in the Contract Documents. When the referee result confirms the acceptance test results, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

931.08.03.04 Acceptance of Rapid Chloride Permeability

931.08.03.04.01 Acceptance Testing of Rapid Chloride Permeability

For each subplot, two cores shall be taken for acceptance testing of rapid chloride permeability. Cores taken for rapid chloride permeability shall be tested according to LS-433. Acceptance testing shall be carried out at 28 to 32 days. One 50 mm long sample shall be cut from each core representing the subplot and tested to determine the acceptance of the subplot. The results from the two cores representing the subplot shall be averaged to determine the acceptability of the concrete within the subplot.

Sublots with rapid chloride permeability less than or equal to 1000 coulombs are considered acceptable. Sublots with a rapid chloride permeability greater than 1000 coulombs and less than or equal 2000 coulombs shall be considered unacceptable but, with the agreement of the Owner, may be permitted to remain in the Work with a payment adjustment. The payment adjustment shall be calculated and applied according to the Basis of Payment section. Sublots with rapid chloride permeability results greater than 2000 coulombs shall be rejected.

931.08.03.04.02 Referee Testing of Rapid Chloride Permeability

Referee testing for a subplot may only be invoked by the Contractor within five Business Days of receiving the test results for that subplot.

Referee testing for a subplot shall be done on a new set of two cores removed by the Contractor within 24 hours of invoking the referee testing. Cores for referee testing for each disputed subplot shall be taken in the presence of the Contract Administrator at a location no more than 1 m from the location that each of the disputed acceptance cores were removed. The core size and core extraction shall be according to the Coring subsection.

The cores shall be tested according to LS-433.

Referee test results shall be forwarded to the Contractor as they become available.

When the referee result is greater than the acceptance test result or no more than 300 coulombs below the acceptance test result, the acceptance test result is then confirmed and shall remain valid.

When the referee test result for the subplot is more than 300 coulombs below the acceptance test result, the acceptance test result is then not confirmed and the referee test result shall replace the acceptance test result in the acceptance requirements of this specification.

The cost of referee testing shall be as specified in the Contract Documents. When the referee result confirms the acceptance test results, the Contractor shall be charged the cost of referee testing. When the referee result does not confirm the acceptance test result, the Owner shall bear the cost.

931.09 MEASUREMENT FOR PAYMENT

931.09.01 Actual Measurement

931.09.01.01 Silica Fume Shotcrete

Measurement of silica fume shotcrete shall be by the volume in cubic metres of the concrete removed according to OPSS 928 except that, when the existing cover to the reinforcing steel is less than 50 mm, the depth used in calculating the volume shall be adjusted by adding the difference between the 50 mm required and the existing cover.

No measurement will be made for areas of shotcrete that were removed according to the Remedial Work subsection.

No measurement will be made for shotcrete required to patch areas of concrete removal where the removal was not approved by the Contract Administrator.

931.10 BASIS OF PAYMENT

931.10.01 Silica Fume Shotcrete - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work, including abrasive blast cleaning of the concrete surfaces.

Payment for the work of abrasive blast cleaning of reinforcing steel will be administered under OPSS 929.

When the Contract does not contain a separate tender item for providing access to the work, the Contract price for the shotcrete items requiring the access shall include full compensation for all labour, equipment and materials to do the work.

Where the work does not conform to the quality requirements specified for compressive strength, tensile bond or rapid chloride permeability, a payment adjustment for each subplot will be made.

931.10.01.01 Payment Adjustment

The payment reduction factor (Pr_i) for each subplot will be calculated by the following equation:

$$Pr_i = 1.0 - \left((0.525 - 0.015S) + \left(\frac{(C - 1000)}{15000} \right) + (0.30 - 0.30B) \right)$$

Where:

S = The average 28-day compressive strength (MPa) for each subplot. (For the purpose of calculating the payment adjustment for shotcrete, a value of 35 MPa shall be used for "S" when the average compressive strength is greater than or equal to 35 MPa.)

B = The average tensile bond strength (MPa) for each subplot. (For the purpose of calculating the payment adjustment, a value of 1.0 MPa shall be used for "B" when the average tensile bond strength is equal to or greater than 1.0 MPa.)

C = The average rapid chloride permeability (coulombs) for each subplot. (For the purpose of calculating the payment reduction for shotcrete, a value of 1000 coulombs shall be used for "C" when the average chloride permeability is less than or equal to 1000 coulombs.)

The payment reduction factor for the lot (Pr) is calculated by the equation:

$$Pr = \frac{(Pr_1 \times LQ_1) + (Pr_2 \times LQ_2) \cdots (Pr_n \times LQ_n)}{(LQ_1 + LQ_2 \cdots LQ_n)}$$

Where:

Pr_i = Payment reduction factor for subplot i.

LQ_i = Quantity of subplot i (m³)

n = The total number of sublots.

The total payment adjustment (Pa) for the lot is calculated by the equation:

$Pa = \text{Quantity} \times \text{Tender Unit Price} \times Pr$

TABLE 1
Minimum Cold Weather Protective Measures

Anticipated Minimum Air Temperature (°C)	Protective Measure
+10 to 0	PM2
-1 to -10	PM4
-11 to -20	PM5
Less than -20	PM5
Maximum Allowable Drop in Concrete Temperature/24 h	15°C
PM2 - Protective Measure - Cover concrete with insulation having an R-Value of 0.67 (Note 1). PM3 - Protective Measure - Cover concrete with insulation having an R-Value of 1.33 (Note 1). PM4 - Protective Measure - Cover concrete with insulation having an R-Value of 2.00 (Note 1). PM5 - Protective Measure - House and heat as specified in "Housing and Heating" of OPSS 904.	
Note 1: All R-Values are metric. The conversion factor from metric to imperial unit is: Metric "R" value x 5.678 = Imperial "R" value	



**CONSTRUCTION SPECIFICATION FOR
CRACK REPAIR - CONCRETE**

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932.01 SCOPE

This specification covers the requirements for the pressure injection, routing, and sealing of cracks in concrete for the purpose of structural rehabilitation and water seepage control.

932.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 920	Deck Joint Assemblies, Preformed Seals, Joint Fillers, Joint Seals, Joint Sealing Compounds, and Waterstops – Structures
OPSS 929	Abrasive Blast Cleaning - Concrete Construction

Ontario Provincial Standard Specifications, Material

OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

ASTM International

C881 / C881M - 15	Epoxy-Resin Based Bonding Systems for Concrete
C920 - 18	Elastomeric Joint Sealants
D4285 - 83(2018)	Test Method for Indicating Oil or Water in Compressed Air

932.03

DEFINITIONS

For the purpose of this specification, the following definitions apply:

Active Crack means a crack in concrete with plane surfaces that are in a state of movement relative to each other.

Crack Depth means the distance that the crack extends from the injection surface into the concrete to the point where the crack is 0.10 mm wide.

Effective Injection Pressure means the fluid grout pressure at point of entry at the injection port. This shall be calculated as gauge pressure minus head losses in injection system.

Flushing means removing debris from the crack section by means of air or a liquid under pressure.

Gauge Pressure means the actual fluid grout pressure reading on the pump gauge.

Injection Port means a mechanical device that is firmly connected into the crack section for the purpose of providing access into a crack for the grouting material.

Passive Crack means a concrete crack in concrete with plane surfaces that are not moving relative to each other.

Payment Adjustment Factor means a multiplier applied to the unit Contract price to determine the actual unit payment price.

Plural Component Pump means a grout pump that separately delivers the grout material components separately to a common static mixer.

Pot Life means the period of time after mixing during which a bonding system or mixture containing it retains sufficient workability for proper use.

Refusal Criteria means zero flow of grout at the proposed effective pressure for a duration of five minutes.

Regulated Operating Pressure means the maximum pressure, measured at the pump discharge, that the pump is capable of producing.

932.04

DESIGN AND SUBMISSION REQUIREMENTS

932.04.01

Submissions

932.04.01.01

Crack Repair Work Plan

A copy of the crack repair work plan shall be submitted to the Contract Administrator at least seven Days prior to the commencement of the work.

The crack repair work plan shall bear the seal and signature of an Engineer and include at least the following information.

- a) A description of the method of repair, including the following minimum information:
 - i. Summary of material and method selection for each crack repair type.
 - ii. Proposed effective injection pressure.
 - iii. Surface finishing.
 - iv. Location, size, spacing and type of injection ports.
 - v. Surface treatment of the concrete prior to surface sealing.
 - vi. Method of storing and handling grouts, cleaning solvents, and waste materials.
- b) A list of the materials to be used for surface sealing and repair, including the following minimum information:
 - i. Material specifications.
 - ii. Product data sheets with test data.
 - iii. Material safety data sheets.
 - iv. Pot life of the components to be used based on a sample size of 200 ml at 5 °C and 20 °C.
 - v. ASTM Type, Grade and Class (applicable for epoxy-resin based bonding systems)
- c) A list of the equipment and accessories to be used including the following minimum information:
 - i. The operating pressure of each component.
 - ii. The type of injection port and means of closure.

932.05 MATERIALS

932.05.01 Grout

932.05.01.01 General

Material used for crack injection shall be polyurethane resins for active cracks and epoxy resins for passive cracks.

Polyurethane and epoxy grout shall prevent the penetration of water and shall fill at least 80% of the depth of the crack using the proposed equipment and method of repair at the ambient and substrate temperatures existing at the time of grouting.

Polyurethane and epoxy grout shall have sufficient pot life to ensure it remains workable throughout the duration of its application and is compatible with the procedures outlined in the submitted crack repair work plan.

932.05.01.02 Epoxy Resin

Epoxy resin shall be according to ASTM C881, Type IV, Grade I, Class B and C.

932.05.01.03 Polyurethane Resin

Polyurethane resin shall be 100% solids, hydrophobic and be suitable for the range of temperatures at the time of repair.

932.05.02 Joint Sealing Compounds

932.05.02.01 Hot-Poured Rubberized Joint Sealing Compound

The hot-poured rubberized joint sealing compound shall be according to OPSS 1212.

932.05.02.02 Cold-Applied Joint Sealing Compound

Cold-applied joint sealing compound shall be according to ASTM C920, Type S or M, Grade NS, Class 25, Use T and M. Type M sealant shall be used where the depth of a chase is greater than 15 mm or the manufacturer's recommended depth for Type S sealant, whichever is less. Where the cold sealing compound is visible after completion of the work a grey colour material shall be used.

932.05.03 Water

Water shall be according to OPSS 1302.

932.06 EQUIPMENT

932.06.01 Gauges

In addition to the calibrated gauges required for use with the pumps and with the injection hose, additional gauges shall be available on site to replace those that malfunction.

Certificates of calibration from an organization accredited by the Standards Council of Canada shall be supplied for each gauge certifying that the gauges are capable of measuring the pressure within a tolerance of ± 5 kPa.

932.06.02 Pumps

Equipment used for pressure injection shall be suitable for the intended use and compatible with the grout.

Pumps shall be positive displacement type and shall be capable of delivering a minimum of two litres of grout per minute.

Pumps shall be capable of developing a maximum regulated operating pressure at least equal to twice the effective pressure.

Pumps shall be equipped with a calibrated gauge and shall be capable of accurately maintaining an effective operating pressure of 50 kPa or less.

Plural component pumps shall be used when multicomponent solution grouts are used.

Hand cartridge pumps shall not be used unless the volume of crack repair is less than one litre of resin for 100 m² of gross repair area.

932.06.03 Mixers

932.06.03.01 Static In-Line Mixers

Static in-line mixers shall produce a homogeneous grout and shall be sized to accommodate the minimum and maximum anticipated flow rates.

Static mixers shall have the manufacturer's plate attached showing the following mixer information:

- a) Size.
- b) Type.
- c) Maximum operating pressure.

932.06.03.02 Agitating Mixer

Agitating mixers shall have a power driven paddle mixing head and produce a homogeneous component. The speed of the mixers shall be variable to a maximum of 500 rpm.

932.06.04 Injection Hoses

Injection hoses shall have a rated working pressure equal to or greater than the maximum pump operating pressure and shall be equipped with a calibrated gauge at the injection port end.

932.06.05 Injection Ports

Injection ports shall be removable or non-metallic insert type units. The pressure capacity of the injection ports shall be at least equal to the maximum operating pressure of the pump. All injection ports shall be equipped with a shut-off valve or other mechanical means of closure under pressure.

932.06.06 Air Compressor

Compressed air shall be free from oil and water when tested according to ASTM D4285.

932.06.07 Drills

Drilling of the injection holes shall be performed using a rotary percussion or rotary diamond type drill. Percussion drilling equipment shall not be used for drilling holes greater than 26 mm diameter and holes within 150 mm of any edge of concrete.

Only holes less than or equal to 26 mm in diameter shall be drilled within 50 mm of any free edge of concrete.

