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REVISION INFORMATION SHEET

ONTARIO PROVINCIAL STANDARDS FOR ROADS AND PUBLIC WORKS

VOLUME 7 MUNICIPAL-ORIENTED OPS GENERAL CONDITIONS OF CONTRACT AND GENERAL AND CONSTRUCTION SPECIFICATIONS

MANUAL REVISION #12

NOVEMBER 2016

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for use of Ontario Provincial Standards; therefore, manual holders are cautioned about immediately discarding superseded and cancelled standards.

A NOTE TO DESIGNERS OF MUNICIPAL CONTRACTS REGARDING APPENDICES

There are a number of OPS specifications published with appendices containing supplemental requirements that modify the specification. These specifications contain information written for use in provincial contracts. The appendices contain supplemental requirements that modify the provincial requirements so the specifications can be used in municipal contracts. The specifications are easily identified, as the table of contents for each specification lists the appendix containing the supplemental requirements (e.g., Supplemental Requirements for Using OPSS XXX in Municipal Contracts).

Designers of municipal contracts should review each specification to determine if the supplemental requirements should be invoked in their contracts. To ensure completeness of municipal Contract Documents, designers should invoke the appendices by referencing them in the Contract Documents.

ACCESSING AND OBTAINING ONTARIO PROVINCIAL STANDARDS

The Ontario Provincial Standards for Roads and Public Works (OPS) manuals and the latest published updates for each of the eight OPS manuals are available as follows:

- Available electronically on the OPS/MTO website. Online access to the current, updated, and archived standards; indexes; OPS User Notes; and publication Revision Information Sheets are available free of charge at the site.
(<http://www.raqs.mto.gov.on.ca/techpubs/ops.nsf/OPSHomepage>)
- Hard-copy format available from Publications Ontario by telephone at 1-800-668-9938 or online. Updates and OPS manuals are available for a cost-recovery fee.
(www.publications.serviceontario.ca)

- The eight OPS manuals of standards are available on one CD in PDF format. The OPS drawings published in Volumes 3 and 4 are available in AutoCAD format on a separate CD. These CDs are available from Publications Ontario or by telephone at 1-800-668-9938 or online for a cost-recovery fee. The updates are not available on CDs as an update package.
(www.publications.serviceontario.ca)

At the Publications Ontario web page, you can type “Ontario Provincial Standards,” “OPS,” “OPSS,” or “OPSD” in the search box, and all related products for the Ontario Provincial Standards will be listed, click on the item you wish to purchase, add the item to your cart, then follow the instructions to complete your order. If trying to order an OPS product online from Publications Ontario and it is shown as Out of Stock, you can backorder the product by telephone at 1-800-668-9938.

In order to receive the Municipal Engineers Association (MEA) purchase price, MEA members should visit the MEA website (www.municipalengineers.on.ca/) for the MEA Publications Ontario order form for hard-copy manuals and CDs.

MTO employees should contact Simon Leung, Account Representative at Publications Ontario, by email (simon.leung@ontario.ca) to set up an account in order to receive the MTO purchase price for technical publications, including the Ontario Provincial Standards.

Links to Publications Ontario and the Ontario Provincial Standards on the MTO Library website are available on the OPS website (www.ops.on.ca). Also on this site under News and Activities are notices for updates and changes in OPS.

Questions should be directed by email to Ontario.Prov.Standards@ontario.ca.

YOU SHOULD REGISTER YOUR OPS MANUALS AND CDs

Users of OPS do not receive notices of OPS updates as they had in the past. Methods of notification from Publications Ontario for the future are being investigated, and you will be informed of them as they become available. In the interim, an email will be sent to OPS users who have registered their OPS manuals and CDs with OPS.

Owners of OPS manuals, who have not yet done so, are requested to register their OPS hard-copy manuals and CDs with OPS by email at Ontario.Prov.Standards@ontario.ca. The registration form and submission instructions are available on the OPS website (www.ops.on.ca), Miscellaneous Info, OPS Forms.

WAITING TO HEAR FROM YOU

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 Head, OPS Administration, for review and possible inclusion into the Ontario Provincial Standards.

THIS MANUAL IS REVISED AS FOLLOWS:

Index Pages Volume 7

Remove the entire index and replace with the revised index.

Standard Specifications Volume 7

Superseded/Cancelled (Remove)		Revised/New (Insert)		Remarks
OPSS.MUNI	Dated	OPSS.MUNI	Dated	
		180	Nov 2016	“GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS” See Summary of Revisions.
		202	Nov 2016	“CONSTRUCTION SPECIFICATION FOR ROCK REMOVAL BY MANUAL SCALING, MACHINE SCALING, TRIM BLASTING, OR CONTROLLED BLASTING” This NEW specification was created to have MUNI version of the PROV 202 dated Nov 2013.
		302	Nov 2016	“CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE” See Summary of Revisions.
		304	Nov 2016	“CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT” See Summary of Revisions.
		305	Nov 2016	“CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING” See Summary of Revisions.
314	Nov 2015	314	Nov 2016	“CONSTRUCTION SPECIFICATION FOR UNTREATED GRANULAR SUBBASE, BASE, SURFACE, SHOULDER AND STOCKPILING” This specification has been reaffirmed with no changes to technical information.

331	Nov 2015	331	Nov 2016	“CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION” See Summary of Revisions.
		332	Nov 2016	“CONSTRUCTION SPECIFICATION FOR HOT IN-PLACE AND HOT IN-PLACE RECYCLING WITH INTEGRAL OVERLAY” The entire specification has been rewritten in order to comply with the new MTO specification. TITLE, Updated to remove “...And Hot In-Place Recycling with Integral Overlay”.
		334	Nov 2016	“CONSTRUCTION SPECIFICATION FOR COLD RECYCLING MIX” See Summary of Revisions.
335	Nov 2015	335	Nov 2016	“CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX” See Summary of Revisions.
		353	Nov 2016	“CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS” See Summary of Revisions.
		402	Nov 2016	“CONSTRUCTION SPECIFICATION FOR EXCAVATING, BACKFILING AND COMPACTING FOR MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS AND VALVE CHAMBERS” See Summary of Revisions.
		403	Nov 2016	“ROCK EXCAVATION FOR PIPELINES, UTILITIES AND ASSOCIATED STRUCTURES IN OPEN CUT” See Summary of Revisions.

		441	Nov 2016	“CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT” See Summary of Revisions.
		442	Nov 2016	“CONSTRUCTION SPECIFICATION FOR CORROSION PROTECTION OF NEW AND EXISTING WATERMAINS” See Summary of Revisions.
		517	Nov 2016	“CONSTRUCTION SPECIFICATION FOR DEWATERING” The MUNI implemented in November 2016 replaces OPSS 517 COMMON, November 2010 with no content changes.
		518	Nov 2016	“CONSTRUCTION SPECIFICATION FOR CONTROL OF WATER AND DEWATERING OPERATIONS” See Summary of Revisions.
		610	Nov 2016	“CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS” See Summary of Revisions.
		630	Nov 2016	“CONSTRUCTION SPECIFICATION FOR INSTALLATION OF SECTIONAL STEEL HIGH MAST LIGHTING POLES” See Summary of Revisions.
		706	Nov 2016	“CONSTRUCTION SPECIFICATION FOR TEMPORARY CONTROL DEVICES” The MUNI implemented in November 2016 replaces OPSS 706 COMMON, November 2010 with no content changes.

721	Nov 2015	721	Nov 2016	“CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL” See Summary of Revisions.
723	Nov 2015	723	Nov 2016	“CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS” See Summary of Revisions.
771	Nov 2014	771	Nov 2016	“CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE” See Summary of Revisions.
		909	Nov 2016	“CONSTRUCTION SPECIFICATION FOR PRESTRESSED CONCRETE - PRECAST GIRDERS” The MUNI implemented in November 2016 replaces OPSS 909 COMMON, April 2012 with no content changes.
		922	Nov 2016	“CONSTRUCTION SPECIFICATION FOR INSTALLATION OF BEARINGS” The MUNI implemented in November 2016 replaces OPSS 922 COMMON, November 2009 with no content changes.

SUMMARY OF REVISIONS TO OPSS.MUNI 180

GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS

- Clause 180.04.01.04, Title “Certificate of” renamed to “Environmental Compliance” Approval. 1st paragraph modified.
- Subsection 180.07.05, Existing 3rd, 5th and 6th paragraphs deleted. Existing 4th paragraph modified.
- Subsection 180.07.07, Existing 2nd paragraph 1st sentence rewritten 2nd to 6th sentence deleted. Existing 4th, 15th and 16th paragraph deleted.
- Table 1, renamed to “Table A”
- Table 2, renamed to “Table B”
- Form, Site Selection Notification for Stockpiling Material Managed through Re-use, “Registered” added to Property Owner(s). Statement of registered owner(s) paragraph modified.
- Form, Site Selection Notification for Material Managed as Disposable Fill, “Registered” added to Property Owner(s). Statement of registered owner(s) paragraph modified.
- Form, Property Owner’s Release, Description line added for, “Quantity and Type of Excess Material used as fill:” and “Quantity and Type of Excess Material stockpiled:” Statement of registered owner(s) paragraph modified.

SUMMARY OF REVISIONS TO OPSS.MUNI 302

CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE

- Title, Updated to remove “...And Hot In-Place Recycling with Integral Overlay”.
- Section 302.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 302.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 302.02, References, Updated for MUNI use.
- Section 302.07.01, Operational Constraints, Updated to allow application of emulsified primer if needed.
- Appendix, Updated to ensure correct numbering of the referenced sections.

SUMMARY OF REVISIONS TO OPSS.MUNI 304

CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT

- Section 304.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 304.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 304.02, References, Updated for MUNI use.
- Section 304.07.02.01, Binder, Minor non-technical rewording.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 305

CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING

- OPSS 305 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.

SUMMARY OF REVISIONS TO OPSS.MUNI 331

CONSTRUCTION SPECIFICATION FOR FULL DEPTH RECLAMATION WITH EXPANDED ASPHALT STABILIZATION

- Section 331.02, References, Added reference to SP-027.
- NEW Section 331.08.03.01, Surface Appearance, New section added, and subsequent sections renumbered.

SUMMARY OF REVISIONS TO OPSS.MUNI 334

CONSTRUCTION SPECIFICATION FOR COLD RECYCLED MIX

- Section 334.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 334.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 334.02, References, Updated for MUNI use.
- Section 334.02, References, Replaced SP-024 with SP-027.
- Section 334.07.01, Operational Constraints, Updated item a).
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 335

CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX

- Section 335.02, References, Added reference to SP-027.
- Table 1, Rewritten to match OPSS.PROV 335 table.

SUMMARY OF REVISIONS TO OPSS.MUNI 353

CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS

- Section 353.02.01, Specification Significance and Use, Updated for MUNI use.
- Section 353.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 353.02, References, Updated for MUNI use.
- Section 353.05.01, Concrete, Rewritten.
- Section 353.07.08.01, Placement of Concrete, Updated.
- Section 353.07.12, Field Sampling and Testing of Concrete, Updated.
- Appendix, Updated to ensure correct numbering of the referenced sections.

SUMMARY OF REVISIONS TO OPSS.MUNI 402

CONSTRUCTION SPECIFICATION FOR EXCAVATING, BACKFILLING, AND COMPACTING FOR MAINTENANCE HOLES, CATCH BASINS, DITCH INLETS, AND VALVE CHAMBERS

- Section 402.01.01, Specification Significance and Use, Updated for MUNI use.
- Section 402.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 402.02, References, Updated for MUNI use.
- Section 402.05.02.02, Native and Imported Material, Boulders' dimension updated.
- Section 402.07.07, Removal of Frozen Ground, Added "Roadways".
- Appendix, Updated for MUNI use.
- Designer Action/Consideration, Updated to include reference use in 402.07.10.01.

SUMMARY OF REVISIONS TO OPSS.MUNI 403

CONSTRUCTION SPECIFICATION FOR ROCK EXCAVATION FOR PIPELINES, UTILITIES, AND ASSOCIATED STRUCTURES IN OPEN CUT

- Section 403.01.01, Specification Significance and Use, Updated for MUNI use.
- Section 403.02, References, Updated for MUNI use.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS 441

CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT

- Section 441.01.01, Specification Significance and Use, Updated for MUNI use.
- Section 441.01.02, Appendices Significance and Use, Updated for MUNI use.
- Section 441.02, References, Updated for MUNI use.
- Section 441.02, REFERENCES, OPSS 442 and MOECC's Disinfection Procedure added.
- Section 441.02, REFERENCES, All external references updated to the latest versions.
- Section 441.03, DEFINITIONS, Watermains definition updated.
- Section 441.05.01, Materials/General, Updated.
- Section 441.05.16, Corrosion Protection, New section added.
- Section 441.07.25, Flushing and Disinfecting Watermains, Rewritten to reference MOECC.
- Designer Actions/Commentary, Updated to remove reference to section 441.07.25 since it is no longer needed.
- Appendix, Updated for MUNI use.

SUMMARY OF REVISIONS TO OPSS.MUNI 442

CONSTRUCTION SPECIFICATION FOR CORROSION PROTECTION OF NEW AND EXISTING WATERMAINS

- Section 442.02, References, the typical wording "This specification refers to...publications" added.
- Section 442.02, References, CSA and ASTM standard versions updated to latest.
- Section 442.05.05, Test Stations, in part (b) the ability to specify lengths in Contract Documents added.
- Section 442.07.03, Anode Installation, section number corrected to 442.07.04.
- Section 442.07.04.02, Existing Metallic Watermains - Anode Bank Method, updated.
- Section 442.07.04.03, Existing Metallic Watermains - Exposed Pipe or Service Method, updated.
- Section 442.07.05, Corrosion Monitoring for Concrete Pressure Pipe, updated.
- Section 442.07.13, Testing and Evaluation, units updated.
- Designer Action/Considerations, updated to correct the section numbering discrepancy in 442.07.03.

SUMMARY OF REVISIONS TO OPSS.MUNI 518

CONSTRUCTION SPECIFICATION FOR CONTROL OF WATER FROM DEWATERING OPERATIONS

- Section 518.02, References, deletion of Fisheries Act, R.S., 1985 c. F-14.
- Section 518.03, Definitions, deletion of “Uncontaminated Water”.
- Section 518.03, Definitions, modified “Dewatering Operation”, “Sediment” and “Sediment Control”.
- Section 518.03, Definitions, renamed “Natural Attenuation” to “Vegetated Discharge” Area and modified.
- Subsection 518.07.01, Title “Disposal” renamed to “Discharge” of Water. 1st, 2nd paragraph modified, deleted 3rd paragraph and, addition of 4th and 5th paragraph.
- Existing Subsection 518.07.02 and 518.07.03, Surface Drainage, Settling Ponds and Sediment Traps or Basins deleted. Subsections reorder.
- Subsection 518.07.02, Title “Temporary Erosion and” renamed to “Discharge to” Sediment Control Measures.
- Subsection 518.07.03, Discharge to Vegetated Discharge Areas, new subsection.
- Subsection 518.07.04, Discharge to the Environment, new subsection.
- Subsection 518.07.06, Protection of Waterbodies and Waterbody Banks, new subsection.
- Appendix 518-A, 1st and 3rd paragraphs modified.
- Related Ontario Provincial Standard Drawings, OPSD 219.120 Light-Duty Fibre Roll Barrier, OPSD 219.131 Heavy-Duty Wire-Backed Silt Fence Barrier, OPSD 219.160 Fibre Roll Grade Breaks and OPSD 219.191 Fibre Roll Flow Check Dam added. OPSD 219.190 Silt Fence Flow Check Dam deleted.

SUMMARY OF REVISIONS TO OPSS.MUNI 610

CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS

- Clause 610.04.01.01, f); Certificate of Approval revised to Environment Compliance Approval.
- Subsection 610.07.03 Removal, new 2nd paragraph added.

SUMMARY OF REVISIONS TO OPSS.MUNI 630

CONSTRUCTION SPECIFICATION FOR INSTALLATION OF SECTIONAL STEEL HIGH MAST LIGHTING POLES

- Section 630.02 References, CSA S6 updated.
- Appendix 630, Related Ontario Provincial Standards Drawings; OPSD 2450.010, OPSD 2450.020, OPSD 2452.010, OPSD 2452.020, and OPSD 2454.010 deleted; and OPSD 2453.001 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 721

CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL

- Section 721.02 References; ASTM A 36, ASTM A 780, and ASTM D 4956 updated.
- Clause 721.09.01.05, measurement for payment for Steel Beam Barricade added.
- Subsection 721.10.01, payment item for Steel Beam Barricade added.
- Appendix 721, Related Ontario Provincial Standards Drawings; OPSD 912.532 deleted and OPSD 973.130 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 723

CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

- New clause 723.07.03.01 added. Other clauses reordered.
- Subsection 723.09.01 Actual Measurement, measurement for payment for SLED System added.
- Subsection 723.10.01 Basis of Payment, payment item for SLED System added.
- Table 2, SLED System added.
- Appendix 723, Related Ontario Provincial Standards Drawings; OPSD 923.002, OPSD 923.010, and OPSD 923.011 added.

SUMMARY OF REVISIONS TO OPSS.MUNI 771

CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE

- Clause 771.07.03.02.03, 1st paragraph, revised.
- Clause 771.07.03.04; 3rd paragraph revised, new 4th paragraph added, existing 6th paragraph revised.
- Appendix 771, Related Ontario Provincial Standards Drawings; OPSD 971.103 added.