932.06.08 Routing Equipment

Routing equipment shall be any of the following:

- a) Concrete router.
- b) Hand-held grinding wheel or a multi-bladed cut-off saw equipped with abrasive or diamond blades.
- c) Multi-bladed floor saw cutting equipment equipped with diamond blades.

932.07 CONSTRUCTION

932.07.01 General

Installation of all accessories and material shall be according to the manufacturer's recommendations and as specified in the submitted work plan.

Work shall only proceed when the temperature of the concrete is greater than or equal to 5 °C.

932.07.02 Access

Access shall be provided to facilitate:

- a) Performance of work.
- b) Inspection and measurement of the work by the Contract Administrator.

932.07.03 Crack Identification

Prior to commencement of the work, the cracks requiring repair, as identified by the Contract Administrator, shall be numbered, physically marked as to their extent and measured in the presence of the Contract Administrator.

This information shall be recorded and a copy submitted to the Contract Administrator.

932.07.04 Crack Injection

932.07.04.01 Drilling for Injection Ports

Holes for injection ports shall be drilled:

- a) Perpendicular to the concrete surface and located directly on top of the crack.
- b) On each side of the crack at a 45-degree angle to the surface of the concrete.
- c) Per the manufacturer's recommendations.

The spacing of the injection ports shall not exceed 200 mm. The size and depth of the injection holes shall be according to the manufacturer's recommendations. Injection ports shall be inserted into the holes and sealed.

Prior to installation of the injection ports each hole shall be individually cleaned of all deleterious material by an air-water blast to completely remove all drill cuttings from the hole.

932.07.04.02 Cleaning and Flushing

After the injection ports have been inserted, cracks shall be flushed with an air-water mixture or an alternating water and air flush to remove all deleterious material prior to the injection of grout. The flushing material shall be injected through the injection port and continued until it exudes from the adjacent injection port and the crack is thoroughly cleaned. This flushing shall proceed from one end of the crack to the other.

A final flush shall be made with air only to remove all of the free water.

932.07.04.03 Surface Preparation and Sealing

Surface opening of the cracks shall be sealed prior to injection.

The surface of the concrete shall be mechanically cleaned for a distance of 25 mm each side of the crack sections to prepare a clean substrate for bonding of the surface sealing compound. The surface preparation and sealing shall be as recommended by the manufacturer of the surface sealing material.

The surface sealing material shall completely confine the injection grout to the crack section with only the injection ports providing access. The surface sealing material shall withstand the maximum injection pressure without developing leakage along the crack section.

Surface sealing of passive cracks shall not commence until at least one hour after the final air flush.

932.07.04.04 Injection of Grout

932.07.04.04.01 General

Grout shall be pressure injected. Injection of grout shall proceed from the injection port at the lowest elevation of the crack and continue upwards along the crack on an injection port to injection port basis without interruption to the other end of the crack. The injection nozzle shall not be moved to the adjacent injection port until grout is showing at the next higher adjacent injection port or refusal criteria is met.

While under pressure, each injection port shall be sealed immediately after completion of injection of grout.

When a maximum operating pressure greater than 3 MPa is required to inject the grout, the injection operation shall cease until the Contractor determines why this operating pressure is required.

932.07.04.04.02 Monitoring

The volume of grout used within each five metres of crack length shall be recorded. The pump gauge pressure shall be recorded every 10 minutes. The volume of grout and pump pressure shall be related to the crack location.

The records shall indicate crack location and number, injection port spacing, operating pressure and confirmation of grout showing or refusal. A copy of the recorded information shall be submitted to the Contract Administrator at the end of each Day.

932.07.04.04.03 Effective Injection Pressure

When calculating the effective pressure, the head losses shall be determined prior to commencement of injection.

Head losses shall be determined in the presence of the Contract Administrator by performing a pressure flow test, through the equipment, for each equipment configuration used.

932.07.04.04.04 Ratio Test

Plural component injection equipment proportioning shall be verified in the presence of the Contract Administrator by measuring the volume output of material in the pressure lines at least once for each two hours of operation.

When deviation from the manufacturer's specified proportioning ratio exceeds 5%, immediate adjustment or replacement of the equipment is required.

932.07.04.04.05 Pot Life Determination

Prior to commencing the grouting operation, a sample shall be taken from the material containers on site and manually proportioned to the specified component ratio in the presence of the Contract Administrator. The total sample size shall be 200 ml, and the same size container shall be used for each sample taken.

The temperature of the material at the time of mixing and the pot life of the mixed material shall be recorded.

The proportions of materials and pot life shall conform to those specified in the original submissions.

An additional sample shall be taken from the end of the injection hose and a further pot life determination performed.

During grouting material samples shall be taken on a frequency of at least one per hour of operation and the pot life recorded.

Deviation from the proportions and pot life specified shall result in immediate discontinuance of use of the material.

All records shall be submitted to the Contract Administrator at the end of each working day.

932.07.04.05 Surface Finishing

Surface finishing shall not proceed until the curing period, as specified by the material supplier, has elapsed. Surface finishing shall consist of removal of the injection ports and the surface sealant flush with the original concrete surface. Core holes and holes left after the removal of injection ports shall be filled with a cement-based non-shrink grout after the surface sealant has been removed.

Where the crack is not completely filled to the injection surface, the crack shall be filled with a compatible material acceptable to the Contract Administrator. The material shall be applied according to the manufacturer's recommendations.

932.07.04.06 Coring

A 50 mm diameter test core shall be taken for each completed ten-metre increment of injected crack at locations specified by the Contract Administrator until satisfactory control is established. The ten-metre increment is the length of a continuous crack or a cumulative measurement of cracks of lesser length. The depth of the test core shall be the full depth of the crack but not greater than 500 mm.

Prior to establishing satisfactory control, test cores shall be taken within two hours after injection, at locations specified by the Contract Administrator.

Satisfactory control is established when three consecutive test cores meet acceptance criteria without payment adjustments as defined in the Acceptance and Rejection clause. If payment adjustments are required, test cores shall continue to be extracted for each completed ten-metre increment of injected crack until three consecutive cores are accepted without payment adjustment.

After satisfactory control has been established, test cores shall be taken for each Day or each completed 50 m increment, whichever is more. If a test core indicates payment adjustments or when there are changes in the material or procedure, testing shall resume on ten-metre increments of injected crack until satisfactory control is re-established.

Reinforcement and other embedded material shall be avoided while coring, and the Contractor shall use a covermeter capable of detecting the type(s) of reinforcement and embedded material in the element prior to coring.

All cores shall be taken in the presence of the Contract Administrator and shall be submitted to the Contract Administrator after coring. Similar coring shall be done to check remedial work.

932.07.04.07 Filling of Core Holes

Filling of core holes shall be according to OPSS 1350.

932.07.05 Routing and Sealing Cracks

Cracks shall be routed to create a chase and then filled with a sealant.

The depth to width ratio of the chase shall be 1H:1V with the crack located within the middle third of the chase. The width of the chase shall be 15 mm ± 5 mm.

The chase shall be abrasive blast cleaned according to OPSS 929. Abrasive blast cleaned areas shall have the subsequent treatment applied within 36 hours or shall be reblasted.

Immediately prior to placing the bond breaker, the chase shall be blasted with compressed air to remove all dust, dirt, and loose material.

A bond breaker compatible with the joint sealing compound and concrete shall be placed at the bottom of the chase.

Joint sealing compound shall be placed in the chase flush with the adjacent concrete surface unless it is subjected to vehicular traffic, in which case, it shall be recessed $2\text{ mm} \pm 1\text{ mm}$.

Hot-poured rubberized joint sealing compounds shall only be used on horizontal surfaces. Cold-applied joint sealing compounds shall only be used on vertical surfaces or on horizontal surfaces that are not to be waterproofed. Cold-applied joint sealing compound shall be installed according to the manufacturer's recommendations. Hot-poured rubberized joint sealing compound shall be installed according to OPSS 920.

932.07.06 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

932.08 QUALITY ASSURANCE

932.08.01 General

When the repair operation is complete, the Contract Administrator shall inspect the work to determine if the completed work contains defects.

932.08.02 Crack Injection

The 50 mm diameter test cores shall be examined for the percentage of the crack depth filled.

932.08.03 Ratio Test

The proportioning ratio of the injection material shall not deviate more than 5% from the manufacturer's specified proportioning ratio stated in the work plan.

932.08.04 Pot Life

The proportion of material and pot life shall not deviate from that specified by the manufacturer in the work plan.

932.08.05 Acceptance or Rejection

The Contract Administrator shall accept or reject material on the basis of the ratio testing and pot life determination results.

Crack injection shall be accepted or rejected on the basis of the percentage of crack depth filled as determined by evaluating the test core taken in each increment.

Rejection of the increment length of crack represented by the test core shall be applied during the entire grouting operation.

Where 90% or more of the crack depth is filled in the test core, the increment of crack length represented by the core shall be accepted.

Where 80 to 89% of the crack depth is filled in the test core, the work shall be accepted and a payment adjustment shall be applied to increment length of crack represented by that core.

Where less than 80% of the crack depth is filled in the test core, the ten-metre increment of crack length represented by the core shall be rejectable. An immediate review and adjustment of the method of injection shall be completed. The method of repair shall be submitted to the Contract Administrator prior to the commencement of the work. The increments represented by the failed test cores shall be repaired such that at least 80% of the crack depth is filled at no addition cost to the Owner.

932.09 MEASUREMENT FOR PAYMENT

932.09.01 Actual Measurement

932.09.01.01 Crack Injection

Measurement of crack injection shall be by length in metres of the accepted injected cracks. The total length shall be the sum of individual increments represented by the accepted test cores taken within each increment. Cracks filled to less than 80% of the crack depth shall not be measured for payment.

932.09.01.02 Routing and Sealing

Measurement of routing and sealing shall be by length in metres.

932.10 BASIS OF PAYMENT

932.10.01 Crack Injection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.

There shall be 100% payment of the Contract price where 90% or more of the crack depth is filled. There shall be no payment where less than 80% of the crack depth is filled.

There shall be a payment adjustment of the unit Contract price for each increment of crack filled to between 80% and 89% of the crack depth.

$$Pa = [100 - (89 - D) \times 2] \div 100$$

Where: Pa = payment adjustment factor
D = percentage of the crack depth filled, rounded to the nearest 0.1%.

and: $89 \geq D \geq 80$

**932.10.02 Routing and Sealing-Hot-Poured Rubberized Joint Sealing Compound-Item
Routing and Sealing-Cold-Applied Joint Sealing Compound - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



CONSTRUCTION SPECIFICATION FOR IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM FOR BRIDGE STRUCTURES

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APPENDICES

935-A	Commentary

935.01	SCOPE

This specification covers the requirements for the installation of cathodic protection system using anode mesh.

935.01.01 Specification Significance and Use

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

935.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

935.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 602	Installation of Electrical Chambers
OPSS 603	Installation of Ducts
OPSS 604	Installation of Cable
OPSS 609	Grounding
OPSS 616	Footings and Pads for Electrical Equipment
OPSS 904	Concrete Structures
OPSS 913	Embedded Work in Structures for Electrical Systems
OPSS 928	Structure Rehabilitation - Concrete Removal
OPSS 929	Abrasive Blast Cleaning - Concrete Construction
OPSS 930	Structure Rehabilitation - Concrete Patches and Overlays

Ontario Provincial Standard Specifications, Material

OPSS 1302	Water
OPSS 2301	Impressed Current Cathodic Protection System for Bridge Structures

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

ASTM International

B 265-95	Titanium and Titanium Alloy Strip, Sheet and Plate
D 4285-83 (1993)	Test Method for Indicating Oil or Water in Compressed Air

Others

Ontario Traffic Signal Control Equipment Specifications (OTSCES)
NACE - National Association of Corrosion Engineers
Ontario Electrical Safety Code

935.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Cathode Connection means a cable connection of the following two types made to reinforcing bars:

- a) CS: a current carrying cathode connection that is connected to the negative terminal of the rectifier.
- b) CM: a non-current carrying cathode connection that is used to monitor the potential of the reinforcing steel with respect to a reference cell.

Corrosion Specialist means an individual having all of the following qualifications:

- a) A minimum of 5 years experience in cathodic protection of reinforced concrete structures.
- b) Is a NACE accredited cathodic protection specialist.
- c) Is an Engineer.

Distribution Bar means a component of the anode that distributes current from the power feed point.

Instant-Off means the potential reading taken immediately after the current flowing to the system has been interrupted.

Subzone means the division of a concrete component into areas where the anode in an area is not continuous with the anode in the adjacent area.

Zone means an area of a concrete component energized by one rectifier unit consisting of one or more subzones.

935.04 DESIGN AND SUBMISSION REQUIREMENTS

935.04.01 Submission Requirements

935.04.01.01 Working Drawings

At least 8 weeks prior to commencement of production of the cathodic protection assembly, 4 copies of the Working Drawings for the components listed below shall be submitted to the Contract Administrator, for information purposes only. Prior to submission, an Engineer's seal and signature shall be affixed on the Working Drawings verifying that the drawings are consistent with the requirements of the Contract Documents.

- a) The cathodic protection equipment assembly.

- b) The cathodic protection terminal block assembly.
- c) The cathodic protection remote monitoring and control unit.
- d) The cathodic protection rectifier.
- e) The wireless modem antenna.

The Working Drawings shall include the information specified in OPSS 2301.

The Working Drawings shall contain at least the following information:

- a) Dimensioned layout drawings including sections, block diagrams, and details to show enclosure, equipment layout, and mounting arrangement.
- b) Wiring diagram, including field location and function labels.
- c) Detailed bill of materials including sources.

935.04.01.02 Technical Documentation

Four copies of the following documents for each rectifier and for the RMU containing at least the following information shall be submitted to the Contract Administrator:

- a) Operation and maintenance manual.
- b) Complete schematic diagrams and parts lists.
- c) Drawings showing external and internal physical dimensions of the unit.
- d) Manufacturer's data sheets and engineering technical data for all electronic, electrical components, and mechanical parts of the unit.
- e) Detailed information and test procedures for trouble-shooting.
- f) Performance reports including the 180 hour burn-in test for the rectifier and RMU documenting all of the required tests for the rectifier and for the RMU.

Two copies of the RMU software shall be submitted to the Owner.

935.04.01.03 Notification of Production

The Contract Administrator shall be given at least one week prior notice of the date of commencement of fabrication and the date of completion of fabrication of the following components:

- a) The cathodic protection rectifier.
- b) The cathodic protection remote monitoring and control unit.

935.04.01.04 Notification of Suppliers

The names of the suppliers of the cathodic protection control and monitoring equipment shall be submitted to the Contract Administrator, upon request.

935.04.01.05 Spacer Grid

The product data sheet of the glass fibre reinforced polymer bars (GFRP) spacer grid shall be submitted to the Contract Administrator prior to installation.

935.04.01.06 Anode Mesh and Distribution Bars

At least one week prior to the commencement of the installation of the distribution bars and the anode mesh, the following samples fabricated with the equipment and procedures to be used in the work together with the power setting used in welding the samples shall be submitted to the Contract Administrator:

- a) Two 300 mm lengths of distribution bar overlapped and welded at 4 locations at 12 mm intervals.
- b) Anode mesh welded at the diamond junctions to two 500 mm lengths of distribution bars.

935.04.01.07 Corrosion Specialist

At least one week prior to commencement of work on the structure, the name and qualifications of the corrosion specialist shall be submitted to the Contract Administrator.

935.04.01.08 Test Results

Within 3 Business Days of the completion of the tests required, the results of all tests that are specified to be recorded shall be submitted in writing to the Contract Administrator.

Each test result shall be identified by the corresponding test location.

935.05 MATERIALS

935.05.01 General

All electrical materials, equipment, components, or completed assemblies of components shall be approved according to the Ontario Electrical Safety Code.

935.05.02 Concrete Pad for Cathodic Protection

Concrete pad for cathodic protection shall be according to OPSS 616.

935.05.03 Cathodic Protection System

Cathodic protection system and its associated materials shall be supplied according to OPSS 2301.

935.05.04 Concrete for Blockout

Concrete used to fill blockouts for installation of cables in curbs, sidewalks, and barrier walls shall have a 28-Day strength of 30 MPa according to OPSS 1350. Nominal maximum size of aggregate shall be 9.5 mm.

935.05.05 Water

Water shall be according to OPSS 1302.

935.05.06 Non-Shrink Grout

Non-shrink grout shall be supplied from a source named on the ministry's DSM.

935.05.07 Spacer Grid

The spacer grid shall be according to OPSS 2301.

935.06 EQUIPMENT

935.06.01 AC Resistance Meter

The AC resistance meter shall be capable of measuring from 0.1 to 10,000 ohms, with an accuracy of ± 1 % of full scale, and shall be insensitive to AC and DC ground currents.

935.06.02 Multimeter

The multimeter shall have an input impedance of not less than 10 megohms when operated at a full scale of 100 mV DC.

The meter shall have an accuracy of ± 2.5 % of the reading in DC volts with a resolution of 0.1 mV.

935.06.03 Clamp-On Ammeter

The clamp-on ammeter shall be capable of measuring DC current ranging from 1 to 4,000 mA.

The ammeter shall measure DC current with an accuracy of $\pm 2.0\%$ and a resolution of 1 mA.

935.06.04 Air Compressor - Air Blasting

The air compressor for air blasting shall have a minimum capacity of 3.5 m³/min. The compressed air shall be free of oil according to ASTM D 4285-83 and be forced through a nozzle at a minimum pressure of 300 kPa.

935.06.05 Pressure Wash Equipment

The pressure wash equipment shall produce a minimum pressure at the nozzle of 1.4 MPa.

935.06.06 Holiday Detector

The holiday detector shall have pulse type output voltages adjustable to produce from 300 to 3,000 volts. The device shall be equipped with a 300 mm wide conductive steel or copper brush to scan the concrete surface and shall produce a loud audible signal when metals that are electrically connected to the reinforcement are detected.

935.06.07 Concrete Cover Meter

The cover meter shall have a digital read out for measurement of cover and an audio signal indicating detection of reinforcing steel bars in concrete with cover up to 150 mm. The accuracy of the meter shall be $\pm 5\%$ of full scale.

935.06.08 Resistance Welder

The resistance welder shall be as recommended by the anode system manufacturer.

935.07 CONSTRUCTION

935.07.01 General

935.07.01.01 Sequence of Work

The cathodic protection work shall not commence until the repairs in the areas to receive cathodic protection have been completed fully or in sections and accepted by the Contract Administrator.

935.07.01.02 Access

The Contract Administrator shall have full access to the place of manufacture of the cathodic protection control and monitoring equipment.

935.07.01.03 Electrical

All electrical work shall be as specified in the Contract Documents.

All resistance measurements shall be made with an AC resistance meter, except when measuring resistance between two cathode connections.

935.07.01.04 Concrete Removal in Recesses and Cable Slots

The recesses for the embedded components and cable slots shall be sawcut prior to concrete removal. Concrete removal shall be according to OPSS 928.

935.07.01.05 Abrasive Blast Cleaning

Abrasive blast cleaning shall be according to OPSS 929.

935.07.01.06 Concrete Placement

Concrete shall be placed according to OPSS 904.

935.07.01.07 Curing

Curing of concrete and non-shrink grout shall be according to OPSS 904 utilizing the wet burlap method.

935.07.02 Cathode Connections

935.07.02.01 Installation

935.07.02.01.01 Scheduling

Cathode connections to the reinforcing steel shall be made after removal of concrete and abrasive blast cleaning in the removal areas.

935.07.02.01.02 Layout

The cathode CS and CM cables shall be connected to the reinforcing steel at the locations as specified in the Contract Documents. Alternative locations for cathode CS and CM connections shall be specified by the Contract Administrator, if required.

Adjustment up to 1 m shall be allowed for the cathode CS connections. The cathode CM connections shall be located between 600 mm and 1 m of the respective reference cells.

At the cathode connection positions specified, the location of the reinforcing steel bars shall be determined by means of a cover meter.

935.07.02.01.03 Preparation of Reinforcement and Recess

Concrete shall be removed to expose a 150 mm length of reinforcing bar.

The reinforcing steel and the concrete surface of the recess shall be abrasive blast cleaned and cleaned of all deleterious material by means of air blasting.

The reinforcing bar shall be ground locally to expose bare metal prior to making the thermite weld connection.

935.07.02.01.04 Connection of Reinforcing Steel

The connection shall be made centred on the ground portion of the reinforcing steel as specified in the Contract Documents. The bare portion of the cathode cable shall be protected by a copper sleeve and shall be connected by thermite welding to the reinforcing bar. Mechanical connections shall not be used.

When the weld has cooled, slag shall be removed and a 5 mm thick layer of silicone sealant shall be applied to the entire weld area of the bar and to all exposed copper cable. After setting of the silicone seal, all debris shall be removed from the recess and the surface of the recess shall be dampened. All free water shall be removed from the recess and the recess shall be filled with non-shrink grout according to the manufacturer's recommendations.

935.07.02.01.05 Cable Installation

Cable slots shall be created by saw cutting. Cable slots, each 6 mm wide by 10 mm deep, shall be sawn between the cathode connection locations and the junction box for the installation of cathode connection cables as specified in the Contract Documents. The edges of the slot shall be rounded where the slot meets the recess. Each slot shall contain only one cable.

When multiple cables converge in to one cable slot, the cable slot shall be adjusted to 9 mm wide by 23 mm deep and sawn from the point where all the cables converge at the install area to the corresponding junction box. Each cable shall share the common saw slot running to the junction box.

Immediately prior to placing material, the recesses shall be abrasive blast cleaned and all deleterious material contained inside the recesses and slots shall be removed by means of air blasting.

The cable shall be continuously contained in the slot between the cathode connection and the junction box and held in place with non-metallic plugs spaced at 600 mm on centres to prevent migration of the cable towards the surface.

Cables that will be unconnected at the junction box location for more than one week shall have a heat shrink end boot installed until the permanent connection is made.

Cable slots shall be backfilled with non-conductive low viscosity epoxy to the level of the original concrete surface according to the manufacturer's recommendations. Care shall be exercised to ensure that the slots are completely filled with epoxy and there is no excess epoxy spilled over the adjacent concrete surface along the slots.

935.07.02.01.06 Testing During Installation

Prior to filling cathode recesses, the mechanical soundness of each completed cathode connection shall be verified and the DC resistance and voltage between the ends of cables from cathode connections shall be measured and recorded.

The resistance between any two cathode connection cables in a single zone shall be less than 1.0 ohm and voltage shall be less than 1 mV. If the resistance is greater than 1.0 ohm, or voltage is greater than 1 mV, each individual cathode connection cable shall be checked and remedial work shall be performed as follows:

- a) When the resistance between the end of the cable and the reinforcing bar to which it is connected is greater than 1.0 ohm or the voltage is greater than 1 mV, the cable shall be cut and reattached to the same reinforcing bar at least 150 mm away from the previous connection.
- b) When the resistance between the end of the cable and the reinforcing bar to which it is connected is less than 1.0 ohm and voltage is less than 1 mV, additional cathode connections shall be installed at locations determined by the Contract Administrator.

Resistance and voltage measurements between pairs of cathode connection cables shall be repeated and recorded following remedial work.

When mechanical soundness of the cathode connections and continuity of reinforcing steel have been verified, patching of cathode cavities may proceed. After patches are placed, the resistance and voltage between pairs of cathode connection cables shall be measured and recorded to check the connections prior to placing anode.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

935.07.03 Reference Cells - Graphite and Silver-Silver Chloride

935.07.03.01 Installation

935.07.03.01.01 Scheduling

The recesses for reference cells and cable slots shall be saw cut prior to concrete removal.

Reference cells shall be installed after removal of concrete and abrasive blast cleaning in the removal areas.

935.07.03.01.02 Layout

The reference cells shall be placed at the locations as specified in the Contract Documents.

At the reference cell positions as specified in the Contract documents, the location of the reinforcing steel bars shall be determined by means of a cover meter.

A recess, 200 mm wide by 400 mm long, to accommodate the reference cell shall be cut into the concrete within 10 to 25 mm from a reinforcing steel bar with the longitudinal axis of the cell parallel to the reinforcing steel bar. The Contract Administrator may specify a smaller size recess, if necessary.

When reinforcing steel interferes with the placement of a cell, the recess shall be extended to permit installing the cell without cutting the reinforcing steel or a new recess shall be cut.

Reference cells shall not be positioned in a patched area or within 600 mm of a patched area.

To comply with the above requirements the cell may be moved a maximum of 1 m from the location as specified in the Contract Drawings.

The Contract Administrator shall specify alternative locations when the above conditions cannot be satisfied or when required.

935.07.03.01.03**Preparation of Recess and Cell Placement**

The depth of the recess shall permit the reference cell to be installed with the adjacent reinforcing steel bar at the mid height of the cell. When 10 mm of cover is not provided to the top of the cell under the above conditions, the recess shall be deepened to provide the 10 mm of cover.

Reference cells installed adjacent to ducts containing post-tensioning steel shall be installed at the depth as specified in the Contract Documents or as directed by the Contract Administrator.

The concrete surface in the recess shall be abrasive blast cleaned and all deleterious material removed by means of air blasting.