MANUAL REVISION RECORD

Municipal-Oriented

Volume 7 – OPS 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	27		
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5	APR 2012	Included in new manuals	31		
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**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

VOLUME 7 INDEX
**MUNICIPAL-ORIENTED
OPS GENERAL CONDITIONS OF CONTRACT AND
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NOV 2006	100	OPS General Conditions of Contract
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NOV 2014	120	The Use of Explosives
NOV 2016	180	General Specification for the management of Excess Materials
NOV 2012	182	Environmental Protection for Construction in Waterbodies and on Waterbody Banks
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NOV 2013	206	Grading
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NOV 2014	220	Wick Drain Installation
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NOV 2016	305	Granular Sealing
NOV 2016	314	Untreated Sub base, Base, Surface, Shoulder, Selected Subgrade, and Stockpiling
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NOV 2014	330	In-Place Full Depth Reclamation of Bituminous Pavement and Underlying Granular
NOV 2016	331	Full Depth Reclamation with Expanded Asphalt Stabilization
NOV 2016	332	Hot In-Place recycling and Hot In-Place recycling With Integral Overlay
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NOV 2016	335	Cold In-Place Recycling with Expanded Asphalt



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NOV 2014	355	Installation of interlocking Concrete Pavers
NOV 2014	363	Repairing Rigid Pavement with Precast Concrete Slabs
NOV 2014	365	Cross-Stitching Longitudinal Cracks in Concrete Pavement and Concrete Base

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NOV 2016	402	Excavating, Backfilling and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets and valve chambers
NOV 2016	403	Rock Excavation For Pipelines, Utilities and Associated Structures in Open Cut
NOV 2015	410	Pipe Sewer Installation in Open Cut
NOV 2015	421	Pipe Culvert Installation in Open Cut
NOV 2016	441	Watermain Installation in Open Cut
NOV 2016	442	Corrosion Protection of New and Existing Watermains

DIVISION 5 - MISCELLANEOUS

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NOV 2014	512	Installation of Gabions
NOV 2016	517	Dewatering
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NOV 2016	610	Removal of Electrical Equipment and Materials



DATE	SPEC. NO. OPSS.MUNI	TITLE
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NOV 2014	905	Steel Reinforcement for Concrete
NOV 2014	908	Metal Traffic Barriers and Metal Railings for Structures
NOV 2016	909	Pre-stressed Concrete – Precast Girders
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NOV 2014	911	Coating Structural Steel Systems
NOV 2014	914	Waterproofing Bridge Decks with Hot Applied Asphalt Membrane
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NOV 2014	930	Structure Rehabilitation - Concrete Patches and Overlays



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VOLUME 7 INDEX

**MUNICIPAL-ORIENTED
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GENERAL SPECIFICATION FOR THE MANAGEMENT OF EXCESS MATERIALS

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180.07	CONSTRUCTION
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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 is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

Transportation of Dangerous Goods Act, 1992,
S.C. 1992, c. 34

Fire Protection and Prevention Act, 1997
S.O. 1997, CHAPTER 4

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 form OPSF 180-1, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or OPSF 180-2, 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 form OPSF 180-3, 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 provided 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 form OPSF 180-5, Waste Quantity Report, shall be provided 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 supplied 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 listed in the form OPSF 180-4, Subject Waste Classification, 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 forwarded 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 listed in form OPSF 180-4, Subject Waste Classification that is being shipped from the Working Area to a waste disposal site, the following documentation shall be provided 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 made available 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 Ministry of Environment and Climate Change of Ontario and such conditions differ from those specified in Table A, a copy of such approval shall be provided 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 A and B and the appropriate subsections of this specification, unless prior alternative management conditions are approved in writing by the Ministry of Environment of Ontario and Climate Change (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 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 B 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 in compliance with 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 in accordance with 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 B 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 A indicates that stockpiling is subject to management conditions in Table B, such management conditions 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 good waste or a subject waste in form OPSF 180-4, Subject Waste Classification, 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 described 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 identified in form OPSF 180-4, Subject Waste Classification, the Contractor shall be responsible to manage it in accordance with the following:

- a) Conduct sampling and testing using a laboratory certified by the Canadian Association of Laboratory Accreditation (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 in accordance with 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 listed in form OPSF 180-4 by the Owner, and is in addition to the cost of disposal as non-hazardous, solid industrial, or commercial waste, shall be paid as Extra Work, with provisions subject to testing to verify that the excess material is subject waste.

Table A
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 B	n/a	Yes	Yes TABLE B
AGGREGATE	Yes	Yes	n/a	Yes	Yes
ROCK	Yes	Yes	n/a	Yes	Yes
BITUMINOUS PAVEMENT	Yes TABLE B	Not Permitted	n/a	Yes	Yes
CONCRETE	Yes TABLE B	Not Permitted	n/a	Yes	Yes
MASONRY	Yes TABLE B	Not Permitted	n/a	Yes	Yes
MANUFACTURED WOOD	Yes	Not Permitted	Not Permitted	Yes	Yes TABLE B
NATURAL WOOD	Yes	Yes TABLE B	Yes	Yes	Yes TABLE B
DEBRIS FROM OPEN FIRES	n/a	Yes TABLE B	n/a	Yes	Yes TABLE B
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 listed in form OPSF 180-4, Subject Waste Classification, 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 Ministry of Environment and Climate Change of Ontario.				

Table B
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

SITE SELECTION NOTIFICATION FOR STOCKPILING MATERIALS MANAGED THROUGH RE-USE

Contract Information

Contract No: _____ Owner: _____

The following describes the notification process between the Owner of the Contract and the Contractor, wherein the Contractor formally notifies the Owner that agreement has been reached with a third party property owner for the stockpiling of Contract generated excess material. Such excess material, stockpiled for re-use or disposal, may be one or a combination of: earth; aggregate; swamp material; rock; concrete; masonry; bituminous pavement; natural wood; metal, plastic, and polystyrene; wood which has been treated, coated, or glued; and debris from open fires, provided the conditions on management are satisfied.

Site Information

Registered Property Owner(s) for the subject property: _____ The subject property:
Lot _____, Concession _____, Township of _____

County/Region/District of _____, Quantity and Type of Excess Material
stockpiled: _____

This is to notify you, as Owner, that permission has been obtained from the property owner(s) named herein for the management of excess materials through re-use from this Contract. The property owner has signed and been provided with a copy of this form and has been advised that a Property Owner's Release Form, OPSF 180-3, will also be required. The use of this management site will comply with the following:

Conditions on Management

It is understood that materials are stockpiled to be re-used or held for disposal at a certified waste disposal site. Stockpiles of natural wood, manufactured wood, debris from open fires, and swamp material may only be located:

- a) A minimum of 2 m above the level of ground water.
- b) A minimum of 30 m from waterbodies.
- c) A minimum of 100 m from any water wells.
- d) A minimum of 100 m from residences.

Stockpiles of bituminous pavement, concrete, and masonry may only be located:

- a) A minimum of 30 m from waterbodies; and
- b) A minimum of 100 m from residences unless

1. on property with a boundary common to a right-of-way, within the contract limits for a period not exceeding 120 calendar days, or
2. such stockpiles are located within a provincial or municipal works yard or in a commercially licensed pit or quarry. I/We state that I/we are the registered owner(s) of the property identified above and I/we agree to sign the Property Owner's Release after the Contractor has placed the excess material on the above-noted property in accordance with the terms of this form.

These conditions do not supersede any constraints imposed on this property by Federal, Provincial or Municipal, including Conservation Authority, statute or regulations and bylaws made thereto.

Dated this _____ day of _____ 20____

Print Contractor's Name & Field Representative's Name

Contractor's Field Representative Signature

Print Registered Property Owner's Name (s)

Registered Property Owner's Signature(s)

cc: Contract Administrator, Property Owner(s), Contractor

SITE SELECTION NOTIFICATION FOR MATERIAL MANAGED AS DISPOSABLE FILL

Contract Information

Contract No: _____ Owner: _____

The following describes the notification process between the Owner of the Contract and the Contractor, wherein the Contractor formally notifies the Owner that agreement has been reached with a third party property owner for the disposition of Contract generated excess material. Such excess material, managed as disposable fill, shall be limited to one or a combination of: earth, aggregate, swamp material, rock, natural wood, and debris from open fires, provided the conditions on management are satisfied.

Site Information

Registered Property Owner(s) for the subject property: _____

The subject property:

Lot _____, Concession _____, Township of _____

County/Region/District of _____, Quantity and Type of Excess Material used as fill:

This is to notify you, as Owner, that permission has been obtained from the property owner(s) named herein for the management of excess materials from this Contract. The property owner has signed and been provided with a copy of this form and has been advised that a Property Owner's Release Form, OPSF 180-3, will also be required. The use of this management site will comply with the following:

Conditions on Management

Swamp material, natural wood, and debris from open fires managed as disposable fill will be top covered by a minimum of 300 mm of earth or topsoil. Swamp material, natural wood, and debris from open fires managed as disposable fill may only be placed:

- a) A minimum of 2 m above the level of ground water.
- b) A minimum of 30 m from waterbodies
- c) A minimum of 100 m from any water wells
- d) A minimum of 100 m from residences.

I/We state that I/we are the registered owner(s) of the property identified above and I/we agree to sign the attached form of Property Owner's Release after the Contractor has placed the excess material on the above-noted property in accordance with the terms of this form.

These conditions do not supersede any constraints imposed on this property by Federal, Provincial, or Municipal, including Conservation Authority, statute or regulations and bylaws made thereto.

Dated this _____ day of _____ 20____

Print Contractor's Name & Field Representative's Name

Contractor's Field Representative Signature

Print Property Owner's Name(s)

Registered Property Owner's Signature(s)

cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-2

PROPERTY OWNER'S RELEASE

Contract No: _____

Work Description: _____

I/We _____ being the owner(s) of Lot, _____

Concession _____, Township of _____, and County/Region/District of _____, verify that the Contractor for the above noted work has placed excess material from the above noted Contract on my/our property with my/our permission. I/We have signed together with the Contractor OPS Forms 180-1, Site Selection Notification for Stockpiling Materials Managed Through Re-Use, or 180-2, Site Selection Notification for Material Managed as Disposable Fill, or both, that describe Conditions on Management, and have been assured by the Contractor that these conditions have been met.

Quantity and Type of Excess Material used as fill:

Where materials are managed as disposable fill, I/we agree to be responsible for any subsequent relocation and management of the material so placed.

Quantity and Type of Excess Material stockpiled:

Where materials are to be stockpiled, I/We agree that the stockpile(s) will be removed by the date(s) herein noted.

I/We state that I/we are the registered owner (s) of the property identified above and I/we hereby release the Owner and the Contractor in respect of the activities of the Contractor carried out in accordance with this release.

Dated this _____ day of _____ 20____

Print Registered Property Owner's Name (s)

Registered Property Owner's Signature(s)

Print Contractor's Name & Field Representative's Name

Contractor's Field Representative Signature

cc: Contract Administrator, Property Owner(s), Contractor

SUBJECT WASTE CLASSIFICATION

The following named waste is to be disposed of as a subject waste:

The classification of the above waste is as follows:

Shipping Name of Waste	
Reg. 347 Classification	
TDGA Identification No. (PIN)	
TDGA Classification	
TDGA Packaging Group	
Volume of Waste	
Container Type and Condition	

The following named waste is to be disposed of as a subject waste:

The classification of the above waste is as follows:

Shipping Name of Waste	
Reg. 347 Classification	
TDGA Identification No. (PIN)	
TDGA Classification	
TDGA Packaging Group	
Volume of Waste	
Container Type and Condition	

cc: Contract Administrator, Property Owner(s), Contractor

WASTE QUANTITY REPORT

For Solid Non-Hazardous Industrial and Commercial Waste

Contract No: _____

Contractor: _____

Material Description	Location of Disposal Site and Certificate of Approval Number	Quantity of Materials

cc: Contract Administrator, Property Owner(s), Contractor

OPSF 180-5

**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

The designer should specify the following in the Contract Documents:

- Property available for stockpiling for re-use and disposable of fill, or management as disposable fill of excess materials. (180.04.01.01)
- Forest resource licensees within the Contract limits. (180.04.01.03)
- Excess material audit or inventory when required. (180.04.01.06)
- Management conditions of materials with asbestos waste. (180.07.01)
- Identification of waterbodies and sensitive areas. (180.07.01)
- Management by re-use. (180.07.02)
- Management of disposable fill within the Owner's property and on other property. (180.07.03)
- Conditions on management by open burning. (180.07.04)
- Management by disposal of non-hazardous solid industrial or commercial waste. (180.07.05)
- Receiving sites. (180.07.05)
- Management by stockpiling within the Owner's property or on other property. (180.07.06)
- Management of dangerous good waste or subject waste. (180.07.07)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR ROCK REMOVAL
BY MANUAL SCALING, MACHINE SCALING, TRIM BLASTING,
OR CONTROLLED BLASTING**

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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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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 municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-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 201	Clearing, Close Cut Clearing, Grubbing, and Removal of Surface and Pile Boulders

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 201.

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, submit to the Contract Administrator 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.

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 Excavator

Excavators shall have a minimum operating weight of 30,000 kg and shall be capable reaching to a height of 10 m from ground level.

202.06.04 Hoe-Ram Excavator

An excavator shall be equipped with a minimum 5,200 Joule hydraulic impact hammer.

202.07 CONSTRUCTION

202.07.01 General

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 as a result of the work that may endanger the traveling public.

202.07.02.01.01 Manual Scaling

Manual scaling shall consist of scaling of the rock cut with hand tools and hand-held machine tools by a manual scaling work unit. Manual scaling shall also include:

- a) Rock cut sounding.
- b) Blasting with small quantities of explosives, as specified in the Contract Documents.
- c) Grubbing.

As a minimum, the manual scaling work unit shall consist of the following:

- a) Two labourers experienced in performing scaling work at the heights required in the Contract who have the appropriate safety training.
- b) All tools and materials required for the performance of the work.

202.07.01.02 Machine Scaling

Machine scaling shall consist of scaling of the rock cut by machine scaling work unit. Machine scaling shall also include the following:

- a) Grubbing.
- b) Rock cut sounding.

As a minimum, the machine scaling work unit shall consist of the following:

- a) Either a:
 - i) Excavator equipped with a narrow scaling/ditching bucket; or
 - ii) Hoe-ram excavator.
- b) 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

Trim blasting or controlled blasting shall consist of drilling and blasting to remove the rock specified in the Contract Documents, while minimizing damage to the surrounding rock.

Any loosened or partially-detached rock shall be properly scaled, as specified in Scaling subsection.

202.07.03.02 Trim Blasting

Trim blasting shall also include locating and drilling vertical holes of minimum diameter of 50 mm along the perimeter of the specified trim at a spacing of 750 mm or at a spacing approved by the Contract Administrator.

202.07.03.03 Controlled Blasting

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.

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 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 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

The designer should specify the following in the Contract Documents:

- Depth of rock removal. (202.06.02)
- Locations necessary to gain access to the rock removal. (202.07.01)
- Removal limits. (202.07.01)
- All blasting, including the use of explosives. (202.07.01)
- Locations and height of removal of scaling. (202.07.02.01)
- Where small quantities of explosives are required with manual scaling. (202.07.02.02)
- Rock that shall be removed by trim blasting or controlled blasting. (202.07.03.01)
- Specify whether excess rock material is to be managed within the right-of-way by slope flattening or other locations. (202.07.04)

The designer should include separate payment item for all associated mucking, hauling, and management of rock material. (202.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR PRIMING GRANULAR BASE

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APPENDICES

302-A	Commentary

302.01 SCOPE

This specification covers the requirements for surface preparation and application of bituminous primer on a granular base and placement of a sand cover to accommodate traffic.

302.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

302.01.02 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.

302.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 304 Single and Double Surface Treatment

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1102 Liquid Asphalt
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

MTO Laboratory Testing Manual

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

302.03 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 pavement portion of the roadway.

Lot means the quantity of work completed with a tanker truck shipment of primer.

Primer means the emulsified asphalt or low viscosity liquid asphalt sprayed on a prepared granular base.

Sand Cover means an aggregate applied over the primer to blot the primer and permit the passage of traffic.

302.05 MATERIALS

302.05.01 Primer

Primer shall consist of one or more of the following types of asphaltic materials:

- a) Emulsified Asphalt Primer according to OPSS 1103.
- b) MTO Primer or RC-30 according to OPSS 1102.

302.05.02 Sand Cover Aggregate

Aggregate shall be a Class 4 aggregate according to OPSS 1006.

302.06 EQUIPMENT

302.06.01 Pressure Distributor

The pressure distributor shall be designed and manufactured to spray primer uniformly on the road surface. The pressure distributor shall be capable of applying primer at the specified rates and in a continuous and uniform manner both longitudinally and transversely for a full lane width.

302.06.02 Mechanical Aggregate Spreader

The mechanical aggregate spreader shall be designed and manufactured to be self-propelled and capable of continuously and uniformly distributing aggregate on the primed granular base at the specified application rate.

302.06.03 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

302.06.04 Rollers

Rollers shall be according to OPSS 304.

302.07 CONSTRUCTION

302.07.01 Operational Constraints

Primer shall not be applied when the ambient temperature at the work location is less than 10 °C or when climatic conditions preclude the curing of the primer.

Primer shall not be applied prior to May 15th south of a line through Pembroke, Magnetawan, and Pointe au Baril Station and not prior to June 1st north of the line.

Emulsified primers shall not be applied after September 1st except with the approval of the Contract Administrator. .

The placing of aggregate shall be terminated one hour before sunset.

302.07.02 Sampling

302.07.02.01 Primer

The Contractor shall provide primer field samples for quality assurance (QA) testing purposes when specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and delivery of samples to the laboratory designated in the Contract Documents within 5 Business Days.

Each liquid asphalt primer sample shall consist of a one-litre quantity of material. The sample containers for liquid asphalt primer samples shall be new epoxy-lined triple tight cans.

Each emulsified asphalt primer sample shall consist of 2 four-litre quantity of material. The sample containers for emulsified asphalt primer samples shall be new triple tight cans.

Sample containers shall be supplied by the Contractor. Sample labels supplied by the Contract Administrator shall be used to identify all samples.

302.07.02.02 Sand Cover Aggregate

The Contractor shall provide sand cover aggregate samples for QA testing purposes when specified in the Contract Documents.

302.07.03 Demonstration of Primer and Aggregate Application Rates

The Contractor shall demonstrate to the Contract Administrator satisfactory compliance to the specified application rates of primer and aggregate. At the Contract Administrator's option, this compliance may include a minimum 300 m length, one lane width trial section to ensure that the primer and aggregate are applied at the specified rate.

302.07.04 Longitudinal and Transverse Joints

Joints shall be constructed so that granular base is fully covered with primer and the overlap of primer and sand cover is minimal.

302.07.05 Protection of the Work

Traffic shall not be allowed on the primed granular base until the sand cover has been applied. Primed surfaces damaged by traffic shall be repaired by the Contractor.

302.07.06 Surface Preparation

The surface shall be free of standing water. The surface shall be prepared by dampening, fine grading, and compacting and finished rolled using a steel-drum roller to ensure a compacted smooth and float free surface immediately prior to the application of primer.

302.07.07 Application of Primer

Primer application temperatures shall be according to OPSS 1102 and OPSS 1103.

After the surface has been prepared, the primer shall be uniformly sprayed on the granular base at the rate specified in the Contract Documents.

The application of primer 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 priming.

302.07.08 Application of Sand Cover

When specified in the Contract Documents, a sand cover shall be applied following the application of primer. A minimum curing time of 20 minutes for the primer shall be provided before sand cover aggregate is applied. Sand cover aggregate shall be uniformly applied by means of a mechanical aggregate spreader at the rate of $11 \pm 1.0 \text{ kg/m}^2$.

Two passes of a pneumatic-tired roller shall be used to seat the aggregate.

302.07.09 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic according to 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. Convoys shall be maintained for a minimum of one hour after application of the sand cover, or longer, if directed by the Contract Administrator.

302.07.10 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

302.08 QUALITY ASSURANCE

When specified in the Contract Documents, testing of the primer shall be conducted by the Contract Administrator, using current LS test methods of the MTO Laboratory Testing Manual or ASTM test procedures as required by OPSS 1102 or 1103.

302.09 MEASUREMENT FOR PAYMENT

302.09.01 Actual Measurement

302.09.01.01 Primer

Primer shall be measured by mass in kilograms as specified in the Contract Documents.

302.09.01.02 Sand Cover Aggregate

Measurement of sand cover shall be by mass or volume as specified in the Contract Documents.