The surfaces of the recess shall be dampened, all free water removed, and coated with non-shrink grout. The reference cell shall be placed tight against the side of the recess closest to the reinforcing steel; however, contact between the cell and the exposed reinforcing steel shall not be permitted. The recess, including cavities induced by saw cutting shall be filled with non-shrink grout according to the manufacturer's recommendations to the level of the original concrete surface.

935.07.03.01.04**Cable Installation**

Cable slots shall be created by saw cutting. Cable slots, each 6 mm wide by 10 mm deep, shall be sawn between the reference cell recess and the junction box for the installation of the reference cell cables as specified in the Contract Documents. The edges of the slot shall be rounded where the slot meets the recess. Each slot shall contain only one cable.

When multiple cables converge in to one cable slot, the cable slot shall be adjusted to 9 mm wide by 23 mm deep and sawn from the point where all the cables converge at the install area to the corresponding junction box. Each cable will share the common saw slot running to the junction box.

Immediately prior to placing material, the recesses shall be abrasive blast cleaned and all deleterious material contained inside the recesses and slots shall be removed by means of air blasting.

The cable shall be continuously contained in the slot between the reference cell recess and the junction box and held in place with non-metallic plugs spaced at 600 mm on centres to prevent migration of the cable towards the surface.

Each cable left unconnected at the junction box location for more than 1 Day shall have a heat shrink end boot installed on it. The heat shrink end boot shall not be removed until the cable is permanently connected.

Cable slots shall be backfilled with non-conductive low viscosity epoxy to the level of the original concrete surface according to the manufacturer's recommendations. Care shall be exercised to ensure that the slots are completely filled with epoxy and there is no excess epoxy spilled over the adjacent concrete surface along the slots.

935.07.03.01.05**Testing During Installation**

Upon completion of cell installation, the voltage and resistance between the reference cell and the cathode CM connection shall be measured and recorded.

If the AC resistance between the graphite cell and the cathode connection is less than 10 ohms or more than 1,000 ohms or if the voltage reading is unstable, the cell shall be removed and replaced. The voltage and resistance measurements shall be repeated and recorded.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

935.07.04 Rigid Ducts and Junction Boxes, Surface Mounted

The duct, fittings, and junction boxes shall be installed in neat straight lines. Rigid ducts shall be installed vertically and either horizontally or parallel to structural surfaces using offset bends or fittings where changes in alignment are necessary. When holes are specified to permit installation through concrete components, they shall be core drilled.

Expansion joints shall be installed according to the manufacturer's recommendations with at least one expansion joint between any two adjacent junction boxes. Conduit straps and junction boxes shall be fastened to the concrete surface by drilling and inserting stainless steel anchors and bolts.

Conduit straps shall be located at a maximum of 1.5 m centres and shall be one trade size larger than the conduit supported.

Ducts and junction boxes shall be installed after concrete repairs have been completed.

935.07.05 Rigid Ducts and Junction Boxes, Embedded in Concrete

The installation of rigid PVC junction boxes and rigid duct embedded in concrete shall be according to OPSS 913.

When cables are to be routed through the curb to a junction box mounted on the outside face of a deck, concrete shall be removed at the curb locations to the width and depth as specified in the Contract Documents. All sharp edges of concrete shall be rounded off. A hole shall be drilled to provide access to the junction box or to provide a deck entry hole where specified in the Contract Documents. A non-conductive duct shall be installed and grouted in place with non-shrink grout.

After the installation of the cables, the duct embedded in the curb shall be sealed with a silicone plug to a depth of 50 mm.

The cavities in the curb, barrier wall, or sidewalk shall be filled with concrete to the original surface according to OPSS 930.

935.07.06 Rigid Ducts, Direct Buried

The installation of rigid ducts direct buried shall be according to OPSS 603.

935.07.07 Extra Low Voltage Cables

The installation of the extra low voltage cables shall be according to OPSS 604.

The run of extra low voltage cable from the initial splice in the junction box to the cathodic protection cabinet shall be of one continuous length. Heat shrink identification sleeves shall be placed over the free end of each cable at the cathodic protection cabinet and at the end of each cable from the structure in the junction boxes with the number of the component as specified in the Contract Documents.

All splices, with the exception of anode distribution bars, shall be made in the junction boxes with compression connectors. Each splice shall be soldered after installation. Both ends of the connector shall be soldered to the cable.

All splices for reference cells and cathode CM cables shall be sealed and insulated with heat shrink tubing. The splices for the cathode CS cables shall be sealed and insulated with a motor splice kit.

Cable that will be unconnected at the junction box location for more than one week shall have a heat shrink end boot installed until the permanent connection is made.

935.07.08 Installation of Cathodic Protection Equipment Assembly

935.07.08.01 Concrete Pad and Ground Electrode

The concrete pad shall be constructed according to OPSS 616, except that the anchor bolts shall be drilled in place.

The installation of the ground wires and ground electrode shall be according to OPSS 609.

935.07.08.02 Installation of Cabinet

The pedestal and cabinet shall be installed squarely and symmetrically on the concrete pad with a neoprene gasket installed on the bottom channel of the enclosure and the bottom of the pedestal.

Holes for mounting bolts shall be drilled, as required, and anchor bolts installed.

935.07.08.03 Grounding

The ground bar installed on the inside and bottom part of the cabinet shall be connected to the system ground as specified in the Contract Documents.

935.07.08.04 Connection of Incoming Cables

The AC power supply shall be connected to the AC power distribution assembly. Each cable from the structure shall be connected to the proper terminal on the terminal block assembly conforming to the colour code and labelling.

Upon completion of wiring and connection, all incoming cables shall be bundled and held in place with nylon cable ties. Cables and connectors shall not be subject to stress during or after installation.

935.07.09 Anode Mesh and Distribution Bars

935.07.09.01 Handling and Storing

The anode mesh and distribution bars shall be handled and stored in such a manner to avoid breakage or shape distortion due to stretching. The anode mesh and distribution bar shall be kept clean and dry prior to installation.

935.07.09.02 Installation

935.07.09.02.01 Scheduling

The anode mesh and distribution bars shall be installed after all concrete patching and abrasive blast cleaning of the concrete surface has been carried out and prior to placement of the concrete overlay.

935.07.09.02.02 Layout

The anode mesh and distribution bars shall be installed on the concrete surfaces as specified in the Contract Documents. Alternative arrangement of anode mesh rows may be considered where it may be practical to use odd shapes of anode mesh, subject to the approval of the Contract Administrator.

935.07.09.02.03 Isolation

The anode mesh and distribution bars shall be electrically isolated from the reinforcing steel and from any metallic components on the surface of the structure prior to proceeding with the work. Only non-metallic fasteners shall be used.

When a deck has been scarified, a concrete cover survey on a 1.5 x 1.5 m grid shall be done after scarifying and prior to the installation of the anode mesh. The results of the survey shall be recorded and submitted to the Contract Administrator.

A spacer grid shall be placed between the anode mesh and distribution bars and the concrete in areas where cover to the reinforcing steel is less than 15 mm or with exposed reinforcing steel. The spacer grid GFRP bars shall be tied together with plastic ties thereby holding the grid together and secured to prevent bars from floating during the overlay pour. Non- conductive fasteners similar to those used to anchor the titanium mesh shall be used to secure the bars to the deck. The titanium mesh in the secured areas shall be placed on top of the GFRP grid and tied by plastic ties to the grid.

Exposed rebars shall not be protected with a coating of grout or epoxy as a means of isolation.

Immediately prior to installation of the anode mesh, all concrete surfaces shall be inspected for exposed metal such as tie-wire, tie-rods, bolts, and other metallic components. All exposed metal and metal within 5 mm of the concrete surface, which is continuous with the reinforcing steel, shall be identified by visual means and by means of a holiday detector and the metal shall be insulated by coating with two coats of epoxy or shall be removed as directed by the Contract Administrator. When epoxy is used, only the metal shall be coated.

935.07.09.02.04 Anode Mesh Placement

Adjacent rolls of anode mesh within the same zone shall be in contact with a minimum overlap of 100 mm.

When two or more zones or subzones are specified, the separation between anode mesh in adjacent zones or subzones shall be 150 ± 25 mm.

Anode mesh shall be cut, where necessary, to provide a separation of 150 ± 25 mm between the anode mesh and metal features mounted on or protruding from concrete surface.

At splices and at joints where irregularly shaped sections are added, the anode mesh shall be overlapped a minimum of 75 mm and both sections of the anode mesh shall be welded to the distribution bar.

The anode mesh shall be either offset a maximum of 75 mm from a concrete corner or shall be wrapped tightly around the corner.

The edge of anode mesh shall be offset 150 ± 25 mm from the curb face throughout the length of the deck.

The location of embedded cables shall be determined and marked on the concrete prior to drilling for fasteners.

The anode mesh shall be held in place by non-conductive fasteners inserted in drilled holes. There shall be at least three fasteners installed across the full width of each roll of the anode mesh such that two anchors are placed 50 to 75 mm from the anode mesh edge with a third anchor in the centre. The maximum distance between two adjacent anchors along the length and width of the anode mesh shall not exceed 600 mm.

When the anode mesh is elevated as a result of the GFRP spacer grid, the mesh shall be secured to the GFRP bars by plastic ties.

Overlapping anode mesh may be attached with a common fastener.

The anode mesh shall be installed as close to the concrete surface as practical with a maximum offset from the surface of 3 mm.

Bulges shall be pressed down and additional fasteners shall be installed to maintain the specified clearance.

The anode mesh shall not be tensioned to such an extent that the anode mesh pattern is distorted. Edges of anode mesh cut to avoid contact with objects on the concrete surface shall be fastened at no more than 300 mm intervals.

All debris and dirt resulting from drilling holes for fasteners and others work associated with the installation of the anode mesh shall be removed from the concrete surface by air blasting at a minimum frequency of once per Day.

Under no circumstances shall the anode mesh be subjected to abrasive blast cleaning.

935.07.09.02.05 Distribution Bar Placement

Distribution bars shall be installed in straight lines as specified in the Contract Documents. The locations shall line up with junction box locations to facilitate connection within the box.

Where specified, distribution bars may be extended by overlapping approximately 200 mm and resistance welding every 12 mm.

The anode mesh shall be resistance welded to the distribution bars at every third diamond intersection point for a spacing of approximately 228 mm.

The welding procedures used shall be according to the anode mesh manufacturer's recommendations and shall be those used in making the samples for submission.

The distribution bars shall be protected by the application of heat-shrinkable tubing:

- a) in conduit connecting to junction box.
- b) where passing through curb.
- c) where traversing concrete cracks greater than 1 mm.
- d) where specified in the Contract Documents or by Contract Administrator.

The distribution bars shall enter the junction box through the conduit as specified in the Contract Documents. The two distribution bars shall be jumpered by a short stub of distribution bar resistance welded to them in the junction box.

The distribution bars shall be connected to the anode bus cables in the junction box by means of a bolted connector as specified in the Contract Documents. The threads of the bolt shall be coated with a locking compound. The connection and any exposed distribution bars shall be sealed and insulated with heat shrink tubing and heat shrink tape.

935.07.09.02.06 Concrete Surface Preparation after Anode Installation

Immediately after installation of the anode mesh and distribution bars, all debris resulting from the drilling of anchor holes and other accumulated dirt shall be removed from the concrete surface by air blasting.

The surface of the concrete with anode mesh and distribution bars in place shall be pre-wetted with water prior to application of the concrete overlay.

935.07.09.02.07 Protection during Placement of Concrete Overlay

During placement of concrete overlay, the anode mesh and distribution bars shall be protected against potential damage caused by construction equipment and workers by means of 20 mm thick plywood sheeting. The plywood sheets shall be removed as the placement of the overlay progresses.

935.07.09.02.08 Junction Box Entry

When wiring is to be routed to junction boxes embedded in new barrier walls or sidewalks, a blackout shall be created to permit installation of conduit and wiring.

After installation of the cables, the conduit in the curb shall be sealed with a silicone plug to a depth of 50 mm.

The cavities in the curb, barrier wall, or sidewalks shall be filled with concrete to the original surface according to OPSS 930. Alternatively, the cavity may be filled with non-shrink grout.

935.07.09.03 Testing

935.07.09.03.01 Pre-Installation

Prior to installing anode mesh and distribution bars, the quality of the weld between the anode mesh and current distribution bar shall be pull tested by preparing a sample weld and pulling the anode mesh from the distribution bar using pliers. If metal is pulled from one substrate, the weld is acceptable. If the anode mesh strand or strip breaks or is burned through, the weld power setting is too high. If the weld breaks, the power setting is too low. A similar test shall be carried out to determine the quality of the weld when two distribution bars are welded together. The weld power setting shall be adjusted to obtain satisfactory welds.