302.09.01.02.01 By Mass

Sand cover aggregate applied to the road shall be measured by mass in tonnes as specified in the Contract Documents.

302.09.01.02.02 By Volume

Sand cover aggregate applied to the road shall be measured by volume in cubic metres, loose, by pre-determined truck capacities. The pre-determined capacity of each truck shall be that computed from its box dimensions.

Loading of each truck shall be to full pre-determined capacity. The Contractor shall not be required 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.

302.09.01.03 Traffic Convoy

The measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is convoying traffic.

302.10 BASIS OF PAYMENT

**302.10.01 Primer - Item
Sand Cover Aggregate - Item
Traffic Convoy - Item**

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Primed surfaces damaged by traffic shall be repaired at no cost to the Owner.

Appendix 302-A, Commentary for OPSS.MUNI 302, 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

The designer should specify the following in the Contract Documents:

- Rate of application of primer. (302.07.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Frequency and type of QA testing required. (302.07.02.01 and 302.07.02.02)
- Location of laboratory for delivery of samples. (302.07.02.01)
- Sand cover. (302.07.08)
- Traffic convoy requirements. (302.07.09)
- Testing of the primer. (302.08)
- Measurement for payment of sand cover aggregate by mass or volume. (302.09.01.02)

Priming of the granular base is required for the application of single surface treatment or one lift of hot mix asphalt.

Sand cover is required when traffic travels on the primed granular base prior to placement of a surface.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here



CONSTRUCTION SPECIFICATION FOR SINGLE AND DOUBLE SURFACE TREATMENT

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304.08	QUALITY ASSURANCE - Not Used
304.09	MEASUREMENT FOR PAYMENT
304.10	BASIS OF PAYMENT

APPENDICES

304-A	Commentary

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.

304.01.01 Significance and Use of Appendices

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

332.01.02 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.

304.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1006 Aggregates - Surface Treatment
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

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

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.

Lot means the quantity of work completed with a tanker truck shipment of binder.

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 Binders

Binders shall be according to OPSS 1103.

304.05.02 Aggregates

Aggregates shall be according to OPSS 1006 and as specified in the Contract Documents.

304.06 EQUIPMENT

304.06.01 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.

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 Rotary Power Brooms

Brooms shall be capable of cleaning gravel, sand, dirt, and other debris from the roadway surface.

304.06.04 Rollers

304.06.04.01 General

Rollers shall be ballasted according to the manufacturer's recommendations.

304.06.04.02 Steel Drum Rollers

Steel drum rollers shall be single drum vibratory rollers according to Table 1 and shall be operated in the static mode, if the drum is not rubber coated. Drive wheels shall not mark the aggregate.

304.06.04.03 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be self-propelled and be according to Table 2. 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 Pilot Vehicle

The pilot vehicle shall be equipped according to the requirements of the OTM, Book 7.

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 Sampling

304.07.02.01 Binder

The Contractor shall provide binder field samples for testing purposes as specified in the Contract Documents.

The work shall include sampling, labelling, packaging, and delivery of samples to the laboratory designated in the Contract Documents within 5 Business Days.

Each binder sample shall consist of a minimum size of two full 4-litre samples of material. The sample containers for emulsified asphalt binder samples shall be triple tight cans. Sample containers shall be new and supplied by the Contractor.

304.07.02.02 Aggregates

The Contractor shall provide aggregate samples for testing purposes as specified in the Contract Documents.

304.07.03 Determination of Binder and Aggregate Application Rates

The application rate for the binder and the aggregate shall be as specified in the Contract Documents.

The Contractor shall demonstrate to the Contract Administrator satisfactory compliance to the specified application rates of binder and aggregate. 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.

304.07.03.01 Acceptance of Binder Application Rate

The binder application rate is acceptable when the rate of application is within a tolerance of $\pm 5\%$ of the specified rate.

304.07.03.02 Acceptance of Aggregate Application Rate

The aggregate application rate is acceptable when the rate of aggregate application is within a tolerance of $\pm 10\%$ of the specified rate.

304.07.04 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.

304.07.05 Binder Application Temperatures

Binder application temperatures shall be according to OPSS 1103.

304.07.06 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. At the written request of the Contractor, the Contract Administrator may 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 single and double surface treatment.

304.07.07 Application of Aggregate

Aggregate shall be uniformly applied at the rate specified. The distance between the pressure distributor and the spreader shall not be more than 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.

304.07.08 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.

304.07.09 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic 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.

304.07.10 Protection of the Work

The Contractor shall repair damaged areas until such time as the work has been accepted by the Contract Administrator.

Signs indicating fresh surface treatment, or similar wording, shall be erected at the project limits and any intersections throughout the project immediately after placement of surface treatment and shall remain in place for a minimum of 72 hours.

304.07.11 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

304.09 MEASUREMENT FOR PAYMENT

304.09.01 Actual Measurement

304.09.01.01 Binder

Binder shall be measured for payment by mass in kilograms according to the requirements of the Contract Documents.

304.09.01.02 Class 1, 2, 3, 4, 5 or 6 Aggregate

304.09.01.02.01 By Mass

Aggregate applied to the road shall be measured in tonnes according to the requirements of the Contract Documents.

304.09.01.02.02 By Volume

Measurement 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. The Contractor shall not be required 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

The measurement for traffic convoy shall be in hours based on the number of hours that the pilot vehicle is conveying 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
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.

Damaged areas requiring repair prior to the acceptance of the work shall be repaired by the Contractor at no extra cost to the Owner.

TABLE 1
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 2
Requirements for Pneumatic-Tired Rollers

Roller Class	Minimum Mass t	Minimum Mass per Tire kg
R1	8	900
R2	18	2500
R3	25	3600

**Appendix 304-A, Commentary for OPSS.MUNI 304, 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 specifications 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

The designer should specify the following in the Contract Documents:

- Class of Aggregate required. (304.05.02.01)
- Frequency and type of QA testing required. (304.07.02)
- Location of laboratory for delivery of samples. (304.07.02.01)
- Application rate for the binder and aggregate. (304.07.03)
- Traffic convoy requirements. (304.07.09)

The following applications are available depending on traffic volumes, status of road, and type of road surface:

- Single surface treatment is typically applied to either a primed road, a roadway with a previously applied surface treatment, or a paved road.
- Double surface treatment is typically applied to either a granular base or a primed road.

For design estimating purposes, the following application rates may be used:

Treatment	Aggregate Type	Primer or Binder (Note 1)			Aggregate		
		Grade	Range kg/m ²	Typical kg/m ²	Class	Range kg/m ²	Typical kg/m ²
Prime	Class 4	Primer	1.90+/-	1.9	4	10-12	12
Single Surface Treatment	Class 1	CRS-2 or RS-2	1.65-1.90	1.8	1	14-17	16
	Class 2 (Notes 2, 6)	HF-150S	1.35-1.55	1.45	2	16.5-19	19
	Class 4 (Note 3)	CRS-2, HF-150S	1.20-1.40	1.3	4	8-11	11
	Class 5	CRS-2 or RS-2	1.15-1.45	1.3	5	11-13	13
	Class 6	HFMS-2(ON) or HFMS-2P(ON)	1.50-1.80	1.7	6	16-20	17
Double Surface Treatment	Class 2, Note 6	HF-150S (Note 4)	1.60-1.80	1.65	2	16-18	18
		HF-150S (Note 5)	1.45-1.65	1.5	2	16.5-19	19
	Class 3 & 1	CRS-2, RS-2 (Note 4)	1.60-2.10	1.9	3	15-18	17
		CRS-2, RS-2 (Note 5)	1.40-2.10	1.8	1	12-15	14
	Class 3 & 4	CRS-2, RS-2 (Note 4)	1.60-1.75	1.65	3	15-18	17
		CRS-2, RS-2 (Note 6)	1.05-1.20	1.1	4	6.5-8	8
	Class 3 & 5	CRS-2, RS-2 (Note 4)	1.80-2.00	1.90	3	15-17	17
		CRS-2, RS-2 (Note 5)	1.30-1.50	1.35	5	11-13.5	13
	Class 2 & 6	HFMS-2P(ON) (Note 4)	1.60-1.80	1.65	2	13.5-18	16
		HFMS-2P(ON) (Note 5)	1.50-1.70	1.60	6	15-19	16

Notes:

1. Decrease binder rates towards the lower limit of the range when there is heavy commercial traffic.
2. Class 2 surface treatment may cause dust problems in urban areas.
3. Do not apply to flushed surface treatments, flushed pavements or where low friction values are a concern.
4. Initial application.
5. Second application.
6. The use of Granular A aggregate in a Single or Double Surface Treatment is not recommended.

Appendix 304-A

If a granular grade is planned to be open to traffic for a considerable length of time prior to the surface treatment operation, the designer should consider including an item for surface restoration according to OPSS 301, Restoring Unpaved Roadway Surfaces.

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here



CONSTRUCTION SPECIFICATION FOR GRANULAR SEALING

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305.10	BASIS OF PAYMENT

APPENDICES

305-A	Commentary

305.01	SCOPE

This specification covers the materials and requirements for the work of surface preparation and the supply and application of sealer to granular shoulders, shoulder rounding, and all other designated areas.

305.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

305.01.02 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.

305.02 REFERENCES

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

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 1102	Liquid Asphalt
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
LS-200	Penetration of Bituminous Materials
LS-202	Method of Test for Kinematic Viscosity of Asphalts
LS-204	Solubility of Bituminous Materials in Trichloroethylene
LS-205	Ductility of Bituminous Materials
LS-216	Determination of Residue by Distillation of Emulsified Asphalts
LS-217	Determination of Oil Portion of Distillate in Emulsified Asphalt Primers
LS-218	Particle Charge of Emulsified Asphalt and Emulsified Asphalt Primers
LS-219	Viscosity of Emulsified Asphalts

LS-221	Settlement and Storage Stability of Emulsified Asphalt
LS-223	Sieve Test for Emulsified Asphalts

ASTM International

D1310-14	Standard Test Method for Flash Point and Fire Point of Liquids by Tag Open-Cup Apparatus
D402/D402M-14	Standard Test Method for Distillation of Cutback Asphalt

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.

Quality Assurance means a system or series of activities carried out by the Owner to ensure that Materials received from the Contractor meet the requirements specified in the Contract Documents.

305.05 MATERIALS

Sealers may consist of one or more of the following materials:

- a) Type I-a: RC-30 and MTO primer according to OPSS 1102; or
Type I-b: Emulsified asphalt primer according to OPSS 1103.
- b) Type II: Solvent-free emulsified asphalt according to OPSS 1103.
- c) Type III: Tall oil pitch (TOP) emulsion according to OPSS 2510.

305.06 EQUIPMENT

The pressure distribution system used for sealer application shall be according to OPSS 304 and, when applicable, shall include an attachment for hand spraying.

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 and, for Type III emulsion applications, precipitation has not occurred within the 24 hours prior to application.
- d) The surface is free of standing water.

- e) The wind is not strong enough to cause drifting of sealer spray.
- f) The shoulder is smooth and conforms to the crossfall and grade specified in the Contract Documents.

305.07.02 Surface Preparation

As soon as is practical prior to applying sealer, the granular shoulder shall be rolled with a minimum of two passes. 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 applying.

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 specified elsewhere in the Contract Documents.

Type I-a or Type I-b sealers may be used in any areas where Type I sealers have been specified.

Sealers shall be uniformly applied in all areas using a pressure distribution system.

Sealer application rates and temperatures shall be as specified in Table 1.

Sealers shall be overlapped a minimum of 100 mm onto adjacent paved surfaces.

All other application requirements shall be in accordance with the Manufacturer's recommendations and the application performed to the satisfaction of the Contract Administrator.

305.07.04 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 QA tests, at such times and locations as the Owner may consider necessary, in order to ensure that the materials supplied and placed are in accordance with this specification.

305.08.02 Sampling of Sealer for Acceptance

Sealers shall be randomly sampled in lots as specified in 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.

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 supplied and filled, leaving sufficient space to allow for expansion.

Sampling requirements shall be as specified below and elsewhere in the Contract Documents.

Sample containers for each portion of each duplicate sample shall be triple tight one-litre cans for Type I-a or 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-b or Type II sealers.

Identification tags, provided by the Contract Administrator, shall be completed and attached to each sample container. All sample containers shall be supplied with appropriate WHMIS labels.

Samples shall be delivered within the required time and to the appropriate laboratory specified by the Owner.

305.08.03 Sealer Quality

305.08.03.01 Acceptance

One portion of each duplicate sample shall be tested for material properties by the QA laboratory according to OPSS 1102 for Type I-a sealers, OPSS 1103 for Type I-b and Type II sealers, and OPSS 2510 for Type III granular sealers, respectively.

Individual test results shall be forwarded to the Contractor as they become available.

A lot of sealer shall be deemed to be acceptable, if all of the test results and other requirements specified in OPSS 1102 for Type I-a sealers, OPSS 1103 for Type I-b and Type II sealers, and OPSS 2510 for Type III granular sealers are respectively met.

A lot of sealer not meeting all of the sealer quality requirements shall be given a payment adjustment, as specified in the clause under Payment Adjustments for Sealers.

The Owner shall be responsible for all costs associated with QA testing for acceptance.

305.08.03.02 Referee Testing

The Contractor may invoke referee testing for one or more tested attributes 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.

Referee testing shall be carried out as specified below and elsewhere in the Contract Documents.

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 at full payment based on the referee test results, then the Contractor shall be responsible for the cost of the referee testing of that lot at the rates specified elsewhere in the Contract Documents. In all other cases, the Owner shall bear the cost of the referee testing of that lot.

305.08.04 Visual Deficiencies

All surfaces deemed visually unacceptable by the Contract Administrator due to uneven application of sealer, surface damage, flushing, bleeding or contamination, shall be repaired to the satisfaction of the Contract Administrator.

305.08.04.01 Repairs

All surfaces deemed unacceptable due to uneven application of sealer shall be repaired.

Deficiencies other than uneven application of sealer shall be repaired by removing all deficient areas of sealed granular material, then replacing it with clean, compacted Granular A meeting the requirements specified in OPSS 1010 and OPSS 501.

All repaired areas 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.

Sprayed areas damaged by the Contractor's operations or identified by the Contract Administrator as being inadequately treated shall be repaired and resprayed, at no additional cost to the Owner.

Sprayed areas 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 price adjustment. A calculated price 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) A lot sample has not been received by the QA laboratory within sufficient time for the sample to be tested;
- b) The lot sample contains insufficient material for testing; or
- c) 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-a 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 particular test in Table 3.

305.10.01.02.03 Adjustment Points for Type I-b 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 particular test in Table 4, plus:

- a) 1,000 adjustment points, if the test result for the LS-218, the Particle Charge Test, fails to meet the requirement specified in OPSS 1103; plus
- b) 1,000 adjustment points, if the test result for LS-221, the Storage Stability Test, 24 hour, fails to meet the requirement specified in OPSS 1103.

305.10.01.02.04 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 1000 adjustment points, if the material is determined to be anionic according to the Particle Charge Test, LS-218.

TABLE 1
Application Rates and Temperatures

Type of Sealer	Application Rate (kg/m ²)		Application Temperature
	Hand-Sprayed Areas	Machine-Applied/Other Areas	
I-a	3.4	2.6	30 to 45 °C
I-b	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 or 3 coats for emulsions with 12% and 8% solids, respectively, to deliver a total of 4.5 kg/m².
- 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-a Sealers

Test Method	Test Description	Unit	Multiplier
ASTM D 402	Residue by Distillation to 360 °C	%	200
ASTM D 402	Distillate, as % of Total Distillate to 360 °C		
	to 190 °C	%	10
	to 225 °C	%	10
	to 260 °C	%	10
	to 316 °C	%	10
LS-202	Kinematic Viscosity at 60 °C	mm ² /s	20
Tests on Residue			
LS-200	Residue Penetration at 25 °C	0.1 mm	15
LS-204	Residue Solubility	%	10
LS-205	Residue Ductility at 25 °C	cm	10

TABLE 4
Tests, Units, and Multipliers for Type I-b and Type II Sealers

Test Method	Test Description	Unit	Type I-b Multiplier	Type II Multiplier
LS-216	Residue by Distillation	%	200	200
LS-217	Oil Portion of Distillate, By Volume	%	50	50
LS-219	Viscosity at 50 °C, Less Than Minimum	Saybolt Furol Seconds	30	-
	Viscosity at 50 °C, Greater Than Maximum	Saybolt Furol Seconds	5	-
LS-219	Viscosity at 25 °C, Less Than Minimum	Saybolt Furol Seconds	-	30
	Viscosity at 25 °C, Greater Than Maximum	Saybolt Furol Seconds	-	5
LS-223	Sieve Test	%	-	1000
ASTM D 1310	Flash Point, Open Tag	°C	10	-
Tests on Residue				
LS-200	Residue Penetration at 25 °C	0.1 mm	15	15
LS-204	Residue Solubility	%	10	10
LS-205	Residue Ductility at 25 °C	cm	10	10

WARRANT: Always with this tender item.

**Appendix 305-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

The designer should specify the following in the Contract Documents:

Sampling requirements shall be as specified below and elsewhere in the Contract Documents.

Security measure shall be implemented for referee sample pick-up and delivery. Contractor should be responsible because of time to delivery and adjustment.

The designer should determine if a particular Sealer Type [I, II or III] should be specified in the Contract Documents (305.05).

The designer may choose the appropriate sealer on the basis of the expected number of years when the shoulder would typically need to be re-sealed as follows:

Sealer Type	Expected # of Years Before Re-Sealing*
I	4
II	3
III**	2

*Note: *The expected years shown below are based on the understanding that the shoulder will only be occasionally subjected to vehicular traffic. Note that all sealers shown below should perform behind guiderails for at least 3 years when they're being applied, in accordance with the manufacturer's requirements.

**Type III should only be selected where there is a minimal risk of the shoulders being subjected to vehicular traffic.

Granular Sealer Type III, should only be applied to aggregates meeting the requirements of Granular A, S, or M.

The designer should ensure that the General Conditions of the Contract and the 100 Series General Specifications are included in the Contract Documents.

- Areas designated for granular sealing. (305.07.03)
- Number of Business Days for the delivery of samples. (305.08.01)
- Name and location of the testing laboratory. (305.08.01)
- Unit of measurement for granular sealer. (305.09.01.01)

Related Ontario Provincial Standard Drawings

OPSD 210.070 Granular Sealing



**CONSTRUCTION SPECIFICATION FOR
UNTREATED GRANULAR SUBBASE, BASE,
SURFACE, SHOULDER, AND STOCKPILING**

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314-A	Commentary

314.01 SCOPE

This specification covers the requirements for the construction of untreated granular subbase, base, roadway surface and shoulder, edge ramping for bituminous pavements, and stockpiling at specified sites.

314.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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.

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

Construction Grading Report means a tabular report provided by the Contract Administrator that identifies stations, offsets, and elevations for granular surfaces consistent with the design cross-section.

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.

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 specified requirements.