One week prior to the commencement of the installation of the distribution bars and the anode mesh, the following samples fabricated with the equipment and procedures to be used in the work together with the power setting used in welding the samples shall be submitted to the Contract Administrator:

- a) Two 300 mm lengths of distribution bars overlapped and welded at four locations at 12 mm intervals.
- b) Anode mesh weld at the diamond junctions to two 500 mm lengths of distribution bars.

935.07.09.03.02 During Installation

935.07.09.03.02.01 Weld between Anode Mesh and Distribution Bars

During installation of the anode mesh and distribution bars, random pull tests shall be performed on the weld connecting as follows to verify the adequacy of the welds:

- a) The anode mesh to the distribution bar.
- b) The distribution bar to the distributor bar.

935.07.09.03.02.02 Short Circuits

Tests for short circuits shall be carried out by the corrosion specialist or a NACE accredited cathodic protection or corrosion technologist under the direct supervision of the corrosion specialist.

Tests for short circuits between the anode mesh, distribution bars, the reinforcing steel, and all metallic appurtenances shall be done during installation of the anode mesh and continuously monitored during application of the concrete overlay.

Short circuits shall be removed and the area retested prior to proceeding with the concrete overlay.

When the area of potential short circuits is equal to or less than 150 x 150 mm, the anode mesh shall be cut clear of the exposed reinforcing steel or in areas where the cover to the reinforcing steel is less than 15 mm. When the area of potential shorts circuits is greater than 150 x 150 mm, the anode mesh shall be separated from the concrete surface using a GFRP spacer grid.

The location and extent of the areas requiring treatment and the treatment undertaken to eliminate the short circuit shall be recorded and submitted to the Contract Administrator.

Prior to installation of the waterproofing on the concrete overlay and at each stage, a test shall be done to confirm that there are no short circuits by temporarily applying a direct current using a portable DC power supply sufficient to produce and applied current density of 10 mA/m². When the occurrence of a short circuit is detected, the short circuit shall be located and removed.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

935.07.09.04 Trial Operating Period - Acceptance Testing

935.07.09.04.01 General

Prior to the acceptance of the Work, it shall be demonstrated that all components of the cathodic protection system, including the rectifier and RMU, are in proper working order. Short circuits are not permitted between the anode mesh and its hardware and the reinforcing steel or any other metallic components of the structure in contact with the reinforcing steel, such as drainage pipe or expansion joints.

Field readings taken during the trial operating period shall be taken by a NACE accredited cathodic protection or corrosion technologist under the direct supervision of the corrosion specialist.

The system shall be energized for a period of 72 hours at a power level that applies an average current density of 2 mA/m² on all cathodically protected areas of the structure. If AC power is not available at the site at the time of the trial operating period, power shall be provided to the rectifier and remote monitoring by means of a portable generator.

Field testing of the installed cathodic protection system shall only be conducted with the Contract Administrator and a representative of the Owner in attendance.

The Contract Administrator shall be informed 4 Business Days in advance of the planned trial operating period.

When measuring the potential of reference cells, the negative lead of the multimeter shall be connected to the reference cell lead wire and the positive lead to the cathode CM wire. The polarity sign of the reading shall be recorded.

Testing shall be done when the air temperature is at least 5 °C.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

A training session for the demonstration of the use of the RMU software including downloading of site data shall be carried out at the ministry's Bridge Office in St. Catharines.

935.07.09.04.02 Testing Prior to Energizing the System

935.07.09.04.02.01 Embedded Components

Immediately prior to energizing the system, the following measurements shall be manually recorded on site at the cathodic protection cabinet with a portable multimeter and AC resistance meter:

- a) Reference cell potential, in mV, relative to cathode CM cable.
- b) Voltage between each anode or anode bus and cathode CS cable, in volts.
- c) Resistance, AC, between each reference cell and cathode CM cable, in ohms.
- d) Resistance, AC, between each anode or anode bus and cathode CS cable, in ohms.
- e) Resistance, DC, between CM and CS cathode connections, in ohms.
- f) Voltage between CM and CS cathode connections, in mV.

To meet the requirements of this specification, the readings obtained shall be according to requirements as shown in Table 1.

935.07.09.04.02.02 Rectifier

It shall be demonstrated in the presence of the Contract Administrator that the rectifier assemblies will function properly throughout the full operating range of the output current and voltage according to OPSS 2301. The rectifier assemblies shall not be connected to the cathodic protection system at the time the testing is conducted.

935.07.09.04.02.03 Remote Monitoring and Control Unit

It shall be demonstrated in the presence of the Contract Administrator that the operation of the RMU meets the requirements according to OPSS 2301.

935.07.09.04.03 Testing after Energizing the System

After the system is energized, the following readings shall be manually recorded on site at the cathodic protection cabinet for a period of 72 hours using a portable multimeter and clamp-on ammeter.

- a) Total current and voltage for each rectifier.
- b) Current flow to each area of the system, zones or subzones or both, or anode bus, as applicable.
- c) Reference cell potentials, on and instant-off.

Manual readings shall be verified with portable computer on site connected to the RMU and at a computer located at a remote location.

The manual readings and the RMU readings from the portable computer on site shall be taken on an hourly basis during the work hours and the readings obtained from the remote location computer shall be taken on an hourly basis.

All the measurements obtained by the RMU shall be the same as the readings obtained manually on site. The RMU shall be calibrated using gains and offsets, as required.

The results of all tests shall be certified by the corrosion specialist and the certified test results shall be submitted to the Contract Administrator.

Immediately after the 72-hour readings are made, the system shall be switched off and allowed to depolarize for a period of 4 hours. At the end of the 4-hour depolarization period, reference cell potentials shall be recorded and the differences between instant-off readings at 72 hours and the 76-hour depolarized readings shall be calculated. Voltage between anodes and cathode shall also be recorded.

The performance of the system shall be monitored during the trial operating period and appropriate actions shall be taken to repair any defects detected. The trial operating period shall be repeated as many times as required to prove proper functioning of the system.

Within 7 Days of the completion of the trial operating period, an acceptance testing commissioning report shall be submitted to the Contract Administrator recording:

- a) The dates and times of the periods of trial operation.
- b) Names of individuals collecting and recording data.
- c) Testing equipment used, manufacturer and model number, including power source, if applicable.
- d) All readings noted above, labelled as to appropriate zone, subzone, or bus, as applicable.
- e) All remedial action taken.

The acceptance testing commissioning report shall bear the seal and signature of the corrosion specialist and certify that:

- a) The rectifier and remote monitoring unit are functional.
- b) The wiring of the system is according to the Contract Drawings, and the labelling and identification of wire terminations is correct in the control panel.
- c) All areas, zones and subzones, or buses, as applicable, of the system were functional and received current flow during the trial operating period.
- d) There are no short circuits between anodes and cathodes.
- e) There are no short circuits between reference cells and cathode.
- f) The accuracy of all meters and proper circuit polarity has been verified using a multimeter.

935.07.10 Remedial Work

Work not meeting the acceptance testing requirements shall be repaired or replaced. Proposals for correcting deficiencies shall be submitted to the Contract Administrator for approval prior to commencement of the remedial work.

935.07.11 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

935.08 QUALITY ASSURANCE

935.08.01 Anode Mesh

A manual pull test will be randomly conducted on the weld connecting the anode mesh to the distribution bar to check the weld quality.

935.08.02 Control and Monitoring Equipment

The Contractor, through the agreement to purchase control and monitoring equipment, shall ensure the ministry's representative be permitted access to the place of assembly of the cathodic protection equipment assembly while work on the unit is being performed for the purpose of inspecting the work and examining plant records, certificates, materials being used, process of fabrication, and to request further tests, as required.

935.08.03 Acceptance and Rejection

Work not meeting the requirements of this specification shall be subject to rejection.

935.09 MEASUREMENT FOR PAYMENT

935.09.01 Actual Measurement

**935.09.01.01 Cathode Connections
Reference Cells
Cathodic Protection Cabinets
Concrete Pad for Cathodic Protection**

For measurement purposes, a count shall be made of each of the above items installed.

935.09.01.02 Anode Mesh

Measurement of anode mesh shall be by area in square metres for the full surface of the concrete being treated with no deduction for minor surface areas not covered, such as at corners, cutouts and the like, nor any addition for surface areas requiring overlapping mesh.

935.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

935.10

BASIS OF PAYMENT

935.10.01

Cathode Connections - Item
Reference Cells - Item
Cathodic Protection Cabinets - Item
Concrete Pads for Cathodic Protection - Item
Anode Mesh - Item
Extra Low Voltage Cables for Cathodic Protection - Item
Cathodic Protection Rectifiers - Item
Cathodic Protection Remote Monitoring and Control Units - Item
Rigid Ducts and Junction Boxes for Cathodic Protection - Item
Acceptance Testing for Cathodic Protection - Item

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.

TABLE 1
Resistance and Voltage Requirements

Component	Resistance Ohms	Voltage
Reference Cell - Graphite	10 - 1000 (AC)	Stable
Reference Cell - Silver-Silver Chloride	As per manufacturer's recommendations.	Stable
Cathode Connection	< 2 (DC)	< 1 mV
Anode	< 3 (AC)	Stable

Appendix 935-A, November 2014
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

No information provided here.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PRESTRESSED SOIL AND ROCK ANCHORS

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942.01	SCOPE

This specification covers the requirements for the design, installation, and testing of prestressed anchors in soil and rock.

942.02	REFERENCES

This specification refers to the following specifications, standards, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 906	Structural Steel for Bridges

Ontario Provincial Standard Specifications, Material

OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production

CSA Standards

A23.1-19/A23.2-19	Concrete Materials and Methods of Concrete Construction/Test methods and Standard Practices for Concrete
A283-19	Qualification Code for Concrete Testing Laboratories
G40.20-13/G40.21-13(R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels

ASTM International

A53 / A53M -18	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A416 / A416M - 18	Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
A500 / A500M - 18	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A722 / A722M - 18	High-Strength Steel Bars for Prestressed Concrete
D1143 / D1143M - 07(2013)e1	Standard Test Method for Deep Foundations Under Static Axial Compressive Load
D1248-16	Polyethylene Plastics Extrusion Materials for Wire and Cable
D1784-11	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
D3350-14	Polyethylene Plastics Pipe and Fittings Materials
D4101-17e1	Polypropylene Injection and Extrusion Materials

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025	General Requirements for the Competence of the Testing and Calibration Laboratories

American Petroleum Institute (API)

13A	Drilling Fluid Materials, 18th Edition, 01.10.06
RP 13B-1	Standard Procedure for Field Testing Water Based Drilling Fluids, 4th Edition

Post Tensioning Institute (PTI)

Recommendations for Prestressed Rock and Soil Anchors

942.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Alignment Load means a nominal minimum load applied to an anchor during testing to keep the testing equipment positioned correctly.

Anchor means a system used to transfer tensile loads to soil or rock that includes the prestressing steel, anchorage, corrosion protection, sheathings, spacers, centralizers, and grout.

Anchorage means the combined system of anchor head, bearing plate, trumpet, and anchorage corrosion protection that is used to transmit the prestressing force from the prestressing steel to the surface of the ground or the supported structure.

Anchor Head means the device by which the prestressing force is permanently transmitted from the prestressing steel to the bearing plate.

Apparent Free Stressing Length means the length of tendon or bar that is apparently not bonded to the surrounding ground or grout, as calculated from the elastic movement measured during the load test.

Bond Length means the length of the tendon that is bonded to the primary grout and capable of transmitting the applied tensile load to the surrounding soil or rock.

Centralizer means a device to support and position the tendon and sleeves in the drill hole throughout the bond length of the tendon so that a minimum grout cover is achieved.

Coupler means the method by which the prestressing force can be transmitted from one partial length of prestressing tendon to another.

Design Load means the anticipated final maximum effective load in the anchor after allowance for time-dependent losses or gains. The design load includes appropriate load factors to ensure that the overall structure has adequate capacity for its intended use.

Free Stressing Length means the designed length of the tendon that is not bonded to the surrounding ground or grout during stressing.

Lift-Off means checking the load in the tendon at any specified time with the use of a hydraulic jack at the moment of lifting of the anchor head off the bearing plate.

Lock-Off Load means the prestressing force in an anchor immediately after transferring the load from the jack to the stressing anchorage.

Log Time Cycle means one rotation of a log cycle of a semilogarithmic plot for the purpose of recording the measurement of movement and time.

Permanent Anchor means a prestressed anchor intended for permanent use.

Performance Test means cyclic and incremental loading and unloading of an anchor, while recording the total movement of the pulling head in each cycle at each increment, including the residual movement at alignment load.

Post-Grouting means regrouting an anchor after the primary grout has set.

Pre-Production Test Anchor means an anchor installed and then loaded to verify the design parameters, prior to the installation of the production anchors.

Prestressing Steel means strands, a group of strands combined to form a tendon, or a high strength steel bar.

Primary Grout means Portland cement based grout that is injected into the anchor hole prior to or after the installation of the anchor tendon to provide for the force transfer to the surrounding ground along the bond length of the tendon.

Production Anchor means an anchor installed and loaded that forms part of the final foundation support system.

Production Test Anchor means an anchor installed and then loaded to verify the design parameters, prior to the installation of the production anchors.

Proof Test means incremental loading of an anchor and recording the total movement of the anchor at each increment.

Residual Movement means the non-recoverable movement of the pulling head measured at alignment load.

Temporary Anchor means a prestressed anchor intended for temporary use.

Test Load (TL) means the maximum load that the anchor is subjected during testing.

Total Movement means the total movement of the pulling head measured at maximum load in each cycle.

942.04 DESIGN AND SUBMISSION REQUIREMENTS

942.04.01 Design Requirements

942.04.01.01 General

Except for Owner designed anchors, the Contractor shall be responsible for the detailed design of the anchor, including the determination of the applied loads, design assumptions, and installation procedures. The Contractor shall also be responsible for the design of the anchor testing equipment and reaction system.

The anchors shall be designed to safely withstand the applied loads specified in the Pre-Production Test Anchor clause and fulfill the acceptance criteria specified in the Production Anchor clause and perform satisfactorily at the design load through the required service life.

The design assumptions shall accurately represent the subsurface conditions prevalent at the site.

Temporary anchors in a corrosive environment shall be designed as permanent anchors.

Except as specified in this specification, the anchors shall be designed according to the design recommendation of the Recommendations for Prestressed Rock and Soil Anchors publication.

942.04.02 Submission Requirements

942.04.02.01 Working Drawings

Five sets of Working Drawings shall be submitted to the Contract Administrator at least 21 Days prior to the commencement of the work of prestressed rock and soil anchors, for information purposes only. Prior to making a submission, the seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings verifying that the drawings are consistent with the Contract Documents.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

Information to be shown on the Working Drawings shall describe and illustrate the complete details of the anchor system, anchor testing equipment, and reaction system for the production anchors and, when specified in the Contract Documents, pre-production test anchors. This information shall include as a minimum:

a) Plans, Elevations, and Sections

- i. Anchor spacing.
- ii. Orientation.
- iii. Minimum total anchor length.
- iv. Free stressing length.
- v. Design load.
- vi. A unique identification number for each anchor.
- vii. Anchor components and details.

b) Installation

- i. Construction methods.
- ii. Work restrictions.
- iii. Schedule.
- iv. Sequence and coordination of work.
- v. Monitoring.
- vi. Type and number of tests
- vii. Evaluation of test results.

c) Materials

- i. Physical properties of monobar and multistrand anchors.
- ii. Primary grout materials and mix proportions.
- iii. Post grouting materials and mix proportions.
- iv. Free stressing length materials and mix proportions.
- v. Corrosion protection material physical and mechanical properties.

d) Anchor Hole Construction

- i. Method of constructing the anchor holes and maintaining the stability of the holes during the anchor installation. The drilling equipment and materials including drill bit or auger diameter and lengths, casing diameter and lengths, and slurry material used to facilitate the construction of the anchor hole. The method of verifying the hole length shall also be identified.
- ii. Details for assembling the anchor in the anchor hole.
- iii. Method of placing and centring the anchor tendons, including the method used to maintain them in the centre of the hole over the design bond length.
- iv. Bond zone primary grout placement. Grout mixing procedure and the method of installation, including grout pressures. The method to determine the surface of the hardened bond length grout shall be identified.
- v. Bond zone post grout placement. Grout mixing procedure and the method of installation, including grout pressures.
- vi. Free stressing zone grout placement. Grout mixing procedure and the method of installation, including grout pressures.
- vii. Waterproofing of holes drilled in rock for permanent anchors. Details of water tightness tests, including setup, water pressure, method of applying pressure, details of consolidation, grouting, redrilling, and retesting.

e) Stressing Information

- i. Anchor stressing schedule that includes the working loads and test loads.
- ii. Anchor stressing equipment, and the method for testing the stressing of pre-production and production test anchors and production anchors. Details of the reaction system used to support the applied loads.
- iii. Equipment, including the calibration records of the gauges and jacks, and procedure to monitor the applied loads and movements during anchor testing.
- iv. Details of the reference system and equipment to monitor the movement.

f) All design assumptions, loads, parameters, and bond stresses used for pre-production and production test anchors and production anchors.

g) Testing records when testing has been done to determine bond stress.

h) Details of destressing and removal of temporary anchors.

942.04.02.02 Slurry

At least 14 Days prior to commencement of the work, the following information for the slurry shall be submitted to the Contract Administrator, for information purposes only:

- a) The type, source, and physical and chemical properties of the bentonite or polymer.
- b) The source of water.
- c) Method of mixing slurry.
- d) The water solids ratio and the mass and volumes of the constituent parts, including any chemical admixtures or physical treatment employed to produce slurry with the required physical properties.
- e) Details of procedure to be used for monitoring the quality of the slurry.
- f) A test report showing the properties of the slurry and certifying that the slurry meets the requirements of API 13A.
- g) Method of disposal of the slurry.

942.04.02.03 Couplers

At least 14 Days prior to commencement of the work, a copy of the following shall be submitted to the Contract Administrator:

- a) Manufacturer's catalogue giving the complete data on the coupler material and installation procedures.
- b) Test reports from the manufacturer certifying strength and fatigue requirements.

942.04.02.04 Prestressing Steel

942.04.02.04.01 Mill Certificates

One copy of the mill test certificates, indicating that the steel meets the requirements of the Contract Documents, shall be submitted to the Contract Administrator at the time the prestressing steel is delivered to the job site.

Identification on the anchor tendon shall allow tracing of the prestressing steel to its heat or reel number.

Where mill test certificates originate from a mill outside Canada or the United States of America the Contractor shall have the information on the mill certificate verified by testing by a Canadian testing laboratory. The laboratory shall be accredited by the Standards Council of Canada as complying with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate. The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material is according to the Contract Documents. The stamp shall include the appropriate material specification number, testing date (i.e., yyyy-mm-dd), and signature of an authorized officer of the testing laboratory.

One copy of the stress-strain curves that are representative of the lots to be used shall be submitted to the Contract Administrator together with the mill certificates specified detailed in OPSS 1440.

942.04.02.04.02 Prestressing Steel Bond Capacity

If not available from the prestressing steel manufacturer, a prestressing strand bond capacity test shall be conducted on the strand according to Appendix A of the Recommendations for Prestressed Rock and Soil Anchors publication. The test information shall be submitted to the Contract Administrator prior to commencement of work.

942.05 MATERIALS

942.05.01 Permanent Anchors

942.05.01.01 General

Tendons shall be manufactured from steel bars or strand either in single or multiple element tendons.

The permanent anchors shall be Dywidag Threadbar Anchors, BBR Cona Multi-Strand Anchors, VSL Multi-Strand Anchors, or other approved equivalent anchors.

942.05.01.02 Anchorages

The components of the anchorage shall be capable of developing at least 100% of the guaranteed minimum ultimate capacity of the tendon or bar.

The anchor head shall be wedges for prestressing strands and anchor nuts for prestressing bars. The wedges shall be designed to uniformly engage the strand with no notch or pinching effects.

The bearing plate shall be fabricated from steel according to CSA G40.20/G40.21.

The trumpet shall be fabricated from steel pipe according to ASTM A53 or tubing according to ASTM A500. The trumpet shall have a minimum wall thickness of 3 mm for diameters up to and including 100 mm and 5 mm for larger diameters. The joint between the trumpet and the bearing plate and the joint between the trumpet and sheath shall be watertight. The trumpet shall overlap the free stressing length corrosion protection by at least 100 mm. The trumpet shall be long enough to accommodate movements of the structure and the tendon during stressing and testing.

The anchorage covers shall completely encapsulate the anchor head with a watertight seal between the cover and the bearing plate.

942.05.01.03 Prestressing Steel

Prestressing steel shall be according to ASTM A416 and ASTM A722.

Bars shall be high-tensile strength bars grade 1,030 MPa, 1,100 MPa, or 1,230 MPa.

Strand shall be seven-wire, uncoated, stress relieved and low relaxation strand grade 1,720 MPa, 1,760 MPa, or 1,860 MPa.

The strand and bar shall meet the bond capacity test specified in the Prestressing Steel Bond Capacity subsection.

942.05.01.04 Couplers

Couplers for bars shall be as specified by the supplier of the anchor and shall develop at least 100% of the guaranteed minimum ultimate strength of the tendon. Strand tendons shall not be coupled.

942.05.01.05 Cement

Cement shall be according to OPSS 1301 and shall be certified free of false set.

942.05.01.06 Water

Water shall be according to OPSS 1302.

942.05.01.07 Sheathing

Plastic sheathing shall be high density polyethylene according to ASTM D1248, Type III, or polyvinyl chloride (PVC) according to ASTM D1784, Class 13464-B or equal. The plastic sheathing shall be such that a bond of 5 MPa is developed when grout with a compressive strength of 30 MPa is used.

Hot melt extruded plastic tubing made from polyethylene according to ASTM D3350 and ASTM D1248 shall have an average minimum wall thickness of 1.5 mm. Hot melt extruded plastic tubing from polypropylene according to ASTM D4101 shall have an average minimum wall thickness of 1.5 mm. Steel tubing or pipe shall have an average minimum wall thickness of 5.0 mm.

The materials for the sheathing accessories such as end caps, grouting caps, grout tubes, and sealing caps shall have properties equal to the plastic sheathing.

942.05.01.08 Heat Shrinkable Sleeves

Heat shrinkable sleeves shall be fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant.

942.05.01.09 Grout Tubes

Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. They shall be able to withstand 1 MPa pressure.

Post-grout tubes shall be strong enough to withstand the post-grouting pressure.

942.05.01.10 Bond Breaker

The bond breaker shall be fabricated from plastic tube or pipe made from medium to high density polyethylene according to ASTM D1248 or from polyvinyl chloride according to ASTM D1784, Class 13464-B or equivalent, with a minimum wall thickness of 1 mm.

942.05.01.11 Centralizers and Spacers

Centralizers and spacers shall be steel or plastic.

942.05.01.12 Grout

The grout cube for high early strength grout shall be at least 20 MPa at 7 Days and 30 MPa at 28 Days. The type of cement used shall be suitable for the required use of the grout. Accelerators shall not be used. The grout shall bleed less than 2% when allowed to stand for one hour.

942.05.01.13 Corrosion Inhibiting Compound

The corrosion inhibiting compound placed in either the free stressing length or the anchorage area shall be an organic compound, grease, or wax with appropriate polar moisture displacing and self-healing properties and corrosion inhibiting additives. The compound shall permanently stay viscous and be chemically stable and non-reactive with the prestressing steel, sheathing material, and anchor grout.

942.05.01.14 Corrosion Protection

The anchor shall be provided with Class I, encapsulated tendon, double corrosion protection according to the Recommendation for Prestressed Rock and Soil Anchors publication.

The tendon shall be fully encased within a corrugated PVC sheathing that is, in turn, encased within a smooth PVC sheathing over the length of the free stressing zone and protected with grout having the 7- and 28-Day compressive strengths.

942.05.02 Temporary Anchors

The material for temporary anchors shall be the same as specified for the permanent anchors except the double protection system is not required.

942.05.03 Pre-Production Test Anchors

The material for the pre-production test anchors shall be the same as specified for the production anchor being evaluated.

942.05.04 Bentonite Cement Slurry

Bentonite and polymers shall meet the requirements of API 13A.

The bentonite cement slurry shall consist of a stable mixture of cement and a colloidal suspension of pulverized solids or polymers thoroughly mixed with water. The density, viscosity, sand content, and pH of the slurry while being used during excavation shall be according to API RP13B-1.

942.05.05 Concrete

Concrete shall be according to OPSS 1350 with a nominal 28-Day compressive strength of 30 MPa.

The slump shall be 150 to 180 mm.

942.06 EQUIPMENT

942.06.01 General

All equipment for the installation of the anchor, anchor stressing, anchor testing, and monitoring of the anchor test shall be suitable for the intended purposes and capable of working on the site under the prevailing access and clearance conditions.

The equipment used shall not cause damage to the anchor tendon, corrosion protection, or retained structural members.

The equipment used shall be in according to those listed in the required submissions.

942.06.02 Grouting Equipment

Mixers and pumps shall be of an adequate capacity and hoses shall be sized to allow continuous grouting of an individual anchor within one hour. A colloidal mixer with a gauge to measure the water shall be used.

942.06.03 Temporary Anchor Concrete Placement Equipment

Continuous flight augers shall be used for the placement of concrete for temporary anchors up to a maximum ratio of hole diameter to length of 1:35. Open hole concrete placement shall be limited to a minimum hole diameter of 600 mm and a maximum ratio of hole diameter to length of 1:15.