314.05 MATERIALS

314.05.01 Aggregates

Granular material and select subgrade material shall be according to OPSS 1010.

314.07 CONSTRUCTION

314.07.01 Granular Subbase, Base, and Surface

Material shall be kept free from clay and other types of deleterious material. The Contractor's operations shall not disturb underlying work.

Material shall be placed without segregation in uniform layers such that the thickness of the compacted layer is not greater than 150 mm, except as provided under the Modified Layer Compaction Method clause.

Each layer shall be bladed to a smooth surface according to the required cross-section and maintained until placement of a subsequent layer, when applicable.

Prior to closing down operations for the completion of each day's work, the subbase material shall be bladed and compacted and, if necessary, covered with sufficient base material to carry traffic.

The granular base shall be maintained to the tolerances in grade and cross-section and to the specified density until the project is accepted or, if the Contract includes paving, until the surface is paved.

314.07.02 Winter Grading of Granular

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, 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 material has thawed.

314.07.03 Edge Ramping of Bituminous Pavement

A ramp of the specified granular 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

Granular shouldering material shall be placed and compacted at locations and to the line, grade, and cross-section specified in the Contract Documents.

Before 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 granular material for shouldering operations shall not commence along any section of pavement until 24 hours have elapsed from the time of completion of the final bituminous pavement course in that section. The shouldering operations shall be completed within 24 hours on sections of pavement that are open to traffic. When the pavement is not open to traffic, the shouldering shall be completed before traffic is permitted.

b) Concrete Pavement and Concrete Base

Shouldering operations shall commence according to OPSS 350. Shouldering shall be completed before 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.

Operation of equipment shall not cause any damage to the pavement.

314.07.05 Compaction

314.07.05.01 General

Each layer of material shall be compacted as specified before the next layer is placed.

314.07.05.02 Compaction Requirements

The compaction requirements shall be according to OPSS 501.

314.07.05.03 Modified Layer Compaction Method

At the option of the Contractor, granular material may be placed in layers thicker than permitted under the Granular Subbase, Base, and Surface subsection, subject to the following provisions:

- a) All material shall be placed in uniform layers such that each layer shall have a depth of not more than 300 mm after compaction.
- b) Before placing each material in thicker layers, the Contractor shall prove, in a two lane trial area, the ability of the proposed compaction method to achieve the specified density. The location and extent of the trial area shall be approved by the Contract Administrator. At least 48 hours notice shall be given to the Contract Administrator before any work commences 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 given 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.

- c) When the Contract Administrator, on the basis of test results, 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 the Contractor find it 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, the Contractor shall first obtain approval 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 specified compaction, the Contractor shall make whatever changes are necessary to satisfy the requirements of this specification.

314.07.06 Tolerances

314.07.06.01 General

The surface of the uppermost layer of granular material shall be bladed, shaped, and compacted to produce the specified grade and cross-section.

In the event of a conflict between meeting horizontal grading tolerances and meeting vertical grading tolerances, the vertical grading tolerance shall take precedence.

314.07.06.02 Granular Courses

The finished granular courses shall not deviate more than 30 mm from the specified grade and cross-section and the surface shall not deviate more than 15 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.03 Bituminous Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 30 mm from the specified grade and cross-section, except when the finished bituminous grade is controlled by fixed components such as existing pavements and curbs, in which case the finished granular surface shall not deviate more than 10 mm from the specified grade. Granular surfaces shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.06.04 Concrete Courses, Sidewalk, Curb, and Gutter

The finished granular surface shall not deviate more than 10 mm from the specified grade and cross-section and the surface shall not deviate more than 10 mm at any place as measured in any direction with a 3 m straight edge.

314.07.07 Stockpiling of Granular Material

Stockpiles of granular material shall be constructed according to OPSS 1001 at sites specified in the Contract Documents.

314.07.08 Quality Control

The Contractor shall carry out grade checks on the finished granular surfaces and carry out all QC grade checks required to ensure that the finished granular courses are built to within the specified tolerances for grade and cross-section. QC of granular grading shall be based on surface tolerances of the finished granular

courses, as provided in the Tolerances subsection. The grade shall be certified at the stations and offsets shown in the Construction Grading Report.

314.07.09 Submission of Grade Checks

All grade checks relating to 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. The Contractor shall sign and certify the construction grading report as correct.

When grading templates are available, the Contractor shall sign and certify the template as correct. If no template is available, the Contractor shall complete, sign, and submit form OPSF 314-1 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 Contract Administrator may conduct random QA grade checks to verify that the grade and cross-section are within the specified tolerances.

314.08.02 Finished Grades Outside Specification

When the finished granular grade or cross-section or both do not meet the acceptance criteria, the granular course shall be brought to grade or cross-section or both within the specified tolerances.

314.08.03 Acceptance

Provided that the Contract Administrator's grade checks are according to those determined by the Contractor, no action shall be taken. If discrepancies between QA and QC grade checks occur, additional QA grade checks may be conducted by the Contract Administrator. If the Contract Administrator chooses not to take QA grade checks, the work shall be accepted on the basis of QC grade checks.

If the finished grade or cross-section or both are not according to the specification, the Contractor shall be required to bring the granular surface to grade or cross-section or both within the specified tolerances and recertify the grade.

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, O, and S
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**

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 so 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 employed as determined by the Contract Administrator:

a) End Area Method

i. At Source

The volume of material shall be measured at the source in their 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 shall be deducted.

ii. In Place

When the measurement for payment of material in their original location is not possible, 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

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.

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**

 - Granular S - 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.

The cost of any additional QA grade checks on the recertified area shall be the responsibility of the Contractor. All grading carried out by the Contractor as a result of QA grade checks to ensure tolerances shall be carried out at no additional charge to the Owner.

Compensation for the cleanup of the stockpile site on completion of the operation, when required, shall be included as part of the granular item cost.

314.10.02 From Stockpile

Compensation for clearing, grubbing, stripping, cleanup of the stockpile site, and for supplying and placing a pad upon which the materials are to be stockpiled shall be included as part of the granular item cost.

CERTIFICATION OF GRADE ELEVATION / CROSSFALL

CONTRACT _____

LOCATION _____

COMPONENTS _____

LOCATION _____

In compliance with the Contract, I hereby certify that the following component of the work has been correctly constructed to the specified line and grade tolerances.

FROM STATION	TO STATION	TYPE OF GRADE	DATE	CERTIFIED BY	
				Print name	Signature

OPSF 314-1

**Appendix 314-A, Commentary for OPSS.MUNI 314, 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

The designer should specify the following in the Contract Documents:

- Location, line, grade, and cross-section for granular material. (314.07.04)
- Sites for stockpiles of granular material. (314.07.07)

On projects requiring grading, the designer should provide a Construction Grading Report.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

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; adding and blending corrective aggregate or active filler or both, if required; 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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 301	Restoring Unpaved Roadway Surfaces
OPSS 310	Hot Mix Asphalt
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

Ontario Ministry of Transportation Publications

SP-027	Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

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-292	Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-297	Determination of Indirect Tensile Strength of Expanded Asphalt Mixes
LS-625	Sampling of Granular Materials

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

331.03 DEFINITIONS

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

Active Filler means substances added to the reclaimed materials that chemically alter the mix properties.

AMRL means as defined in OPSS 310.

CCIL means as defined in OPSS 310.

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.

Performance Graded Asphalt Cement (PGAC) means as defined in OPSS 310.

Quality Assurance (QA) means as defined in OPSS 310.

Quality Control (QC) means as defined in OPSS 310.

Reclaimed Asphalt Pavement (RAP) means as defined in OPSS 310.

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. The design rate of the expanded asphalt shall be a minimum of 2.8%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt mix design. 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 per cent by mass of expanded asphalt in the mix, referred to as the design rate, and all calculations performed to determine the design rate of the expanded asphalt.
- c) The recommended PGAC temperature for foaming, the half life, the expansion ratio, and the per cent 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 affects 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

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Business Days prior to the start of the reclamation and stabilization. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

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 or both of the existing pavement changes significantly.

331.05 MATERIALS

331.05.01 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. No more than one per cent by mass of Portland cement shall be added to the mix.

331.05.02 Corrective Aggregate

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 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding the PGAC zone requirements.

331.05.04 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.

331.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

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 per cent expanded asphalt, rate of application, and per cent 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.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Expanded Asphalt Trial Section subsection.

331.06.02 Placing Equipment

Placing of the expanded asphalt mix shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified cross-fall and grade. 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 shall be according to the requirements of the 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 wearing surface 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 2 Days.
- b) The Contractor has 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 on the Contract, 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 any 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. The Contractor shall give the Contract Administrator a minimum of 48 hours notice 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 this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

331.07.04 Expanded Asphalt Stabilization

The Contractor shall stabilize 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 Grading and Compacting the Expanded Asphalt Mix

The material shall be compacted to a minimum 97% of the target density, as determined in OPSS 501 for granular materials.

The compacted surface of the EAM shall be according to the surface tolerances specified in OPSS 301. Regrading of the EAM to correct crossfall deficiencies shall be minimized.

The compacted surface of the EAM shall be uniform in texture and free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other surface defects.

331.07.06 Sampling

The Contractor shall be responsible for all sampling.

331.07.06.01 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

331.07.06.02 Active Filler

The Contract Administrator may request samples of active filler to demonstrate conformance to the requirements of this specification.

331.07.06.03 Expanded Asphalt Mix

Samples of unstabilized material and EAM shall be taken at a minimum frequency of one set of samples per 5,000 m². To obtain a set of samples, the Contractor shall take one 15 kg sample of unstabilized material 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.

The samples shall be packaged in a non-absorptive material to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

331.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic 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. Convoing shall be maintained until such time as the expanded asphalt stabilized mat is able to carry traffic without damage.

331.07.08 Management of Excess Material

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

331.08 QUALITY ASSURANCE

331.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

All unacceptable material and all unacceptable surface deficiencies, mix, or work shall be rejected. Defective material, mixture, and work shall not be incorporated into the finished work.

331.08.02 Acceptance of Corrective Aggregate

QA testing may 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.

331.08.03 Acceptance of the Expanded Asphalt Mix

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

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 in accordance with LS-282 or LS-292. 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 each 5,000 m² placed 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, wet tensile strength, and tensile strength ratio according to LS-297.

Dry tensile strength requirements for the sample are met when the dry tensile strength of the sample is equal to or greater than the minimum requirement of 225 kPa.

Wet tensile strength requirements for the sample are met when wet tensile strength of the sample is equal to or greater than the minimum requirement of 100 kPa.

The tensile strength ratio for the sample shall not be less than 50%.

331.08.04 Acceptance of Thickness

Thickness of the EAM shall be measured by the Contract Administrator. 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 each 5,000 m² are met when the following are satisfied:

- a) At least 90% of all thickness measurements for each 5,000 m² are equal to or greater than the specified thickness minus 20 mm.
- b) No individual thickness measurement for each 5,000 m² is less than the specified thickness minus 30 mm.

331.08.05 Acceptance of Compaction

Compaction measurements shall be taken by the Contract Administrator according to OPSS 501 for granular materials. Compaction requirements of the EAM placed are met when the following are satisfied:

- a) The average of all compaction measurements for each 5,000 m² is greater than or equal to 97% of the target density.
- b) No individual compaction measurement for each 5,000 m² is less than 95% of the target density.

331.08.06 Repairing and Re-Decisioning

With the exception of repairs for surface tolerance, the minimum width of repair shall be the full width of the reclaimer-stabilizer equipment, the minimum length shall be sufficient for the repair to be carried out, and all repairs shall be made using the same equipment as was used during initial production and placement.

To meet the specified surface tolerance, all deficient areas shall be re-profiled by grading or padding or padded with the same HMA type to be used in the overlying HMA lift.

Unacceptable EAM, including any area damaged or contaminated by traffic or by natural or added water shall be reprocessed and, if required, additional expanded asphalt added. 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 310.

Mixes that cannot be compacted to the specified density shall be removed to a minimum depth of 50 mm and replaced by an appropriate HMA approved by the Contract Administrator. When it is determined that the compaction cannot be achieved due to poor subgrade conditions, the Owner shall be responsible for the cost of repairs.

331.09 MEASUREMENT FOR PAYMENT

331.09.01 Actual Measurement

331.09.01.01 Full-Depth Reclamation with Expanded Asphalt Stabilization

Full-depth reclamation with expanded asphalt stabilization shall be measured for payment 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 item shall be full compensation for all labour, Equipment, and Material to do the work.

The addition of corrective aggregate or active filler to the mix 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.

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 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

The designer should specify the following in the Contract Documents:

- The depths and widths for reclaiming existing asphalt pavement and underlying granular base. (331.07.02)
- The depth and limits of expanded asphalt stabilization. (331.07.04)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Traffic convoy requirements. (331.07.07)

Expanded asphalt mix (EAM) is a reclaimed asphalt pavement and granular base stabilized in-place by the addition of expanded asphalt and, if required, corrective aggregate and active filler.

EAM is a bound material and does not exhibit the same drainage characteristics as granular base material.

Expanded or "foamed" asphalt is created by injecting a carefully metered amount of cold water into hot asphalt cement in the mixing chamber of a pulverizer-stabilizer. The asphalt expands, reducing the viscosity of the asphalt cement and allowing easier dispersion throughout the mix.

The expanded asphalt bonds most effectively with finer aggregate particles forming a mortar to bond the coarser aggregate particles together. The stabilization process requires fines in order to be effective.

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the contract documentation.

The selected performance graded asphalt cement (PGAC) must have suitable expansion characteristics. Polymer modified PGAC may adversely affect the foaming process. There is no requirement for a PGAC to be selected based on climatic zones, as the stabilized layer is expected to have good fatigue properties and should not be prone to low temperature cracking.

Since EAM has a higher structural equivalency than granular base material, it is suitable for pavement strengthening purposes where aggregate availability is low or where elevation restrictions exist.

This specification requires that the EAM be paver laid, i.e., be placed by a self-propelled mechanical paver. If an Owner would like the EAM to be grader laid, i.e., to allow the use of a grader to place the EAM, a special provision to allow that option should be included in the Contract Documents.

When additional full-depth reclamation is required beyond the limits of the expanded asphalt stabilization, the depth and limits of full-depth reclamation should be clearly indicated in the Contract Documents. (331.07.02)

Appendix 331-A

When compaction is to be determined according to OPSS 501 Method B, a minimum roller size should be specified.

A minimum 2-Day curing period is recommended prior to overlaying the EAM. The EAM should be surfaced as soon as possible after curing, as the mix is susceptible to damage by traffic and rain.

A tack coat is recommended on the EAM prior to hot mix overlay.

EAM is typically overlain with hot mix asphalt. A surface treatment or slurry surfacing may be considered; however, this specification may require modification.

Contract scheduling should allow for stabilization and overlay to be completed within the hot mix temperature operational constraints.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should an Owner desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid EAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR HOT IN-PLACE RECYCLING

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332-A Commentary

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; adding and mixing in one or more of rejuvenating agent and beneficiating hot mix asphalt; and redistribution and compaction of the Hot In-Place Recycled mix in a single operation.

332.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

332.01.02 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.

332.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1101 Performance Graded Asphalt Cement
OPSS 1150 Hot Mix Asphalt
OPSS 1151 Superpave and Stone Mastic Asphalt Mixtures

Ontario Ministry of Transportation Publications

MTO Laboratory Testing Manual

LS-261 Preparation of Marshall Specimens
LS-262 Bulk Relative Density of Compacted Bituminous Mixes
LS-263 Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
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 Abson Method or Rotavapor
LS-287 Determination of Percent Compaction of Compacted Bituminous Paving Mixture (MRD Method)

- LS-292 Quantitative Determination of Asphalt Cement Content by Ignition and Analysis of Remaining Aggregate from Bituminous Paving Mixtures
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens

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)

- M 323-13 Superpave Volumetric Mix Design
T 166-13 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
T 209-09 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
T 275-07 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

332.03 DEFINITIONS

For the purpose of this specification, the definitions in OPSS 310, OPSS 1150, OPSS 1151, and the following definitions apply:

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, compaction, or recovered asphalt cement (RAC) performance grade.

Beneficiating HMA means a HMA designed so that the final HIR mix shall be as specified in the Contract Documents.

Design Lift Thickness (T_D) means the thickness in millimetres of the HIR mix as specified in the Contract Documents.

High Temperature Performance Grade (XX) means the high temperature performance grade specified in the Contract Documents and also referred to as the XX specified for the RAC where the RAC grade specified is PG XX-YY, and the maximum design pavement temperature.

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.

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 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.

Low Temperature Performance Grade (-YY) means the low temperature performance grade specified in the Contract Documents and also referred to as the -YY specified for the RAC where the RAC grade specified is PG XX-YY, and the minimum design pavement temperature.

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 recovered from the HIR mix according to the Rotavapor Method in 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

The HIR mix design shall be as specified in the Contract Documents and according to the Design and Submission Requirements section of OPSS 1150 for HIR mixes required to meet a Marshall mix type and OPSS 1151 for HIR mixes required to meet a Superpave mix type.

HIR mix designs shall not incorporate RAP from other sources or RST into the HIR mix.

The following additional information shall be submitted to the Contract Administrator in writing with the mix design:

- a) The amount, name, manufacturer, and supplier of the rejuvenating agent or beneficiating HMA or both, if to be used;
- b) The hot milling depth to meet the required mix properties and the design lift thickness, as specified in the Contract Documents, with a maximum increase in pavement elevation of 15.0 mm;
- c) The mix proportions, gradation, and source of the materials in the beneficiating HMA, if to be used;
- d) A copy of all calculations that were completed to determine the amount of rejuvenating agent or beneficiating HMA or both, if to be used;
- e) Air void laboratory test results and calculations for the HIR mix; and
- f) A graph of temperature-kinematic viscosity relationship for the combined rejuvenating agent, the recovered AC present in the existing pavement, and the new AC in the beneficiating HMA.
- g) When applicable, a declaration that the percentage of the beneficiating HMA comprising quartzite and dolomitic sandstone aggregates, or combinations thereof, is more than 75%.

Each mix design shall be valid for the section of roadway it was designed for.

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 Tables 1, 2, and 3. For HIR mix required to meet a Marshall mix type, the HIR mix produced shall also meet the requirements of Table 4.

332.05.01.01 Recovered Asphalt Cement

The RAC recovered from the HIR mix produced shall be according to the Materials section of OPSS 1101 for PGAC and as specified in the Contract Documents.

332.05.01.02 Beneficiating Hot Mix Asphalt

The materials used in the production of the beneficiating HMA shall be according to OPSS 1150 for HIR mixes required to meet a Marshall type and OPSS 1151 for HIR mixes required to meet a Superpave mix type.

The composition of the beneficiating HMA shall not contain RAP or RST.

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 Paving Equipment

Paving equipment shall be according to OPSS 310.

332.06.02 Rollers

Rollers shall be according to OPSS 310.

332.06.03 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 so 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.

332.06.04 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.

332.06.04.01 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.

332.06.04.02 Blending Unit

The blending unit shall be capable of thoroughly mixing the hot milled material, rejuvenating agent, and beneficiating HMA.

332.06.05 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 0.9 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

QC procedures shall be conducted to ensure the HIR mix meets the requirements of the Contract Documents. The Contractor shall be responsible for interpretation of the QC test results and the determination of any action to be taken to ensure that all materials and work are as specified in the Contract Documents. QC documentation shall be made available to the Contract Administrator upon request. Sampling and testing methods shall be included in the QC documentation.

A laboratory that has current CCIL Type B Certification or AMRL equivalent certification or other equivalent certified laboratory acceptable to the Contract Administrator shall be used. Testing of the samples shall be conducted under the direct and constant supervision of technicians certified to perform the QC tests according to CCIL or equivalent certification.

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. 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) Removal of cold mix patching material, crack sealant, and spray patch material shall be as specified in the Contract Documents (FS: pp 44)
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

The beneficiating HMA shall be transported from the asphalt plant to the work in leak proof truck boxes that have been previously cleaned of all foreign materials. If required, truck boxes shall be lightly coated with a uniform application of a release agent. Truck boxes shall be drained after each application and before loading.

Each truck shall use a tarpaulin of sufficient size to completely cover the load at all times.

332.07.04 Placing Hot In-Place Recycled Mix

332.07.04.01 Operational Constraints

The HIR process shall not be carried out if the roadbed is frozen.

The surface of a pavement which is to be HIR shall be dry at the time of the HIR processing. 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.

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 shall be heated to a minimum temperature of 50 °C.

When inspection and testing indicates 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 the hot milled material 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 overlap the previously HIR adjacent surface by a minimum of 100 mm.

The temperature of the HIR mix immediately behind the screed and prior to rolling shall not be less than 120 °C.

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.

All through lane HIR mix shall be completed prior to the placement of adjacent sideroads, speed change lanes, and other paved areas.

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 tacked coated and paved with the HMA mix type the HIR is required to meet according to OPSS 310. 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 the Contractor's actions fail to prevent continued medium or severe segregation regardless of cause, the Contract Administrator may instruct the Contractor 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 within 50 mm of the demarcation between the lanes specified in the Contract Documents.

When matching a compacted joint, the depth of the uncompacted mat shall be set to allow for compaction. The paver screed shall overlap the adjoining mat by at least 50 mm.

332.07.06 Compaction

Compaction of the HIR mix shall be conducted using appropriate methods and equipment to provide a uniformly compacted mat according to the compaction requirements as per OPSS 310.

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 Sampling

332.07.07.01 General

Samples shall be taken in accordance with the Contract Documents under the direction and in the presence of the Contract Administrator. Samples shall be placed in an appropriate container supplied by the Owner.

HIR mix and compaction requirements for filling all 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.

332.07.07.01.01 Labelling

All samples shall be labelled with the following:

- a) Contract number.
- b) Location of sampling.
- c) Date (i.e., yyyy-mm-dd) and time of sampling.
- d) Asphalt type.

332.07.07.02 Hot In-Place Recycled Mix

The Contractor is responsible for obtaining QA and referee HIR mix samples using sample plates for Marshall mixes and other methods approved by the Contract Administrator for Superpave mixes.

When the mass of the sample does not meet the requirements of Table 5, the sample shall be discarded and a new one taken immediately.

332.07.07.02.01 Frequency and Location

The minimum frequency for sampling and testing shall be as specified in Table 5.

332.07.07.03 Lift Thickness Cores

The Contractor is responsible for obtaining QA and referee lift thickness core samples.

Each core shall be 100 mm in diameter, and shall 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.

332.07.07.03.01 Frequency and Location

The minimum frequency for sampling and testing shall be approximately once every 100 m along the length of the roadway or 300 m² of pavement surface.

332.07.07.04 Compaction Cores

When a coring and testing program is undertaken to resolve a dispute related to HIR compaction, the Contractor shall be responsible for all traffic control required to carry out the coring, obtaining, and labelling the core samples, delivery of the samples to a mutually agreed upon third party referee laboratory, and repairing core sample holes.

Each core shall be 150 mm in diameter, and shall 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 ± 0.1 m between each individual core edge.

Care shall be taken to ensure that cores are not 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.

332.07.07.04.01 Frequency and Location

The minimum frequency of sampling and testing shall be as determined by the Contract Administrator.

332.07.08 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

332.08 QUALITY ASSURANCE

332.08.01 General

The Contract Administrator is responsible for conducting QA procedures for all HIR attributes to meet the requirements of the Contract Documents. QA HIR testing shall be conducted at a frequency specified in Table 5 or as specified in the Contract Documents.

All QA testing shall be completed in a certified laboratory that is CCIL Type B or C, or AMRL accredited, or equivalent.

When the HIR fails to meet the requirements of the Contract Documents, the Contract Administrator may refuse further material until the mix properties are verified for compliance by one of the following methods:

- a) For Marshall mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, air voids, flow, voids in mineral aggregate, and stability requirements.
- b) For Superpave mixes, samples shall be used to determine compliance to asphalt cement content, aggregate gradation, and Superpave mix properties in accordance to AASHTO M 323.

332.08.02 Surface Tolerance

After final compaction, HIR mix shall be smooth and true to the established crown and grade. HIR mix shall be free from deviations exceeding 3 mm as measured in any direction with a 3 m straight edge. Defective areas shall be removed and replaced with acceptable HIR or HMA pavement and compacted to the satisfaction of the Contract Administrator.

332.08.03 Surface Appearance

The Contract Administrator may reject visually defective HIR areas based on, but not limited to the following defects: flushing, segregation, fat spot, surface damage, roller marks, or surface contamination. Defective areas shall be removed from the work and replaced with acceptable HIR or HMA pavement and compacted to the satisfaction of the Contract Administrator.

332.08.04 Asphalt Cement Content and Aggregate Gradation Acceptance

Aggregate gradation and asphalt cement content test results for HIR mix samples based on LS-282 and LS-292 shall meet the requirements specified in Table 1.

If the HIR mix is deemed borderline for aggregate gradation or asphalt cement content according to Table 1, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control. A total of three borderline test results for the same attributes representing up to 40,000 m² of HIR production shall result in the work being deemed rejectable.

Test results shall be acceptable if they meet the requirements specified in Table 1. If the HIR mix is deemed rejectable according to Table 1, both the Contract Administrator and the Contractor shall review, agree, and

identify the limits of rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify aggregate gradation or asphalt cement content or both. When the results from the referee samples are deemed rejectable according to Table 1, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.05 Mix Properties Acceptance

The production air voids for all HIR mixes shall be evaluated according to Table 2. Marshall test results for HIR mix samples based on LS test procedures shall also meet the requirements specified in Table 4.

If the HIR mix is borderline for air voids as specified in Table 2, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control.

If the HIR mix does not meet Table 4 minimum requirements for Marshall stability or Marshall flow or is deemed rejectable for air voids according to Table 2, both the Contractor Administrator and the Contractor shall review, agree, and identify the limits of the rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify Marshall test or air voids results or both. When the results from the referee samples do not meet Table 4 minimum requirements or are deemed rejectable according to Table 2, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.06 Lift Thickness Acceptance

The average thickness for a lift thickness core shall be based on the measurement from each quadrant of the core. The average thickness for the area shall be determined by averaging the core thicknesses.

When the average thickness is more than or equal to 95% of the specified thickness, the total surface area of the HIR mix is acceptable.

When the average thickness is less than 95% of the specified thickness, the area represented by the lift thickness core shall be subject to a payment adjustment as specified in the Payment Adjustment for Lift Thickness subsection.

332.08.07 Recovered Asphalt Cement Performance Grade Acceptance

All RAC test samples shall be obtained by recovery according to the Rotavapor Method in LS-284 using re-agent grade trichloroethylene, or other solvent acceptable to the Owner, from the loose mix HIR mix samples taken as specified in Table 5.

Test results that do not comply with the performance grading requirements shall be categorized as borderline or rejectable. RAC test results shall be categorized based on each test result's deviation from the individual design maximum or minimum pavement temperature and the sum of the deviations from the design maximum or minimum pavement temperatures defined as specified in Table 6. The actual performance grading that is either higher than the maximum design pavement temperature or lower than the minimum design pavement temperature is not considered a deviation.

If the HIR mix is deemed borderline for RAC performance grade according to Table 6, the Contractor shall be notified in writing by the Contract Administrator and shall take immediate corrective action through process control. A total of three borderline test results for the same attributes representing up to 40,000 m² of HIR production shall result in the work being deemed rejectable.

Test results shall be acceptable if they meet the requirements specified in Table 6. If the HIR mix is deemed rejectable according to Table 6, both the Contract Administrator and the Contractor shall review, agree, and identify the limits of rejected HIR mix that has been placed. Referee samples within the limits of the affected area shall be delivered by the Contractor to a mutually agreed upon third party referee laboratory to verify the RAC performance grading. When the results from the referee samples are deemed rejectable according to Table 6, the HIR mix shall be removed and replaced with acceptable HIR or HMA pavement. Alternatively, the Contract Administrator may accept a guaranteed maintenance bond, an increased maintenance period, or a negotiated price adjustment.

332.08.08 Compaction Requirements

332.08.08.01 General

Compaction testing of the placed HIR mix shall meet the requirements specified in Table 3.

Nuclear density test gauge results shall be used to assess in-place compaction. When compaction test results do not meet the minimum percent compaction specified in Table 3, the Contractor shall be notified in writing and either the affected area of HIR shall be removed and replaced with acceptable HIR or HMA, or in the case of a dispute, the Contractor or the Owner may request that a coring and testing program be undertaken to verify compaction percentage of the mix. The cores shall be provided to the Owner and compaction shall be determined according to the Compaction Determined by Core Density Testing clause using a mutually agreed upon third party referee laboratory. When compaction results from core densities do not meet the minimum percent compaction specified in Table 3, the HIR shall be removed and replaced with acceptable HIR or HMA.

332.08.08.02 Compaction Determined by Nuclear Density Gauge

Compaction testing shall be conducted randomly at a minimum frequency of every 100 m per lane or 150 m² area.

332.08.08.02.01 Marshal Hot In-Place Recycled Mix

Percent compaction shall be determined by comparing the nuclear density in situ Bulk Relative Density (BRD) according to LS-262 to the average plant produced Maximum Relative Density (MRD) according to LS-264.

332.08.08.02.02 Superpave Hot In-Place Recycled Mix

Percent compaction shall be determined by comparing the nuclear density in situ BRD to the average plant produced MRD both according to AASHTO T 209.

332.08.08.03 Compaction Determined by Core Density Testing

332.08.08.03.01 Marshall Hot In-Place Recycled Mix

Density testing of the cores shall be according to LS-287. Percent compaction shall be determined by comparing the core BRD according to LS-262 to the average MRD according to LS-264 of the plant produced HIR.

332.08.08.03.02 Superpave Hot In-Place Recycled Mix

Density testing of the cores shall be according to AASHTO T 166. If the percent water absorbed by the specimen is found to exceed 2% by volume as described in AASHTO T 166, then the bulk specific gravity shall be according to AASHTO T 275, LS-306, or ASTM D 6752. Percent compaction shall be determined by comparing the core BRD to the average MRD both according to AASHTO T 209 of the plant produced HIR.

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.

332.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement is based on the units shown in the clauses under Actual Measurement.

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 cost to the Owner.

HMA required to retrofit partially paved shoulders or for pavement widening shall be paid for at the Contract price for the appropriate HMA tender item. No additional payment shall be made under this item for HMA required to retrofit partially paved shoulders or for pavement widening.

When removing and replacing HIR mix, the Contractor shall be responsible for and shall carry out all associated work and replace or restore all associated damage and removals at no cost to the Owner.

Referee testing undertaken to resolve a dispute shall be at no extra cost to the Owner if the referee test results confirm that the HIR mix does not meet the requirements or is deemed borderline or rejectable according to the Quality Assurance section.

A coring, testing, and traffic control program undertaken to resolve a dispute shall be at no extra cost to the Owner if the HIR mix compaction is confirmed to not meet the requirements of the Compaction Requirements subsection.

When the Contract Administrator instructs the Contractor to cease HIR operations due to continued medium or severe segregation regardless of cause, the Owner shall not be held responsible for any additional costs that the Contractor may incur.

332.10.02 Payment Adjustment for Lift Thickness

When the average thickness is less than 95% of the specified thickness, the area represented by the lift thickness core shall be subject to a payment adjustment calculated as follows:

Payment for the area = $\frac{\text{area} \times \text{average thickness}}{\text{specified thickness}}$

TABLE 1
Asphalt Cement Content and Aggregate Gradation Tolerance Requirements

Properties and Attributes	Tolerance on	Tolerances %		
		Acceptable	Borderline	Rejectable
Asphalt Cement Content	Asphalt Cement Content specified (Note 1)	< 0.30	0.30 to 0.50	> 0.50
Designated Large Sieve (DLS)	Maximum and Minimum Percent Passing (Note 2 & 3)	< 1.0	1.0 to 5.0	> 5.0
4.75 mm Sieve	Maximum and Minimum Percent Passing (Note 2 & 3)	< 1.0	1.0 to 5.0	> 5.0
75 µm Sieve	Maximum Percent Passing (Note 2)	< 1.0	1.0 to 3.0	> 3.0
	Minimum Percent Passing (Note 3)	< 1.0		> 1.0
Notes: 1. Tolerances on the asphalt cement content specified in the Contract Documents apply as both plus and minus from the asphalt cement content specified in percent. 2. Tolerances on the maximum percent passing apply as plus from the maximum percent passing by dry mass of aggregate for the mix type the HIR mix shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave mixes. 3. Tolerances on the minimum percent passing apply as minus from the minimum percent passing by dry mass of aggregate for the mix type the HIR mix shall be according to OPSS 1150 for Marshall mixes and OPSS 1151 for Superpave mixes.				

TABLE 2
Air Voids Requirements (LS-265)

Properties and Attributes	Mix Type HIR Mix is Required to Meet	Acceptable %	Borderline %	Rejectable %
Air Voids	DFC	2.0 to 4.5	1.5 to 1.9 and 4.6 to 5.0	< 1.5 and > 5.0
	All Other Mixes	2.5 to 5.0	1.5 to 2.4 and 5.1 to 6.0	< 1.5 and > 6.0

TABLE 3
Minimum Pavement Compaction Based on Maximum Relative Density

Properties and Attributes	Minimum Compaction %
Pavement Compaction	92.0

TABLE 4
Marshall Stability and Flow Properties

Mix Type HIR Mix is Required to Meet	Marshall Flow at 3.5% Air Voids: LS-261 and LS-263	Minimum Marshall Stability: Newtons (N) at 60 °C, LS-261 and LS-263
DFC	8.0 minimum	(Note 1)
HL 1, HL 3, and HL 4,	8.0 to 14.0	
HL 3F	9.0 to 18.0	
Notes: 1. Stability requirements shall be according to OPSS 1150.		

TABLE 5
Sampling and Testing of Hot In-Place Recycled Mix

Material Sample	Properties and Attributes	Quantity Per Day Per HIR Mix Type	Minimum Frequency of Sampling and Testing (Note 1)	Minimum Sampling Size
HIR Loose Mix	Asphalt Cement Content, Aggregate Gradation, and Mix Properties	$\leq 4,000 \text{ m}^2$	One sample	20 kg (Note 2)
		$> 4,000 \text{ and } \leq 12,000 \text{ m}^2$	One sample per $4,000 \text{ m}^2$ or part thereof	
		$> 12,000 \text{ m}^2$	One sample per $4,000 \text{ m}^2$ (Note 2), minimum of 3	
HIR Loose Mix	RAC Performance Grade	Any	One sample per $40,000 \text{ m}^2$	10 kg
HIR Lift Thickness Core	Lift Thickness	Any	every 100 m along the length of the roadway or 300 m^2 of pavement surface	100 mm in diameter
HIR Compaction Core	Pavement Compaction	Any	every 100 m per lane or 150 m^2 of pavement surface	150 mm in diameter (Note 3)
Notes:				
1. The Contract Administrator may reduce the testing frequency for HIR mix that is consistently being produced to meet the specification requirements.				
2. For HIR mixes required to meet Marshall mix requirements the minimum sampling size shall be 10 kg.				
3. HIR compaction core only required when compaction shall be determined by core density testing as specified in the Contract Documents.				

TABLE 6
Performance Grading Requirements and Categories for RAC

Category	Deviation (Note 3)	RAC Requirements
Borderline (Note 1)	below XX and	$\leq 6^{\circ}\text{C}$
	above -YY and	$\leq 8^{\circ}\text{C}$
	Sum	$> 8^{\circ}\text{C}$ and $\leq 12^{\circ}\text{C}$
Rejectable (Note 2)	below XX or	$> 6^{\circ}\text{C}$
	above -YY or	$> 8^{\circ}\text{C}$
	Sum	$> 12^{\circ}\text{C}$
Notes: 1. Performance grading shall be deemed borderline when both the individual deviations and the sum of deviations specified for the category are met. 2. Performance grading shall be deemed rejectable when any individual deviation or the sum of deviations specified for the rejectable category is met. 3. XX is the specified high temperature performance grade and design maximum pavement temperature. -YY is the specified low temperature performance grade and design minimum pavement temperature.		

Appendix 332-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 specifications 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

The designer should be aware of the following when selecting HIR:

HIR is limited to resurface pavements exhibiting only surficial distresses. HIR should be considered for roads with the following distress manifestations:

- Very slight to moderate ravelling / coarse aggregate loss, segregation, very slight to moderate flushing, and/or distortions
- Few to frequent very slight to moderate non-working cracks
- For 2 lane highways up to 1.0% correction in crossfall can be achieved across a single lane width using HIR, provided there are no bridge clearance or grade raise restrictions
- For multi-lane highways correction of crossfall with HIR is not recommended

HIR is not suitable for pavements exhibiting structural distresses, i.e. alligator cracking, lack of structural capacity, working cracks, severe distortions, and/or instability rutting. HIR is not suitable for pavements exhibiting severe or very severe ravelling / coarse aggregate loss due to stripping.

HIR is not permitted for use on bridge decks; therefore, if the contract contains multiple bridges that require paving, the designer should consider whether stopping and starting the HIR process at each bridge is acceptable for the contract.

HIR is recommended only for existing flexible pavements, excluding SMA, with a minimum asphalt pavement thickness of 70 mm. The specified HIR lift thickness is 40 mm to a maximum of 50 mm (including any beneficiating HMA). The measured lift thickness is the actual lift thickness of the HIR placed and may or may not be equal to the hot milling depth. A minimum of 25 mm of existing asphalt pavement should be maintained below the HIR.

The HIR process should not be used to recycle SMA or composite pavements.

HIR must be placed in warm, dry weather; and therefore, HIR contracts should be tendered so that the HIR work can be carried out between May 15th and October 15th, inclusive.