942.06.04 Anchor Testing Equipment

The rated capacity of the equipment shall not be exceeded when stressing the tendon to the maximum specified test load. The pump shall be capable of applying each load increment in less than 60 seconds.

The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be increased or decreased according to the test specifications and to allow the anchor to be lift-off tested to confirm the lock-off load.

Dial gauges shall have at least a 75 mm travel. Longer gauge stems or sufficient gauge blocks shall be provided to allow for greater travel where required. Gauges shall have precision of at least 0.02 mm.

Dial gauges shall permit the measurement of total tendon movement to the nearest 0.02 mm at every load increment. The gauge shall have sufficient travel to record the total anchor movement at test load without the need to reset at an interim point.

Jacks used for stressing tendons shall have a minimum ram extension of 150 mm.

Stressing equipment shall be calibrated within an accuracy of $\pm 2\%$ immediately prior to use.

Current calibration curves bearing the seal and signature of an Engineer shall be provided for all gauges and jacks.

942.07 CONSTRUCTION

942.07.01 General

The Contractor shall be responsible for the material, fabrication, installation, testing, and monitoring of pre-production and production test anchors and production anchors.

In addition, for non-Owner designed anchors, the Contractor shall be responsible for the preparation of a soils report, the determination of design parameters, and the design of the anchors.

The anchor system shall be according to this specification and the Working Drawings.

Concrete placement according to the Concrete clause of the Caisson Piles subsection of OPSS 903 may be used for temporary anchors inclined a minimum of 30 degrees below the horizontal and having a minimum hole diameter of 450 mm.

942.07.02 Structural Steel

Structural steel components shall be fabricated according to OPSS 906.

942.07.03 Anchor Fabrication

Anchors shall be either shop or field fabricated according to the Working Drawings and schedules by personnel trained and qualified for this work.

Prestressing steel shall be cut with an abrasive saw or, when approved by the prestressing steel supplier, an oxyacetylene torch may be used.

All of the bond length shall be free of dirt, manufacturers' lubricants, corrosion-inhibiting coatings, or other deleterious substances that may significantly affect the grout-to-tendon bond or the service life of the anchor.

When encapsulated anchors are pregouted, they shall be done on an inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

Joints in the protection system shall be made watertight by use of an epoxy bonding agent.

942.07.04 Storage and Handling

Upon delivery, the fabricated anchors and the prestressing steel for fabrication of the tendons and all hardware shall be stored and handled in a manner that avoids mechanical damage, corrosion, and contamination with dirt or deleterious substances.

Handling of the tendons shall not cause mechanical damage or contamination to the prestressing steel, the corrosion protection, or the epoxy coating.

Rope or nylon slings shall be used.

Cement and additives for grout shall be stored under cover and protected against moisture.

Lifting of any pregouted tendons shall not cause excessive bending that may debond the prestressing steel from the surrounding grout.

942.07.05 Corrosion Protection

942.07.05.01 Anchorage Protection

The corrosion protection of the tendon in the vicinity of the anchorage shall ensure proper protection.

All stressing anchorages permanently exposed to the atmosphere or that has a concrete cover less than 50 mm shall be covered with a corrosion inhibiting compound-filled or grout-filled cover.

On strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon along the free stressing length to the diameter of the tendon at the wedge plate without damaging the encapsulation.

The trumpet shall be completely filled with a corrosion inhibiting compound or grout. Compounds may be placed any time during construction. Grout shall be placed after the anchor has been tested and stressed to the lock-off load.

Corrosion inhibiting compound-filled trumpets shall have a permanent seal between the trumpet and the free stressing length corrosion protection.

Trumpets filled with grout shall have either a temporary seal between the trumpet and the free stressing length corrosion protection or the trumpet shall fit tightly over the free stressing length corrosion protection for a minimum of 0.3 m.

942.07.05.02 Free Stressing Length Protection

The tendon shall be fully encased within a corrugated PVC sheathing that is in turn encased within a smooth PVC sheathing over the length of the free stressing zone and protected with grout.

Corrosion protection of the free stressing length shall be provided by a sheath filled with a corrosion inhibiting compound or grout or a heat shrinkable tube internally coated with a mastic compound. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath, and fill the interstices between the wires of 7-wire strands. Provisions shall be made to retain the compound within the sheath.

The corrosion protective sheath surrounding the free stressing length of the tendon shall be long enough to extend into the trumpet but shall not come into contact with the stressing anchorage during testing.

For pregrouted encapsulations, a separate bond breaker shall be provided to prevent the tendon from bonding to the grout surrounding the free stressing length.

Fusion bonded epoxy may be used to provide an additional layer of protection to the prestressing steel.

942.07.05.03 Free Stressing Length and Bond Length Transition

The transition between the corrosion protection for the bonded and free stressing lengths shall be designed and fabricated to ensure continuous protection from corrosion.

The corrosion protection surrounding the free stressing length of the tendon shall not contact the bearing plate or anchor head.

942.07.05.04 Coupler Protection

On encapsulated bar tendons, the coupler and any exposed bar section next to it shall be covered with a corrosion proof compound or wax impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube overlapping the adjacent sheathed tendon by at least 25 mm. The two joints shall be sealed each by a coated heat shrink sleeve of at least 150 mm length or approved equivalent. The corrosion proof compound shall completely fill the space inside the cover tube.

942.07.06 Construction of Anchor Holes

942.07.06.01 General

The anchor holes shall be constructed to the diameter, orientation, and length specified in the Contract Documents and detailed on the Working Drawings. A drilling method that establishes a stable anchor hole within the tolerances specified in the Contract Documents shall be used.

The sides and end of the completed anchor holes shall be maintained in a stable condition.

The anchor hole entry shall be located within 300 mm of its plan location. The deviation of the anchor hole entry angle from its inclination as specified the Contract Documents shall be no greater than ± 3 degrees.

Open anchor holes and drilled casings shall be cleaned upon completion of drilling.

Anchor holes open for longer than eight hours shall be recleaned prior to insertion of the tendon and primary grouting.

The following information shall be recorded for each anchor hole and submitted to the Contract Administrator:

- a) Identification number.
- b) Anchor hole diameter.
- c) Anchor hole length.
- d) Drilling procedure.

- e) Soil, rock, and ground water conditions encountered.
- f) Time required to drill the anchor hole.
- g) Problems encountered.

942.07.06.02 Waterproofing Anchor Holes

Waterproofing of anchor holes shall be done when specified in the Contract Documents and according to the Working Drawings, procedures, and equipment.

If during the water tightness test, the leakage from an anchor hole over a ten-minute period exceeds 9.5 L, the anchor hole shall be consolidation grouted, redrilled, and retested.

Redrilling shall be done when the grout strength is considerably less than the strength of the surrounding rock.

942.07.07 Anchor Installation

The anchors shall be installed as specified in this specification and detailed on the Working Drawings.

Care shall be taken to ensure the sheathing, corrosion protection, and grout tubes are not damaged during installation of the anchors.

Damaged anchors that cannot be repaired to the satisfaction of the Contract Administrator shall be replaced.

Method of repair shall be submitted to the Contract Administrator for approval.

The prestressing steel in the tendon bond length shall be protected with a grout filled corrugated plastic encapsulation. Centralizers shall be used to ensure a grout cover of at least 12 mm over the encapsulation.

The centralizers shall be maintained in position during installation.

The centralizer shall support the tendon in the drill hole and position the tendon so a minimum grout cover of 12 mm is achieved. Centralizers used inside a sheath shall provide a nominal grout cover of 5 mm over the prestressing steel. All centralizers shall be designed to permit grout to flow freely around the tendon and up the drill hole.

The Contractor shall determine the number of centralizers required; however, one unit shall be placed within 1 m of the bottom of the hole and another at the bond length and free stressing length interface. The centralizers shall not interfere with the placement of grout.

Spacers shall be used in multiple element tendons to separate the strands or bars individually or into small groups.

942.07.07.01 Inspection during Anchor Installation

The Contractor's Engineer shall inspect the following Work:

- a) Construction of anchor holes.
- b) Anchor installation.
- c) Primary grouting.
- d) Post grouting.
- e) Placement of slurry in free stressing length.

- f) Anchorage installation.

942.07.08 Primary Grouting of Anchors

The grout shall be placed as specified in this specification and as detailed on the Working Drawings.

The grout shall entirely fill the annular space between the anchor and the borehole wall in the bond length.

Anchors shall be grouted as soon as practical after installation. The stressing tails of prestressing steel strands shall be aligned prior to initial set of the grout.

After grouting, the anchor shall remain undisturbed until the grout has reached the strength specified in the Contract Documents.

The following information shall be recorded for each anchor and submitted to the Contract Administrator:

- a) Identification number.
- b) Type of grout.
- c) Grout pressure.
- d) Volume of grout used.
- e) Location of the top of the bond length grout.

942.07.09 Post-Grouting of Bond Length

When specified in the Contract Documents, post-grouting of the bond length shall be done according to the submitted procedures and equipment.

The information required to be recorded for primary grouting shall be recorded for post grouting.

Ground movement shall be monitored and, if excess movement is observed, the grouting shall be terminated and the situation reported to the Contract Administrator.

The Contract Administrator shall be notified prior to the commencement of post-grouting of both permanent and temporary anchors.

942.07.10 Placing of the Cement Bentonite Slurry in the Free-Stressing Length

The method of placing the cement bentonite slurry shall be as specified in this specification and as detailed on the Working Drawings.

The cement bentonite slurry for the free stressing length shall completely fill the annular space between the prestressing steel and the borehole wall and shall prevent any transfer of the anchor load to the free stressing zone.

942.07.11 Installation of Anchorage

The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon within ± 3 degrees and centred on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be free of rust, grout, and dirt. Special care shall be exercised to obtain the continuity of corrosion protection in the vicinity of the anchorage as described in the Corrosion Protection subsection. The stressing tail shall be cleaned and protected from damage until final testing and lock-off.

The tendon stressing tail shall be cut to its final length according to the tendon manufacturer's recommendations after the anchor is accepted by the Contract Administrator.

Anchorage permanently exposed to the atmosphere shall be covered with a corrosion inhibiting compound filled or grout filled cover

942.07.12 Testing

942.07.12.01 General

Testing shall be carried out as detailed on the Working Drawings and as specified in this specification.

The maximum anchor load shall not exceed 80% of the guaranteed minimum ultimate strength of the tendon.

Stressing shall not commence until the grout has reached its 28-Day strength.

The Contractor's Engineer shall inspect the pre-production and production anchor testing.

942.07.12.02 Reaction System

The reaction system shall be installed as detailed on the Working Drawings.

942.07.12.03 Reference System and Testing Equipment

The layout of the reference systems and testing equipment required for testing shall be as detailed on the Working Drawings and as specified in this specification.

All reference beams shall be independently supported with the support firmly embedded in the ground at a distance of not less than 2.5 m from the anchor. Reference beams and their supports shall be sufficiently rigid to support instrumentation and to prevent movement relative to the test anchor as a result of stressing or other construction activity during testing.

Dial gauges shall bear on the pulling head of the jack and their stems shall be co-axial with the tendon direction.

The jacks shall be secured with chains to provide adequate protection to personnel in the event of breakage of the anchor or stressing system.

942.07.12.04 Reference System Enclosures

Suitable enclosures shall be constructed to provide complete protection for personnel, equipment, and instruments from variations in the weather conditions and disturbances during the test program.

These provisions shall meet the approval of the Contract Administrator and include the following specific requirements:

- a) The test enclosures shall be weatherproof and adequately lighted and have consistent and controllable heat in order to eliminate temperature variations.
- b) The test enclosure shall be provided with a level dry floor.
- c) A field office equipped with tables, chairs, heating, and lighting shall be provided adjacent to the test anchors.

942.07.12.05 Pre-Production Test Anchors

942.07.12.05.01 General

Pre-production tests shall be conducted to determine the bond stress when:

- a) A bond stress is not specified in the Contract Documents.
- b) A higher bond stress than specified in the Contract Documents is used in the design.
- c) To establish the adequacy of other components of the anchor in advance of the production anchors.

For Contractor designed anchors, at least one pre-production test anchor shall be installed and tested in each significantly different ground condition.

For Owner designed anchors, the number of pre-production test anchors shall be as specified in the Contract Documents. The test anchor shall be constructed using the materials, methods, and procedures specified in this specification and as detailed on the Working Drawings.

Pre-production test anchors shall not be incorporated into the permanent or temporary work unless approved by the Contract Administrator.

942.07.12.05.02 Pre-Production Test Procedures and Measurements

The pre-production anchor test shall be carried out generally in accordance with the prevailing requirements of ASTM D1143 superseded where applicable by the procedure specified in this specification.