The designer should note that HIR equipment may be restricted to a specific processing width. The equipment is usually able to process a width of up to 4.0 m. This could restrict the use of HIR with partially paved shoulders. However, the placement width is similar to that of a conventional paver, and partially paved shoulders that cannot be removed along with the lane, due to the restricted processing width, could be removed conventionally ahead of the HIR operation to allow the new partially paved shoulder to be placed in conjunction with the lane. Partially paved shoulders that cannot be accommodated as part of the lane placement width and fully paved shoulders, if these are to be HIR, require a separate pass of the HIR equipment.

HIR is usually considered for projects at least 20 lane-kilometres, including fully paved shoulders. Partially paved shoulders and pavement widening can be retrofitted using this process. Advance grading and

compaction of the shoulders is required as well as beneficiating HMA to make up the extra being placed on the shoulders or in pavement widening.

The following information is given for estimating purposes only.

HIR can be considered a suitable resurfacing treatment for a project where the pre-engineering cores meet the following guidelines:

1. The existing aggregate gradation should meet the gradation requirements of mix type the HIR is required to meet, or be close enough that a reasonable amount of beneficiating HMA could be added to meet these requirements.
2. The RAC performance grade from the extracted AC of the existing asphalt pavement can achieve the target performance grade using the blending calculations in AASHTO M 323 for rejuvenator products and new PGAC added to a beneficiating HMA.
3. Average in-situ air voids of:
 - > 4.5% a beneficiating HMA is normally not required,
 - ≤ 4.5% and > 2.0% beneficiating HMA may be required, and
 - ≤ 2.0% the designer should expect beneficiating HMA to be required.

Generally in-situ air voids are between 2.0 and 2.5% for asphalt pavements 10 to 15 years old.

4. The existing pavement conditions should not vary greatly from one core to the next.

The designer should specify the following in the Contract Documents:

- HIR crossfall, profile, cross-section, and alignment. (323.03)
- HMA mix type the HIR mix is required to meet. A Marshall mix type or Superpave 12.5 mix type should be selected based on existing materials from the following list: (332.04)
 - A. Superpave 12.5
 - B. Superpave 12.5FC 1
 - C. Superpave 12.5FC 2
 - D. DFC
 - E. HL 1
 - F. HL 3
 - G. HL 3F
 - H. HL 4
- Design thickness. (323.04)
- The RAC recovered from the HIR mix produced. (332.05.01.01)
- Quality assurance sample requirements. (332.07.01)
- HIR sample delivery location. (332.07.01)
- Removal of cold mix patching material, crack sealant, and spray patch material. (332.07.02)
- Lane demarcation. (332.07.05)
- Longitudinal and transverse joints. (332.07.05)

- Management of excess material. (332.07.08)
- QA HIR testing frequency if different than OPSS 332, Table 5. (332.08.01)
- Performance grade requirement for RAC. (332.08.07)
- Asphalt cement content specified. (Table 1)
- HIR compaction core. (Table 5)

Any available core data on existing pavement conditions should be included in the bidding documents for information only.

The designer should determine if the following is required and, if so, specify in the Contract Documents:

The designer may specify in a special provision when quality control (QC) test results are to be used for acceptance in place of QA test results.

The designer may consider extending delivery times for samples required on Contracts in remote areas. The designer should be aware that there is a 4 hour delivery requirement for samples and the laboratory should be open to receive them.

For smaller projects, the borderline category for tolerances in Table 1 may not be appropriate. The designer may consider specifying that all work represented by borderline test results shall be deemed rejectable.

The complete tender item description for HIR should include a “type” of HMA according to Table 1 of OPSS 1150 for HIR mixes required to meet Marshall mixes and according to Tables 1 and 2 of OPSS 1151 for HIR mixes required to meet Superpave mixes.

The designer should consider specifying that prior to HIR all materials such as cold mix patching material, crack sealant, and spray patch material shall be removed or that 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 Contractor deems necessary, to heat, hot mill, blend, and place the HIR mix to meet the surface tolerance and surface appearance requirements as specified in the Contract Documents.

For premium mixes, the designer should consider specifying that correcting the existing pavement by cold milling prior to HIR should not result in the existing binder course pavement materials being hot milled and added to the HIR mix.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR COLD RECYCLED MIX

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334.01 SCOPE

This specification covers the requirements for a cold mix paving process incorporating reclaimed asphalt pavement (RAP) from stockpiles. The process includes production and processing of RAP, design and testing, placement, and compaction.

334.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

334.01.02 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.

334.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt
OPSS 313 Hot Mix Asphalt - End Result

Ontario Provincial Standard Specifications, Material

OPSS 1102 Liquid Asphalt
OPSS 1103 Emulsified Asphalt

Ministry of Transportation Publications

SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing

MTO Laboratory Testing Manual:

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 Mixture
LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

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

334.03

DEFINITIONS

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

CCIL means the Canadian Council of Independent Laboratories

Cold Recycled Mix (CRM) means a mix of processed RAP and asphalt modifier produced through a cold mixing process.

Foreign matter means anything other than hot mix aggregate or granular aggregate.

Hot Mix Asphalt (HMA) means hot mixed, hot laid asphaltic concrete. The terms are used interchangeably. HMA may include recycled or specialty mixes.

Reclaimed Asphalt Pavement (RAP) means the processed HMA material that is recovered by partial or full-depth removal.

334.04

DESIGN AND SUBMISSION REQUIREMENTS

334.04.01

Design Requirements

Prior to commencing the work, for mix design purposes, the Contractor shall obtain RAP samples that are representative of the material to be processed. These samples shall be used to establish the design rate of the asphalt modifier as a percentage by mass of the RAP. The design rate of the asphalt modifier shall be a minimum of 1.2%.

The mix design shall be completed by a laboratory with either CCIL Type A certification or equivalent. Each mix design shall include the following:

- a) Information on the type, manufacturer, and supplier of the asphalt modifier.
- b) A copy of the mix design and all calculations performed to determine the mix design.
- c) All calculations performed to determine the design rate of asphalt modifier.
- d) Maximum field rate adjustment allowed to the design rate without adverse affects to mix properties.

334.04.02

Submission Requirements

The mix design shall be submitted to the Contract Administrator a minimum of 7 Days prior to the start of CRM operations.

A new mix design shall be submitted when the asphalt modifier design rate is adjusted by greater than 0.5%. A new mix design shall be submitted if the composition of the existing RAP changes significantly.

334.05

MATERIALS

334.05.01

Reclaimed Asphalt Pavement

The processing operation shall ensure that 100% of the RAP aggregate passes the 26.5 mm sieve. The amount of RAP aggregate passing the 75 µm sieve shall not exceed 15% by mass. Adequate measures shall be taken to manage the RAP source to ensure consistency and prevent contamination.

RAP containing steel slag or asbestos is not permitted. RAP that has become mixed with foreign matter of any description shall not be used.

334.05.02 Asphalt Modifier

The asphalt modifier shall be emulsified asphalt or liquid asphalt as specified in the Contract Documents.

Emulsified asphalt shall meet the requirements of OPSS 1103 and be either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt, as specified in the Contract Documents.

Liquid asphalt shall be according to OPSS 1102.

334.06 EQUIPMENT

334.06.01 Production and Processing Equipment

Crushing or milling equipment and screening equipment shall be used to generate and process the RAP to the size specified in the mix design. Material shall be handled in such a way as to prevent recompaction of the material before mixing takes place.

334.06.02 Mixing Equipment

The mixing unit shall be capable of producing a uniform thoroughly blended CRM consisting of RAP and asphalt modifier. The RAP feed system to the mixing unit shall be equipped with a means of determining the mass of material being deposited into the mixing unit prior to the addition of the asphalt modifier. The mixing unit shall be capable of continuously maintaining the amount of asphalt modifier added within $\pm 0.2\%$ by weight of the RAP. All measuring devices shall be calibrated according to the manufacturer's specifications at the start of the Contract and whenever deemed necessary by the Contract Administrator.

The asphalt modifier supply system shall identify and display flow and delivery information.

334.06.03 Placing Equipment

Placing of the CRM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. 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.

334.06.04 Compaction Equipment

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

334.06.05 Drying Unit

The drying unit shall be specifically designed to provide radiant heat to the CRM mat. 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.

334.06.06 Straight Edge

A 3 m commercially made metal straight edge is required. The straight edge shall have a level recessed in its upper surface, parallel to the lower edge.

334.06.07 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

334.07 CONSTRUCTION

334.07.01 Operational Constraints

The placing of CRM 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. After September 1st, written approval must be obtained from the Contract Administrator prior to CRM paving.

The work shall be carried out when the roadway is clean and free of standing water. CRM shall not proceed during periods of rain.

The wearing surface shall not be placed on the CRM mat until the following requirements have been met:

- a) The CRM mix has been allowed to cure for a minimum of 14 Days. The curing period may be shortened with the approval of the Contract Administrator.
- b) The average in situ moisture content of the CRM is 2% or less with no test value greater than 3% immediately prior to placing the wearing surface.
- c) The specified density has been achieved.
- d) All defective areas in the CRM mat have been repaired to the satisfaction of the Contract Administrator.

The wearing surface shall be placed within 30 Days of placing the CRM mat, provided the CRM mix meets the requirements of this specification.

All traffic, including construction traffic, shall be kept off the freshly placed CRM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CRM mat.

334.07.02 Mixing

The asphalt modifier shall be added at the design rate. The rate of addition of asphalt modifier may be adjusted as required to within 0.5% of the design rate or to the maximum field rate adjustment of the design rate allowed according to the mix design, whichever is less, to produce a uniformly coated CRM mix that can be compacted to the required density.

334.07.03 Compaction

The CRM shall be compacted to a minimum of 96% of the laboratory bulk relative density as determined by the submitted mix design, according to LS-300.

CRM that cannot be compacted to the required density shall be removed and replaced according to Table 1.

334.07.04 Surface Appearance

The compacted CRM surface shall be smooth and conform to the crossfall and grade specified in the Contract Documents. The surface of the CRM mat shall be of uniform texture and free of segregation, longitudinal streaks, fat spots, oil spills, roller marks, and other defects.

334.07.05 Drying

Prior to the placement of the wearing surface, the Contractor may elect to use a drying unit. Overheating or burning of the CRM shall not be allowed.

334.07.06 Sampling

334.07.06.01 General

The Contract Administrator may apply security seals to the samples taken for Quality Assurance (QA) testing.

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.

The Contractor may carry out quality control sampling and testing of the CRM mat.

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310 or OPSS 313, as appropriate to the Contract, using surface course HMA or other material approved by the Contract Administrator.

334.07.06.02 Compaction

After initial compaction, a minimum of three samples of the compacted CRM shall be obtained by the Contractor, at random locations as determined by the Contract Administrator, for each full day or partial day of production. These samples shall be used for compaction testing.

Samples shall be removed intact from the pavement in sufficient quantities to carry out testing according to the MTO Laboratory Testing Manual.

334.07.06.03 Moisture Content

At least 4 Business Days prior to the planned overlay of the CRM mat, the Contractor shall obtain 2 slab samples of the CRM mix for each subplot taken at random locations, as directed by the Contract Administrator.

The moisture content shall be determined in accordance with LS-291. The Contractor shall test one of the duplicate samples and the other shall be delivered to the testing laboratory designated in the Contract Documents.

Each sample shall be dry cut 150 x 150 mm and removed intact from the pavement. It shall be packaged to protect sample integrity, appropriately labelled, sealed in waterproof containers, and delivered by the Contractor in good condition to the designated testing laboratory within 24 hours of sampling.

If a sample condition is found to be unsuitable for testing by the laboratory, the Contractor shall be notified immediately by the Contract Administrator to resample that location.

334.07.06.04 Asphalt Modifier

Samples of the asphalt modifier used in the mix, shall be obtained, labelled, properly identified, and delivered within 5 Business Days of sampling to the testing laboratory designated in the Contract Documents. Each sample of material shall be a minimum of 2 full four-litre containers.

Samples shall be taken at the job site from each tanker load of material. Each sample shall be taken after a minimum of 4,000 kg has been drawn from the tanker, from a sampling spigot on the transfer line, if available, or from the end of the transfer line.

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.

334.07.07 Traffic Convoy

When specified in the Contract Documents, the Contractor shall convoy traffic 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 CRM mat is able to carry traffic without damage.

334.07.08 Management of Excess Material

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

334.08 QUALITY ASSURANCE

334.08.01 General

The Contract Administrator shall reject all visually defective material, mix, or work according to Table 1. Such defective material, mixture, and work shall not be incorporated into the finished work.

QA testing shall be carried out at a laboratory currently certified by CCIL with Type A or Type B certification or equivalent. Samples shall be used to determine compliance for moisture content and compaction. Acceptance criteria shall be based on the lot mean computed from QA test results for each subplot within the lot.

If a tested sample fails to meet the Contract requirements, the Contractor shall be notified of the failure by the Contract Administrator within 24 hours of the Contract Administrator receiving the information.

334.08.02 Lot Size

A lot shall consist of a single day's production of CRM processed to a given mix design. Each lot shall be divided into a minimum of 3 equal sublots of 5,000 m² or smaller.

334.08.03 Surface Tolerance

After compaction, the surface of the CRM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

334.08.04 Acceptance Criteria for Moisture Content

The moisture content shall be determined according to LS-291. The mean moisture content for each lot shall be less than 2.0% with no subplot moisture content exceeding 3.0%.

334.08.05 Acceptance Criteria for Compaction

The compaction of the CRM mix shall be determined according to LS-306. Each lot of CRM mix shall be compacted to a minimum mean of 96.0% of the target density established for the mix with no subplot result falling below 95.0%.

334.08.06 Asphalt Modifier

The supplied emulsified asphalt samples shall be according to OPSS 1103 for the particular type and grade, when tested according to the test methods specified.

The supplied liquid asphalt samples shall meet the requirements of OPSS 1102 for the particular type and grade, when tested according to the test methods specified.

Failure of the sample to conform to any of the material requirements shall be cause for rejection of the material. The CRM that has incorporated asphalt modifier represented by the failed test result shall be unacceptable and remedial measures up to and including removal and replacement of the deficient mix shall be negotiated with the Contract Administrator.

334.08.07 Repair of Unacceptable Cold Recycled Mix Mat

The CRM mat that is unacceptable shall be repaired or removed and replaced as specified in Table 1. Repairs shall be for the full width of recycling to the depth specified in Table 1. Removal shall be for the full depth and lane width of recycling. Reprocessing may be considered as a repair method, upon submission of a proposal by the Contractor and approval by the Contract Administrator.

334.09 MEASUREMENT FOR PAYMENT**334.09.01 Actual Measurement****334.09.01.01 Cold Recycled Mix**

Measurement of the CRM placed shall be by area in square metres.

334.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

334.10**BASIS OF PAYMENT****334.10.01****Cold Recycled Mix - Item**

Payment at the Contract price for the above items shall be full compensation for all labour, Equipment, and Material to do the work.

Asphalt modifier is included in the cold recycled mix item.

Samples found to be unsuitable for testing upon delivery to the laboratory shall be resampled at no cost to the Owner.

Repair to or removal and replacement of unacceptable CRM mat shall be carried out at no cost to the Owner.

HMA required to replace unacceptable CRM material shall be at no cost to the Owner.

TABLE 1
Unacceptable CRM Mix and Required Repairs

Deficiency Type	Severity	Required Repair
Ravelling/Coarse Aggregate Loss (Note 1)	Very Slight to Slight	No action required.
	Moderate to Severe	Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
	Very Severe	Remove all CRM material and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Segregation (Note 2)	Slight to Medium	No action required.
	Severe	Mill 50 mm and replace with same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Moisture content could not be achieved as per the Acceptance Criteria for Moisture Content subsection.	N/A	Remove all CRM material in the subplot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Compaction could not be achieved as per the Acceptance Criteria for Compaction subsection.	N/A	Remove all CRM material in the subplot represented by the test and replace with CRM or the same HMA to be used on surface course or an acceptable HMA as specified in the Contract Documents.
Notes: 1. Deficiency and severity definitions according to SP-027. 2. Deficiency and severity definitions according to Field Guide for the Acceptance of Hot Mix and Bridge Deck Waterproofing. A. The HMA shall be placed in compacted lift thicknesses between 40 and 75 mm.		

Appendix 334-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

The designer should specify the following in the Contract Documents:

- Type of asphalt modifier (i.e., emulsified asphalt or liquid asphalt modifier). (334.05.02)
- Type of wearing surface. (334.07.01)
- Crossfall and grade. (334.07.04)
- Location of testing laboratory. (337.07.06.01, 334.07.06.02, 334.07.06.03, 334.07.06.04)
- Replacement HMA to be used. (334.08.07)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- The emulsified asphalt as either a mixing grade polymer modified high float emulsified asphalt or a mixing grade high float emulsified asphalt. (334.05.02)
- Traffic convoy requirements. (334.07.07)

CRM can be a cost-effective paving material for structural improvement of low volume roads.

CRM is susceptible to moisture intrusion and ravelling, and must be sealed with a wearing surface. Typically, cold recycled mix is overlain with a surface treatment or single lift hot mix overlay. For higher traffic volume application, multiple lifts of hot mix may be considered.

Designer should be aware of when setting up quantities, due to the variability of RAP, field adjustment of the quantity of asphalt modifier may be required.

Currently, there is no standardized mix design methodology for CRM.

Designer should address the issue of RAP ownership and quality of RAP during the preparation of contract specifications. Identify who owns the RAP and who is responsible for RAP quality.

CRM contracts should be tendered to allow for placement in warm summer months to achieve proper curing of the CRM mat.

A single contract incorporating placement of CRM and wearing surface is recommended.

Since payment for the CRM is by the square metre, the designer should ensure that grade preparation is part of the CRM contract.

A tack coat is recommended prior to surfacing CRM with HMA.

When specifying liquid asphalts, the designer should consider the environmental aspects of the product.

Appendix 334-A

Contract scheduling should allow for CRM paving and follow-up wearing surface placement to be completed within the time and temperature operational constraints.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here



CONSTRUCTION SPECIFICATION FOR COLD IN-PLACE RECYCLED EXPANDED ASPHALT MIX

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335-A	Commentary

335.01 SCOPE

This specification covers the requirements for cold in-place recycling of existing hot mix asphalt (HMA) pavement; sizing; adding corrective aggregate or active filler or both, 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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 310 Hot Mix Asphalt

Ontario Provincial Standard Specifications, Material

OPSS 1003 Aggregates - Hot Mix Asphalt
OPSS 1101 Performance Graded Asphalt Cement
OPSS 1301 Cementing Materials

Ontario 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-625 Sampling of Granular Materials
SP-027 Manual for Assessment of Surface Defects of In-Place Recycled Pavement Mats

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

ASTM International

D 6752-09 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

Wirtgen GmbH Publication

Wirtgen Cold Recycling Technology manual, 3rd edition, 2010

335.03 DEFINITIONS

For the purpose of this specification, definitions shall be as per SP-027.

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 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 design rate of the expanded asphalt shall be a minimum of 1.0%. The dry tensile strength shall be a minimum of 225 kPa and the wet tensile strength shall be a minimum of 100 kPa. The tensile strength ratio shall be a minimum of 50%.

The mix design shall be carried out according to the Wirtgen Cold Recycling Technology manual using briquettes produced according to LS-297. Mix design work shall be completed by a laboratory with CCIL Type A certification or equivalent equipped to carry out expanded asphalt mix design. 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 the 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 affects to the 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.

335.04.02 Submission Requirements

The mix design shall be submitted by the Contractor to the Contract Administrator a minimum of 7 Days prior to the start of CIREAM operations. When more than one mix design is required, the area for which each mix design is to be used shall be clearly identified.

A new mix design shall be submitted when the expanded asphalt design rate is adjusted by greater than 0.2%. Separate or new mix designs shall be submitted if the composition or layer thicknesses or both of the existing pavement changes significantly.

335.05 MATERIALS

335.05.01 Active Filler

If required by the mix design, active filler shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined by the mix design.

When used as active filler, Portland cement shall be according to OPSS 1301. No more than one percent by mass of Portland cement shall be added to the mix.

335.05.02 Corrective Aggregate

If required by the mix design, corrective aggregate shall be incorporated into the reclaimed existing asphalt pavement at the application rate determined in the mix design. Corrective aggregate shall meet the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.05.03 Performance Graded Asphalt Cement

The Contractor shall select a PGAC with suitable expansion characteristics. PGAC shall be according to OPSS 1101, excluding PGAC zone requirements.

335.05.04 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.

335.05.05 Water

Water shall be clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

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 sizing unit capable of processing the RAP to meet the requirements of this specification.

- 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 at the start of the Contract 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 equipped with a device capable of producing a uniform and thoroughly blended CIREAM.

Alternative equipment may be considered subject to approval by the Contract Administrator and demonstration of meeting the requirements of the Cold In-Place Recycled Expanded Asphalt Trial Section subsection.

335.06.02 Placing Equipment

Placing of the CIREAM shall be carried out by means of a self-propelled mechanical paver capable of spreading the mix evenly in front of the screed in one continuous pass to the specified crossfall and grade. 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

The Contractor shall select the appropriate compaction equipment to achieve the required compaction.

335.06.04 Pilot Vehicle

The pilot vehicle shall be according to the requirements of the OTM, Book 7.

335.06.05 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.

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.

335.07.02 Operational Constraints

CIREAM shall not be placed after September 1st without written approval from the Contract Administrator.

The work shall be carried out when the roadway is clean and free of standing water. CIREAM shall not proceed in the rain.

All traffic, including construction traffic, shall be kept off the freshly placed CIREAM mat until it is able to carry traffic without damage. The Contractor shall be responsible for repair of the damaged CIREAM mat.

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 Recycled Expanded Asphalt Trial Section

Prior to carrying out CIREAM on the Contract, the Contractor shall demonstrate to the Contract Administrator the ability to successfully carry out CIREAM 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 CIREAM with the same equipment, placing crew, and methodology to meet the Contract requirements for placing CIREAM on any Contract within the last 12 months.

The trial section shall be one lane width and 500 m in length. The Contractor shall propose the location of the trial section to the Contract Administrator for approval. The Contractor shall give the Contract Administrator a minimum of 48 hours notice prior to placing the trial section.

The Contract Administrator shall allow the Contractor to continue the CIREAM work 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 Contractor shall repeat additional trial sections until the CIREAM meets the requirements of this specification.

The Contractor shall be responsible for the repair, removal, or replacement of an unacceptable trial section.

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 at 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 minimum percent of expanded asphalt added shall be 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 shall be according to the crossfall and grade specified in the Contract Documents. The surface of the CIREAM mat shall be of uniform texture and shall be free of segregation, longitudinal streaks, flushing, fat spots, oil spills, roller marks, and other defects.

335.07.08 Sampling

335.07.08.01 General

Holes resulting from the removal of samples shall be repaired according to the sampling provisions of OPSS 310, using an acceptable binder course HMA or other material approved by the Contract Administrator.

335.07.08.02 Cold In-Place Recycled Expanded Asphalt Mix

After placement and prior to compaction, the Contractor shall obtain one 15 kg sample of the CIREAM from each 5,000 m² placed, 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, wet tensile strength, and tensile strength ratio according to LS-297.

Prior to the planned overlay of the CIREAM mat, the Contractor shall obtain 2 slab samples of the CIREAM from each 5,000 m² placed, to be taken at random locations as directed by the Contract Administrator. One slab sample shall be used to test for moisture content and the other shall be used to test for compaction. Each slab sample shall be dry cut 150 x 150 mm and removed intact from the CIREAM mat.

The samples shall be packaged in non-absorptive materials to protect sample integrity, sealed in waterproof containers, appropriately labelled, and delivered by the Contractor in good condition within 48 hours of sampling to the designated QA testing laboratory specified in the Contract Documents.

Additional slab samples to test for compaction shall only be taken once the Contractor has carried out remedial work to improve compaction in the failed areas. The Contractor shall be charged the cost of additional testing.

The Contractor shall be permitted to carry out QC sampling and testing of the CIREAM mat.

335.07.08.03 Corrective Aggregate

The Contract Administrator may request samples of the corrective aggregate to demonstrate conformance to the requirements of this specification. When requested, two 25 kg samples shall be taken in the presence of the Contract Administrator.

QA samples shall be taken in accordance with procedures given in LS-625 and at the time and location determined by the Contract Administrator.

Samples of the corrective aggregate shall be obtained, properly labelled and identified, and delivered within 48 hours of sampling to the designated QA testing laboratory as specified in the Contract Documents.

335.07.08.04 Active Filler

The Contract Administrator may take samples of active filler to demonstrate conformance to the requirements of the Contract Documents.

335.07.09 Traffic Convoy

The Contractor shall convoy traffic 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 CIREAM mat is able to carry traffic without damage.

335.07.10 Management of Excess Material

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

335.08 QUALITY ASSURANCE

335.08.01 General

Acceptance shall be based on QA testing. QA testing shall be carried out by a laboratory currently certified by CCIL with Type A or Type B certification or AMRL accredited or equivalent laboratory.

Acceptance criteria shall be based on the QA test results for each 5,000 m² placed.

The Contract Administrator shall reject all unacceptable material and all visually defective-material, mix, or work as shown in Table 1. Defective material, mixture, and work shall not be incorporated into the finished work.

If the CIREAM does not meet the requirements of the specification within 30 Days after placing the CIREAM mat, it shall be deemed unacceptable.

335.08.02 Surface Tolerance

After compaction, the surface of the CIREAM mat shall be free from deviations exceeding 6 mm, as measured in any direction with a 3 m straight edge.

335.08.03 Acceptance Criteria for Compaction

The CIREAM shall be compacted to a minimum of 96% of the target density.

Compaction shall be calculated for each 5,000 m² placed 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%

The target density to be used for acceptance purposes shall be calculated for each 5,000 m² placed by averaging the densities of 6 compacted specimens produced for indirect tensile strength testing according to LS-297.

335.08.04 Acceptance Criteria for Cold In-Place Recycled Expanded Asphalt Mix

Acceptance of the CIREAM shall be based on dry tensile strength, wet tensile strength, and tensile strength ratio.

Samples of CIREAM shall be tested for acceptance purposes in accordance with LS-297.

Dry tensile strength requirements for each 5,000 m² placed are met when the dry tensile strength of the sample is equal to or greater than 225 kPa.

Wet tensile strength requirements for each 5,000 m² placed are met when the wet tensile strength of the sample is equal to or greater than 100 kPa.

The tensile strength ratio for the individual samples shall not be less than 50%.

CIREAM that does not meet the above dry tensile strength, wet tensile strength, and tensile strength ratio requirements shall be deemed unacceptable.

335.08.05 Acceptance of Corrective Aggregate

QA testing may be carried out to ensure that corrective aggregate to be used in the work is according to the physical and consensus property requirements of OPSS 1003, with the exception of the sand equivalent test, for the coarse and fine aggregates of Superpave 19.0 binder course.

335.08.06 Repair of Unacceptable CIREAM

CIREAM that is unacceptable shall be repaired as shown in Table 1.

Repairs shall be for the full lane width and minimum length of 15 m to the depth shown in Table 1.

The HMA required to repair unacceptable CIREAM shall be placed in compacted lift thickness between 40 to 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.

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 corrective aggregate or active filler to the mix 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 unacceptable CIREAM mat shall be carried 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 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.
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) Recompact 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, Commentary for OPSS.MUNI 335, 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

Cold in-place recycling with expanded asphalt (CIREAM) is suitable for treating a wide range of pavement distresses. CIREAM can repair pavements exhibiting age; thermal, fatigue, or reflective cracking and previously recycled pavements and is beneficial in mitigating reflective cracking. CIREAM is not suitable for pavements with extensive base or subbase problems, pavements containing steel slag, or pavements of insufficient strength.

The designer should specify the following in the Contract Documents:

- Depth of CIREAM. (335.07.01)
- Grade and crossfall. (335.07.07)
- Designated testing laboratory. (335.07.08.02, 335.07.08.03)

The designer should determine if the following is required and, if so, specify it in the Contract Documents:

- Additional items for milling or padding or both if significant crossfall deficiencies exist in the existing pavement surface. (335.07.04)

It is recommended that adequate pre-engineering be carried out on the project and that existing pavement thicknesses and composition be established. Additional investigation should be carried out when pavement composition changes, such as patched areas. Pre-engineering data should be included in the Contract Documents.

Corrective aggregates are used when existing pavements are experiencing rutting, shoving, or flushing and it is suspected that the existing bituminous material is the cause of these distresses. Corrective aggregate may also be required to achieve mix design properties.

Any full depth repairs required for frost heave and distortion corrections should be repaired prior to CIREAM.

In urban areas, the designer should be aware of appurtenance adjustment requirements, curb heights, and accessibility concerns to accommodate the CIREAM equipment train and the requirement for traffic detours.

Contract scheduling should allow CIREAM and follow-up pavement to be completed within the time and operational constraints.

The designer should be aware that severe distresses (e.g., significant alligator cracking, map cracking) may create an abundance of oversize material and remediation (e.g., pre-milling, pre-pulverizing) needs to be addressed to meet gradation requirements.

The designer should be aware that the length of CIREAM paving operation may affect traffic management.

Appendix 335-A

It is recommended to have at least 25 mm of remaining HMA pavement below the CIREAM.

CIREAM is typically overlaid with a HMA wearing course. Surface treatment, slurry surfacing, or microsurfacing may be considered.

A tack coat is recommended prior to paving HMA wearing course.

QC requirements have been removed from this specification, as acceptance is based on QA testing. If an Owner requires Contractor QC to confirm that the work meets the specification requirements, a special provision detailing the required Contractor QC should be included in the Contract Documents.

The payment clause for this specification is all inclusive. Should a municipality desire to pay for corrective aggregate, active filler, or asphalt cement separately, separate payment items are required.

In times of volatile asphalt cement prices, on multi-year contracts, and on Contracts with greater than 1,000 tonnes of paver laid CIREAM material, designers may consider using the MTO PGAC price index for payment adjustment. The MTO PGAC price index is available on the Ontario Ministry of Transportation website at www.raqs.mto.gov.on.ca, by clicking on Contractor, Contract Bulletin, Asphalt Price Index. The MTO PGAC price index is only a tool for qualifying PGAC prices and is not intended as a standard asphalt cement price to be incorporated into the contract bid. The MTO PGAC price index calculation for a given month takes in the average of the 4 weeks of the month and is published on the last day of the month.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONCRETE CURB AND GUTTER SYSTEMS

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353-A	Commentary

353.01 SCOPE

This specification covers the requirements for the construction of concrete curb and gutter, setbacks, gutter outlets, and bullnoses together with the installation of catch basin frames and grates which lie within the flow lines of the curb and gutter system.

353.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

353.01.02

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.

353.02

REFERENCES

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-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 314	Untreated Granular Subbase, Base, Surface Shoulder, and Stockpiling
OPSS 350	Concrete Pavement and Concrete Base
OPSS 407	Construction of Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 501	Compacting
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete
OPSS 919	Formwork and Falsework

Ontario Provincial Standard Specifications, Material

OPSS 1212	Hot Poured Rubberized Asphalt Joint Sealing Compound
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 1850	Frames, Grates, Covers, and Gratings

353.03 DEFINITIONS

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

Cold Joint means as defined in OPSS 904

Concrete Pavement means concrete pavement or concrete base.

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.

353.05 MATERIALS

353.05.01 Concrete

Concrete shall be according to OPSS 1350. Concrete shall also be according to the following requirements:

- a) Minimum specified 28-Day compressive strength: 30 MPa

Concrete shall also be according to the following requirements:

- a) Coarse Aggregate: 19.0 mm nominal maximum size
- b) When used supplementary cementing material shall be ground granulated blast furnace slag or fly ash or a combination of the two materials and shall be restricted to the following proportions by mass of the total cementing material:
 - 1) Slag up to 25%; or
 - 2) Fly ash up to 10%, or
 - 3) A mixture of slag and fly ash up to 25% except the amount of fly ash shall not exceed 10% by mass of the total cementing materials.

353.05.02 Catch Basin Frames and Grates

Catch basin frames and grates shall be according to OPSS 1850.

353.05.03 Joint Materials

Expansion joint fillers shall be according to OPSS 1308 for types A or B except that granulated cork fillers shall not be accepted.

Hot rubberized asphalt joint sealing compound shall be according to OPSS 1212.

353.05.04 Curing Compound

Curing compound shall be according to OPSS 1315.

353.05.05 Forms

Forms shall be according to OPSS 919.

353.05.06 Steel Reinforcement

Steel reinforcement shall be according to OPSS 1440.

353.07 CONSTRUCTION

353.07.01 General

The Construction section applies equally to concrete curb and gutter, concrete spillways, and concrete gutter outlets.

353.07.02 Foundation and Backfill

Excavation and embankment construction shall be according to OPSS 206.

Granular base and granular backfill construction shall be according to OPSS 314.

353.07.03 Compaction

Compaction shall be according to OPSS 501.

353.07.04 Steel Reinforcement

Placement of steel reinforcement shall be according to OPSS 905.

353.07.05 Formwork

Formwork shall be according to OPSS 919 and shall be set true to the lines and grades specified in the Contract Documents and in direct contact with the subgrade or granular course.

353.07.06 Slipform

Slipform paving equipment is acceptable for use provided the slipform product meets the specified cross-sectional requirements.

353.07.07 Joints

When concrete curb and gutter is constructed adjacent to concrete pavement, the transverse joint spacing of the curb and gutter shall coincide with that of the concrete pavement. When concrete curb and gutter is constructed adjacent to asphalt pavement, transverse joints shall have a uniform spacing not exceeding 5 m. In addition to the foregoing, joints shall be constructed between the curb structure, including catch basin frames, setbacks, and gutter outlets.

Joints, including those between curb and gutter systems and any abutting sidewalk, catch basin frames, setbacks, gutter outlets, or any structure, shall be formed with 12 mm thick panels of joint filler except as follows:

- a) Contraction joints in extruded curb and gutter and in formed curb and gutter shall be saw cut.
- b) Longitudinal joints, as shown in the Contract Documents, shall be sawn between a curb and gutter system and concrete pavement and shall be according to OPSS 350, when the curb and gutter

system is placed adjacent to the concrete pavement. The joint shall be sealed with liquid joint sealer and shall be according to OPSS 350.

Joint filler panels shall be set in a vertical position and, if for transverse joints, shall be set normal to the inside edge of the structure.

Panels shall be precut from a single piece of joint filler to the shape of the curb and gutter cross-section as shown in the Contract Documents, but so as to provide a 6 mm recess on the exposed surfaces. Cutting and tolerances shall be according to OPSS 1308.

Expansion joint material shall be set in place before concrete placement begins and shall be supported by removable forms.

All concrete immediately above the filler material shall be carefully removed to form a 6 mm deep, 12 mm wide recess then finishing both edges of each joint to 5 mm radius with a suitable short edging tool.

Contraction joints shall be formed within a sufficient time of placing of the curb and gutter to prevent uncontrolled cracking. The width of the joint shall be 3 to 5 mm and a minimum depth of 65 mm.

353.07.08 Concrete

353.07.08.01 Placement of Concrete

Concrete shall not be placed until the base course, on which the concrete is to be placed, and the forms or stringline have been inspected by the Contract Administrator.

Before placing concrete, the subgrade immediately ahead of the concrete placing shall be wetted by means of a uniform spray of water sufficient to wet the subgrade thoroughly without leaving standing water.

The concrete shall be placed and consolidated such that segregation of the aggregate does not occur.

Concrete shall be placed continuously. If placement of concrete is interrupted, recommencement of the placement operation shall be against a vertical formed joint. A 5mm bituminous fibre joint filler shall be placed at the point of interruption before recommencing placement of concrete. Cold joints shall not be permitted.

The concrete shall be thoroughly consolidated against all formwork and all entrapped air shall be eliminated.

353.07.08.02 Concrete Finishing

The concrete on the upper surfaces shall be floated to a smooth uniform finish of the required cross-section, free of open texturing, plucked aggregate, and local projections. Only hardwood or magnesium trowels shall be used for hand finishing.

Care shall be taken to avoid over finishing or working more mortar to the surface than is actually required. Back edges shall be rounded by use of a 5 mm radius edging tool. Neat cement shall not be used as a drier to facilitate finishing.

Any honeycombed areas occurring along the formed surfaces shall be filled with mortar composed of one part Portland cement and two parts sand with 12% of entrained air.

353.07.08.03 Concrete Curing

Formed and slipformed concrete shall be cured with one or more of the following methods:

- a) Burlap and water.
- b) Moisture vapour barrier.
- c) White pigmented curing compound.

For curing with burlap and water, the burlap shall be presoaked by immersing it in water for a period of 24 hours immediately prior to placing it. Two layers of burlap shall be applied to the surface of the concrete. Strips of burlap shall overlap 150 mm and shall be held down without marring the surface of the concrete. The burlap shall be applied immediately after finishing of the concrete surface, from 2 to 4 m from the finishing operation. The burlap shall be maintained continuously in a wet condition throughout the 96-hour curing period. The burlap shall be covered with a layer of moisture vapour barrier in a manner which 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 in conformance with the requirements of curing with moisture vapour barrier. The moisture vapour barrier shall be placed within 12 hours following placement of the concrete.

For curing with only a moisture vapour barrier, the moisture vapour barrier shall be placed immediately after finishing of the concrete surface, from 2 to 4 m from the finishing operation. Strips of moisture vapour barrier shall overlap a minimum of 150 mm. Air flow in the space between the moisture vapour barrier and the concrete surface shall be prevented. To achieve this, the moisture vapour barrier shall be held down at the edges and at all laps to prevent displacement. The material shall be kept in place for a minimum curing period of 96 hours.

Curing with curing compound shall not be used on any construction joint or when cold weather concreting is in effect.

The curing compound shall be agitated by mechanical means to provide a homogeneous mixture immediately prior to application. It shall be applied immediately after finishing of the concrete surface, from 2 to 4 m from the finishing operation, completely covering 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 surface shall be maintained in this condition for a minimum period of 7 Days. The rate of each application shall not be less than the rate specified by the manufacturer of the compound.