When the pre-production test anchor is to be incorporated into the work, the load in the anchor shall be adjusted to lock-off load in the final cycle.

The pre-production test shall be conducted by cyclically and incrementally loading and unloading the anchor according to the schedule below or until the anchor fails.

AL, 0.25 DL, AL
AL, 0.25 DL, 0.50 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, AL
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL, AL
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL, 1.75 DL, AL,
AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.25 DL, 1.50 DL, 1.75 DL, 2.00 DL*, AL
AL, 0.00 DL

Where:

AL = alignment load
DL = design load of anchor

* At 2.00 DL, the load shall be maintained for 24 hours.

Each load shall be maintained for a minimum of 15 minutes or until the rate of displacement is not greater than 0.25 mm per hour.

Vertical and horizontal movement of the reaction system and tendon elongation shall be recorded with respect to an independent fixed reference point. A record of the test enclosure temperature is also required.

During the load hold periods, the anchor load shall not be allowed to deviate from the test pressure by more than 0.35 MPa.

When required, repumping back to test load shall be done to compensate for small movements, hydraulic oil seepage, and changes in temperature of the hydraulic oil.

The load shall always be returned to the specified test load prior to taking the movement reading at the specified interval. The test load shall not be exceeded during the period of observation.

942.07.12.05.03 Removal of Pre-Production Test Anchors

The test anchors not approved to be incorporated into the work shall be removed flush with the surrounding ground and the test site restored to its pretest conditions.

The test anchorages shall not be removed until the Contract Administrator has given permission in writing to remove them.

942.07.12.05.04 Request to Proceed and Notice to Proceed

A Request to Proceed with production anchors shall be submitted to the Contract Administrator following the pre-production anchor stressing

The next operation shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

942.07.12.06 Production Anchors

942.07.12.06.01 General

Every temporary and permanent anchor shall be tested according to the Proof Test - Permanent Anchors or Proof Test - Temporary Anchors clause, as appropriate.

942.07.12.06.02 Proof Test - Permanent Anchors

The following proof test shall be applied to the anchorages:

After preloading the anchor to 1.5 DL for 30 minutes, the proof test shall be conducted by incrementally loading and unloading the anchor according to the following schedule or until the anchorage fails, as determined by the Contract Administrator. The acceptance criteria apply to only the peak loading.

Loads shall be applied as follows:

0.25 DL, 1.00 DL, 1.50 DL, 1.00 DL, 0.25 DL

Where:

DL = specified working load of anchorage

At 1.50 DL, the load shall be maintained for a minimum of 30 minutes. Measurement shall be recorded according to the following time increment schedule.

0 min, 1 min, 2 min, 3 min, 6 min, 9 min, 12 min, 15 min, 18 min, 30 min.

If the acceptance criteria as specified herein are met, the anchorage shall be prestressed to 1.50 DL, then shall be locked-off at the transfer load of 1.10 DL.

If the acceptance criteria as specified herein are not met in the 30-minute period the test shall be extended as required, with readings at 30-minute increments, up to 180 minutes.

If the acceptance criteria as specified herein are not met, the provisions of the Unacceptable Stressing Results clause shall apply.

942.07.12.06.03 Proof Test - Temporary Anchors

The proof test shall be conducted by incrementally loading the anchor according to the following schedule:

AL, 0.25 DL, 0.50 DL, 0.75 DL, 1.00 DL, 1.20 DL, 1.33 DL, AL, and adjust to lock-off load

Where:

AL = alignment load

DL = specified working load of anchorage

At the test load of 1.33 DL, the load shall remain constant for 10 minutes and the total movement shall be recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the difference between the total movements at 1 minute and 10 minutes exceeds 1 mm, the test load shall be maintained for an additional 50 minutes, and the movements readings shall be recorded at 20, 30, 40, 50, and 60 minutes. The anchor shall be returned to AL after holding the load at test load for 50 minutes and the residual movement recorded.

The hydraulic pressure during the load hold period shall not deviate by more than 0.35 MPa and the load shall be returned to the test load prior to taking the movement reading. The total movements at each load increment shall be recorded.

942.07.12.06.04 Lock-Off Procedure

After testing has been completed, the load in the tendon shall be such that, after seating losses (wedge seating), the specified lock-off load has been applied to the anchor tendon.

The magnitude of the lock-off load shall be 1.10 DL or as specified by the Contract Administrator and shall not exceed 70% of the ultimate load of the tendon or bar (F_{pu}).

The wedges shall be seated at a minimum load of 50% of F_{pu} . If the lock-off load is less than 50%, shims shall be used under the wedge plate and the wedges seated at 50% of F_{pu} . The shims shall then be removed to reduce the load in the tendon to the desired lock-off load. Bar tendons may be locked off at any load less than 70% of F_{pu} .

942.07.12.06.05 Lift-Off Tests

A minimum of three lift-off tests shall be conducted at each site. The location of the anchor to be tested shall be as determined by the Contractor. The lift-off test shall not be performed until 48 hours has elapsed after transferring the lock-off load. The method of testing shall be as detailed on the Working Drawings.

The lift-off test shall be performed after transferring the load to the anchor and prior to removing the jack from its location. The lift-off load shall be determined by re-applying the load to the tendon or bar to lift off the wedge plate or anchor nut without unseating the wedges or turning the anchor nut.

942.07.12.07 Acceptance Criteria

An anchor shall be considered acceptable when all three of the following acceptance test criteria are satisfied:

- a) The total creep movement at test load during the last log time cycle is less than 1.5 mm.
- b) The apparent free stressing length based on the elastic movement at the test load is not less than 80% of the designed free stressing length.
- c) The load measured during the lift-off test is within 10% of the designed lock-off load.

942.07.12.08 Unacceptable Stressing Results

For the anchorages that do not meet the acceptance criteria for the performance test or the proof test, the Contractor shall submit one of the following alternatives as a proposal to the Contract Administrator for approval:

- a) Abandon the deficient anchor and install a new anchor.
- b) Lock-off the anchors at no more than 50% of the accepted test load sustained during test or as determined by the Contract Administrator and install an additional anchor to compensate for the deficiency.
- c) Post grout the anchor at a grouting pressure not exceeding 3.6 MPa or as recommended by the Contract Administrator and then conduct a proof test and apply the acceptance criteria to the test results. The post grouting shall be terminated immediately if any distress on the ground surface is observed during grouting.
- d) Readjust the transfer load to 1.10 DL for an anchor that does not meet the lift-off criteria and repeat the test after a minimum of 48 hours. If the anchor does not meet the lift-off test criteria after completing this procedure, it shall be considered unacceptable.

942.07.13 Quality Control

942.07.13.01 General

In addition to the quality control procedures initiated by the Contractor, the following work shall also be done.

942.07.13.02 Quality of Grout Mixture

942.07.13.02.01 General

The Contractor shall be responsible for testing of bleeding, preparation and initial storage of grout cubes for determination of compressive strength, and delivery of the grout cubes to a testing laboratory designated by the Owner.

The Contractor shall employ staff from a testing company certified according to CSA A283, Certification for Additional Tests 1B, by an organization accredited by the Standards Council of Canada to carry out testing for bleeding, making, and curing of grout cubes and early strength determination.

Grout cubes for compressive strength test and testing of bleeding shall be made on a level, vibration free surface.

942.07.13.02.02 Testing for Bleeding

The testing for bleeding of the grout shall be according to CSA A23.2-1B.

Prior to the grouting operation, in the presence of the Contract Administrator, a trial batch shall be mixed and the grout tested for bleeding to ensure that the grout meets the requirements of this specification. The trial batch of grout shall not be used in the actual grouting operation.

During the grouting operation, bleeding measurements shall be performed on the grout sampled at the mixer. The measurements shall be performed at least once a day and as requested by the Contract Administrator.

The bleeding test results shall be submitted to the Contract Administrator in writing. The test results that indicate the grout is not meeting the requirements of the Contract Documents shall be reported immediately to the Contract Administrator and the grouting operation halted until the cause of the problem is identified and corrected.

942.07.13.02.03 Making, Curing, and Transportation of Cubes for Compressive Strength Tests

Grout cubes shall be prepared as follows on site from the grout pumped into the anchor body:

- a) One set of grout cubes, consisting of three cubes, shall be made each day the grouting operations are carried out.
- b) The grout cubes shall be prepared according to CSA A23.2-1B and stored at a temperature between 15 and 25 °C and shall not be moved prior to demoulding.
- c) The grout cubes shall be demoulded and transported to the laboratory designated by the Owner within 24 hours.
- d) The grout cubes shall be transported in a sealed white opaque plastic bag containing at least 250 mL of water and maintained at a temperature between 15 and 25 °C.

942.07.13.02.04 Early Strength Determination

The Contractor shall prepare and test additional grout cubes to determine when the grout has attained a strength of 20 MPa.

The laboratory conducting the test shall be certified as specified in this specification.

942.07.13.03 Inspection after Anchor Installation

The Contractor's Engineer shall inspect and verify that the materials have been supplied and installed according to the Contract Documents.

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the anchor installation.

The Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the stressing operations.

942.07.14 As-Built Drawings

As-built drawings shall be submitted to the Contract Administrator in a reproducible format prior to final acceptance of work.

The as-built drawings shall be dated and bear the seal and signature of the Contractor's Engineer.

942.07.15 Management of Excess Materials

Management of excess material shall be as specified in the Contract Documents.

942.09 MEASUREMENT FOR PAYMENT

942.09.01 Actual Measurement

942.09.01.01 Pre-Production Test Anchors and Production Anchors

Measurement of pre-production test anchors and production anchors shall be by length in metres along the actual length of the anchor from the anchor plate to the tip.

942.09.01.02 Post-Grouting of Bond Length

Measurement of post-grouting of bond length shall be by mass in kilograms of mixed grout used.

942.10 BASIS OF PAYMENT

**942.10.01 Pre-Production Test Anchors - Item
 Production Anchor - Item
 Post-Grouting of Bond Length - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, Equipment, and Material to do the work.



Ontario Provincial Standards Unit
301 St. Paul St., 2nd Floor North
St. Catharines, ON L2R 7R4

REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 5 PROVINCIAL-ORIENTED MTO GENERAL CONDITIONS OF CONTRACT AND GENERAL AND CONSTRUCTION SPECIFICATIONS

MANUAL REVISION No. 28

JULY 2023

UPDATING ONTARIO PROVINCIAL STANDARDS FOR YOUR USE

Each roads and public works owner (Owner) is responsible for determining implementation dates and directions for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.

ACCESSING AND OBTAINING ONTARIO PROVINCIAL STANDARDS

Individual OPS standards, revision packages, and complete manuals are available for download, free of charge, in PDF format, from the [MTO Technical Publications](https://www.mto.gov.on.ca/technicalpublications/) website.

WAITING TO HEAR FROM YOU

Further news and information about the Ontario Provincial Standards organization can be obtained from the OPS website at www.ops.on.ca.

Questions should be directed by email to Ontario.Prov.Standards@ontario.ca

If you have a suggestion to revise a standard or you have a standard that works in your ministry, municipality, or area, send it to the OPS Administration, for review and possible inclusion into the Ontario Provincial Standards.

THIS MANUAL IS REVISED AS FOLLOWS:

Index Pages Volume 5

Remove the entire index and replace with the revised index.

Standard Specifications Volume 5

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.PROV	Dated	OPSS.PROV	Dated	
308	Apr 2012	308	July 2023	Construction Specification for Tack Coating and Joint Painting OPSS.PROV 308 was administratively converted to an OPSS from the delete and replace SSP 103S03.
350	Apr 2023	350	July 2023	Construction Specification for Concrete Pavement and Concrete Base OPSS.PROV 350 was updated administratively with the rolling-in of SSP 350S01.
410	Nov 2022	410	July 2023	Construction Specification for Pipe Sewer Installation in Open Cut OPSS.PROV 410 has been revised administratively with the rolling-in of SSP 410S03.
421	Nov 2022	421	July 2023	Construction Specification for Pipe Culvert Installation in Open Cut OPSS.PROV 421 has been revised administratively with the rolling-in of SSP 421S06.
721	Nov 2015	721	July 2023	Construction Specification for Steel Beam Guide Rail Systems OPSS.PROV 721 was administratively converted to an OPSS from the delete and replace SSP 721S09.
914	Nov 2014	914	July 2023	Construction Specification for Waterproofing Bridge Decks and Culverts with Hot-Applied Rubberized Asphalt Waterproofing Membrane OPSS.PROV 914 has been revised extensively. It is recommended that users read the entire specification, as there are major differences between this version of the specification and previous versions.

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.PROV	Dated	OPSS.PROV	Dated	
		919	July 2023	Construction Specification for Formwork and Falsework OPSS.PROV 919 has been revised extensively. It is recommended that users read the entire specification, as there are major differences between this version of the specification and previous versions.