353.07.08.04 Concrete Tolerances

The exposed surfaces of the finished concrete shall be such that, when tested with a 3 m long straight edge placed anywhere along the surface parallel to the edge of curb face, there shall be no deviation greater than 3 mm between the bottom of the straight edge and the surface of the concrete nor shall there be any deviation from alignment in excess of 3 mm.

353.07.09 Cold Weather Concreting

Protection of concrete shall be according to OPSS 904. The components of the curb and gutter system shall be considered as slabs on the ground.

353.07.10 Catch Basin and Maintenance Hole Frames and Grates

Catch basin and maintenance hole frames and grates which lie within the flow lines of the curb and gutter system shall be installed as part of the construction of the various components making up the curb and gutter system. Frames shall be set to their final elevation according to OPSS 407. The exposed surfaces of the mortar bed shall be left in a smooth condition, free of depressions, and projections. All remaining formwork shall be removed.

353.07.11 Identification Stamp

At the request of the Contract Administrator, each end of the work and every 20 m shall be legibly marked with an approved stamp. The mark shall be located in the centre of an exposed face of the curb and gutter systems. The mark shall bear the Contractor's name and the year of construction.

353.07.12 Field Sampling and Testing of Concrete

Field sampling and testing of concrete shall be according to OPSS 1350.

Field sampling and testing of concrete shall be according to OPSS 1350.PROV.

353.07.13 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.

353.09 MEASUREMENT FOR PAYMENT

353.09.01 Actual Measurement

353.09.01.01 Concrete Curb and Gutter

Measurement of concrete curb and gutter shall be by length in metres along the flow line of the gutter whether straight or curved, without separation into types. Such measurements shall include the space occupied by setbacks, gutter outlets, and frames with grates.

353.09.01.02 Concrete Spillways

Measurement of concrete spillways shall be by length in metres along the flow line from the end of the gutter outlet to the spillway termination.

353.09.01.03 Concrete Gutter Outlets

For measurement purposes, a count shall be made of the number of setbacks and gutter outlets installed without separation into types.

353.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clause under Actual Measurement.

353.10 BASIS OF PAYMENT

353.10.01 Concrete Curb and Gutter - Item Concrete Spillways - Item Concrete Gutter Outlets - 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 roadbed granular material is measured in square metres, the Contract price for the above item shall be full compensation for all labour, Equipment, and Material for the material directly below or behind the concrete curb and gutter system.

There shall be no separate payment of concrete used for fillets in bullnoses.

353.10.02 Hot Mix Asphalt

Hot mix asphalt designated for constructing bullnose fillets shall be paid for at the Contract price for the appropriate Hot Mix Asphalt tender item.

353.10.03 Granular

Granular materials required for the work shall be paid for at the Contract price for the appropriate granular tender item.

353.10.04 Excavation

Excavation required to set the various components to the required line and grade shall be considered as part of the work of installing the curb and gutter system. When such excavation overlaps excavation required for any other work under the Contract, then payment shall be made in accordance with the specification for such other work as though no excavation were required for curb and gutter construction.

353.10.05 Steel Reinforcement

Costs for supplying and placing steel reinforcement are deemed to be included in the items for concrete curb and gutter systems.

Appendix 353-A, Commentary for OPSS.MUNI 353, 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

The designer should specify the following in the Contract Documents:

- Line and grade for curb and gutter systems. (353.07.05)
- Testing frequency. (353.07.12)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 600.010	Concrete Barrier Curb with Wide Gutter
OPSD 600.020	Concrete Semi-Mountable Curb with Wide Gutter
OPSD 600.030	Concrete Mountable Curb with Wide Gutter
OPSD 600.040	Concrete Barrier Curb with Standard Gutter
OPSD 600.060	Concrete Semi-Mountable Curb with Standard Gutter
OPSD 600.070	Concrete Barrier Curb with Standard Gutter, Two-Stage Construction
OPSD 600.080	Concrete Barrier Curb with Narrow Gutter
OPSD 600.090	Concrete Semi-Mountable Curb with Narrow Gutter
OPSD 600.100	Concrete Mountable Curb with Narrow Gutter
OPSD 600.110	Concrete Barrier Curb
OPSD 604.010	90° Concrete Outlet for Concrete Curb with Gutter
OPSD 605.010	45° Concrete Outlet for Concrete Curb with Gutter
OPSD 605.030	45° Concrete Outlet for Concrete Curb with Gutter at End of Run
OPSD 606.010	600 mm Radius Barrier Bullnose
OPSD 606.020	600 mm Radius Mountable Bullnose
OPSD 606.030	800 mm Radius Mountable Bullnose, Curb with Gutter Twin Inlet
OPSD 607.010	Over 600 mm Radius Mountable Bullnose
OPSD 607.020	Over 600 mm Radius Barrier Bullnose
OPSD 608.010	Method of Termination for Concrete Curb with Gutter



**CONSTRUCTION SPECIFICATION FOR
EXCAVATING, BACKFILLING, AND COMPACTING
FOR MAINTENANCE HOLES, CATCH BASINS,
DITCH INLETS, AND VALVE CHAMBERS**

TABLE OF CONTENTS

402.01	SCOPE
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402.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
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402.07	CONSTRUCTION
402.08	QUALITY ASSURANCE - Not Used
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402.10	BASIS OF PAYMENT

APPENDICES

402-A	Commentary

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 is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in 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 municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-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 25 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, roadways, 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.

Appendix 402-A, Commentary for OPSS.MUNI 402, 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

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer should specify the following in the Contract Documents:

- Type of backfill material. (402.05.02)
- Lines, elevations, and dimensions of structure excavation. (402.07.08.01)
- Investigate and resolve any overlapping work. (402.07.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 701.010 to 701.015	Precast Concrete Maintenance Holes, 1,200 mm to 3,600 mm in Diameter
OPSD 701.030 to 701.081	Precast Concrete Maintenance Hole Components, 1,200 mm to 3,600 mm in Diameter
OPSD 702.040 to 702.050	Precast Concrete Ditch Inlet Maintenance Hole, 1,200 mm x 1,200 mm
OPSD 703.011 to 703.015	Precast Concrete Single Inlet Flat Cap, 1,500 mm to 3,600 mm in Diameter
OPSD 703.021 to 703.024	Precast Concrete Twin Inlet Flat Cap, 1,500 mm to 3,000 mm in Diameter
OPSD 705.010 to 705.020	Precast Concrete Catch Basins
OPSD 705.030 to 705.040	Precast Concrete Ditch Inlets
OPSD 706.010 to 706.041	Precast Concrete Ditch Inlets with 1,500 mm to 3,000 mm Diameter Flat Cap
OPSD 1100.010	Cast-In-Place Chamber for Valves up to 350 mm Diameter
OPSD 1101.010	Precast Valve Chamber, 1,200 mm and 1,500 mm Diameter
OPSD 1101.012 to 1101.015	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1,800 mm x 2,400 mm
OPSD 1101.016 to 1101.019	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2,400 mm x 3,000 mm



**CONSTRUCTION SPECIFICATION FOR ROCK EXCAVATION FOR PIPELINES,
UTILITIES, AND ASSOCIATED STRUCTURES IN OPEN CUT**

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403.01	SCOPE
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403.05	MATERIALS - Not Used
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403.07	CONSTRUCTION
403.08	QUALITY ASSURANCE - Not Used
403.09	MEASUREMENT FOR PAYMENT
403.10	BASIS OF PAYMENT

APPENDICES

403-A	Commentary

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 is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

**Appendix 403-A, Commentary for OPSS.MUNI 403, 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

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the tender documents.

The designer should specify the following in the Contract Documents:

- Line and grade requirements 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. (403.07.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT

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441.07	CONSTRUCTION
441.08	QUALITY ASSURANCE - Not Used
441.09	MEASUREMENT FOR PAYMENT
441.10	BASIS OF PAYMENT

APPENDICES

441-A	Commentary

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 is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in 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 municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-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 442	Corrosion Protection of New and Existing Watermains
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

B137.1-13	[Part of B64 Series-11, Backflow Preventers and Vacuum Breakers Compendium] Polyethylene Pipe, Tubing and Fittings for Cold-Water Pressure Services
B137.2-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Polyvinyl Chloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications
B137.3-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Rigid Polyvinyl Chloride (PVC) Pipe and Fittings for Pressure Applications
B137.3.1-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe and Fittings for Pressure Applications
B137.10-13	[Part of B137-13, Thermoplastic Pressure Piping Compendium] Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure-Pipe Systems [Part of B137-13, Thermoplastic Pressure Piping Compendium]

ASTM International

A 153M-09	Zinc Coating (Hot Dip) on Iron and Steel Hardware
A 276-15	Stainless Steel Bars and Shapes
A 307-14	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
B 88-09	Seamless Copper Water Tube
B 633-13	Electrodeposited Coatings of Zinc on Iron and Steel
B 766-86 (2015)	Electrodeposited Coatings of Cadmium
C 361-14a	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/A21.10-12	Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-12	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151/A21.51-02	Ductile-Iron Pipe, Centrifugally Cast, for Water
C153/A21.53-11	Ductile-Iron Compact Fittings for Water Service
C200-15	Steel Water Pipe - 6 In. (150 mm) and Larger
C205-12	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger
C206-11	Field Welding of Steel Water Pipe
C208-12	Dimensions for Fabricated Steel Water Pipe Fittings
C301-14	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
C502-14	Dry-Barrel Fire Hydrants
C504-15	Rubber-Seated Butterfly Valves
C509-15	Resilient-Seated Gate Valves for Water Supply Service
C510-07	Double Check Valve Backflow Prevention Assembly
C800-14	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

Ministry of Environment and Climate Change (MOECC)

Watermain Disinfection Procedure

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.

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 and Associated Appurtenances 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.

441.05.16 Corrosion Protection

Corrosion protection shall be according to OPSS 442.

441.07 CONSTRUCTION

441.07.01 General

The work for the installation of watermain 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 in accordance with the MOECC Watermain Disinfection Procedure.

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

Appendix 441-A, Commentary for OPSS.MUNI 441, 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

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should include the following in the Contract Documents:

- Pipe size, type, and class. (441.05.01)
- Service line valve type, pressure class, and end connections. (441.05.09.02)
- Gate valve end configuration. (441.05.09.03)
- Type of hydrants. (441.05.10)
- Alignment and grade tolerances for the pipe installation. (441.07.14)
- Valve type and location. (441.07.18.01)
- Air release and air/vacuum valve locations. (441.07.18.02)
- Location of hydrant sets. (441.07.19)
- Location and size of service connections. (441.07.20)
- Thrust restraints. (441.07.23)

The designer should determine if valve boxes are needed and, if so, they should be specified in the Contract Documents. (441.07.18.01)

Tracer wire or tracer tape should be specified, if appropriate.

Under conditions of high ground water, external fluids may enter via air release and air/vacuum release valves; therefore, appropriate measures should be taken.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Appendix 441-A

Related Ontario Provincial Standard Drawings

OPSD 1101.012	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Components
OPSD 1101.013	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Riser and Base
OPSD 1101.014	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Thrust Blocks
OPSD 1101.015	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 1800 x 2400 mm, Chimney and Cap
OPSD 1101.016	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Components
OPSD 1101.017	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Riser and Base
OPSD 1101.018	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Thrust Blocks
OPSD 1101.019	Precast Concrete Valve Chamber with Poured-In-Place Thrust Blocks, 2400 x 3000 mm, Chimney and Cap
OPSD 1101.020	Valve Operator
OPSD 1101.030	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Components
OPSD 1101.031	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Riser and Base
OPSD 1101.032	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Thrust Blocks
OPSD 1101.033	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3000 x 3000 mm Chimney and Cap
OPSD 1101.040	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Components
OPSD 1101.041	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Riser and Base
OPSD 1101.042	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Thrust Blocks
OPSD 1101.043	Precast Concrete Valve Chamber With Poured-in-Place Thrust Blocks, 3600 x 3000 mm Chimney and Cap
OPSD 1103.010	Concrete Thrust Blocks for Tees, Plugs, and Horizontal Bends
OPSD 1103.020	Concrete Thrust Blocks for Vertical Bends
OPSD 1104.010	Water Service Connection, 19 and 25 mm Diameter Sizes
OPSD 1104.020	Water Service Connection, 32, 38, and 50 mm Diameter Sizes
OPSD 1104.030	25 mm Blow Off Installation
OPSD 1105.010	Hydrant Installation
OPSD 1107.010	Piping Layout for Water Meters 50 mm and Smaller in Chambers
OPSD 1107.020	Piping Layout for Water Meters 75 to 250 mm in Chambers with By-Pass
OPSD 1107.030	Piping Layout for Water Meters in Building with By-Pass
OPSD 1108.010	Cast-In-Place Water Meter Chamber for 75 to 250 mm Meters
OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems
OPSD 1109.012	Cathodic Protection off Existing Metallic Watermains, Exposed Service or Pipe Method
OPSD 1109.013	Anode Installation Over Pipe Method for Existing Metallic Watermains
OPSD 1109.014	Horizontal Anode Bank at Service
OPSD 1109.015	Vertical Anode Bank at Service
OPSD 1109.025	Waterproofing of Splices



**CONSTRUCTION SPECIFICATION FOR
CORROSION PROTECTION OF NEW AND
EXISTING WATERMAINS**

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APPENDICES

D 442-A	Commentary

442.01 SCOPE

This specification covers the requirements for providing corrosion protection to watermains and their metallic components using galvanic anodes, or petrolatum or petroleum wax tape coating systems, or both methods in typical soil conditions on new PVC watermains, new metallic watermains, and existing metallic watermains. Galvanic anode methods include the over pipe method, anode bank method, and exposed watermain methods.

This specification also covers the requirements for corrosion monitoring for concrete pressure pipe.

442.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

442.01.02 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.

442.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 441	Watermain Installation in Open Cut
OPSS 490	Site Preparation for Pipelines, Utilities, and Associated Structures
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures

CSA Standards

C22.2 No. 197-M1983 (2013) PVC Insulating Tape

ASTM International

B 418-14	Cast and Wrought Galvanic Zinc Anodes
B 843-09	Magnesium Alloy Anodes for Cathodic Protection
G 97-97(2013)	Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

American Water Works Association (AWWA)

C217-09	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel water Pipelines

Underwriters Laboratories of Canada (ULC)

UL 467-09	Grounding and Bonding Equipment

442.03 DEFINITIONS

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

Anode means the electrode of an electrochemical cell where corrosion occurs and metal ions enter solution. An anode refers to a packaged anode consisting of the casting, chemical packing material, lead wire, tube, and label.

Anode Chemical Packing means select materials used to surround an anode in its tube in order to improve current efficiency, reduce local corrosion of the anode casting, help keep the anode moist, and increase the effective anode size and, for zinc, prevent the passivation of the anode.

Anode Type means both the material and the size of the anode shown in Table 1, which is included in the A-WW-LL label on the outside of the anode. The A location indicates the casting alloy material, Z for zinc and M for magnesium. The WW indicates the weight of the casting in pounds and the LL indicates the length of the casting in inches.

Associated Appurtenances means structures, devices, and appliances, other than pipe and conduit that are used in connection with a water distribution system, such as valves, hydrants, saddles, corporation and main stops, curb stops, services, and thrust restraints.

Backfill means material placed in a hole to fill the space around the anodes and other portions of the project.

Bonding means the joining of metallic components together to ensure complete electrical continuity throughout the piping system.

Cathodic Protection means a technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Certified Cathodic Protection Specialist means a person that has received Cathodic Protection Specialist Certification by NACE International.

Coating means a dielectric material applied to a structure to separate it from the environment.

Corrosion Protection means corrosion control of a metal surface either by coatings or cathodic protection or both.

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

Fittings means as defined in OPSS 441.

Galvanic Anode means a metal that provides protection to metals that are more noble in the galvanic series when coupled in an electrolyte. This is in contrast to impressed current anode systems that use an external direct current power source between the cathode and anode bed.

Ground Clamp means a copper clamp device used to connect a wire to copper service tubing in order to create an electrical connection to earth.

Holiday means a discontinuity in the coating.

Mastic means a cold applied self-supporting petrolatum compound containing beads of closed cell polymer and flow control additives for molding irregular shapes.

Metallic Components means metallic hydrants, valves, fittings and associated appurtenances designed to be used in connection with pipes.

Metallic Watermain or Pipe means a ductile iron, cast iron, or steel watermain pipe, excluding copper services.

Negative Lead means the wire running from the watermain or service pipe to the test station.

Petrolatum means a purified mixture of semisolid hydrocarbons obtained from petroleum jelly.

Petroleum Wax means a refined mixture of solid hydrocarbons, paraffinic in nature, obtained from petroleum. It may be prepared as a refined paraffin wax or as a microcrystalline wax.

Primer means a soft compound of petrolatum or petroleum wax containing moisture displacing corrosion inhibiting compounds.

Tape means a cold applied saturant tape made from either petrolatum or petroleum wax and a noncellulosic synthetic fiber fabric.

Tape Coating System means the finished product consisting of the petrolatum or petroleum wax primer, mastic, where applicable, and tape.

Test Station means a pole or flush mounted terminal that is used to conveniently monitor electrical currents and potentials associated with galvanic cathodic protection systems.

Thermite Weld means a permanent low resistance electrical connection made by a powder welding process using an exothermic copper-depositing mixture ignited in a graphite mold.

Watermains means as defined in OPSS 441.

442.05 MATERIALS

442.05.01 Zinc and Magnesium Anodes

442.05.01.01 Zinc Anode Castings

Zinc anode castings shall have a high potential alloy composition according to ASTM B 418, Type II.

442.05.01.02 Magnesium Anode Castings

Magnesium anode castings shall have a composition according to ASTM B 843, Type M1-C, and have a minimum current efficiency of 50% and shall be according to ASTM G 97.

442.05.01.03 Steel Core of Anode Castings

The steel core of the anode castings shall be electro-galvanized and extend 75% of the anode length.

442.05.02 Anode Packaging

The magnesium and zinc anode castings shall be supplied complete with an anode lead wire and shall be centred in and surrounded by chemical packing material. The anode casting and chemical packing shall be contained within a biodegradable, water permeable cardboard tube of sufficient durability to permit normal handling without appreciable damage. Anode castings and overall packaging shall meet the requirements specified in Table 1.

442.05.02.01 Anode Chemical Packing Composition

The chemical packing material shall have an electrical resistivity of less than 45 ohm-cm when saturated with distilled water, a compacted density of 1.5 g/cm³, and the following composition:

<u>Chemical Packing Component</u>	<u>% by Volume</u>
Gypsum	77 ± 2%
Bentonite	15 ± 1%
Sodium Sulphate	8 ± 1%

442.05.02.02 Labelling

All anodes shall be labelled on the outside of the cardboard tube indicating the type and the specification designation OPSS 442, as follows:

a) For each zinc anode, each tube shall be labelled as follows:

A-WW-LL Anode According to OPSS 442 (e.g., Z-6-12 Anode According to OPSS 442)

b) For each magnesium anode, each tube shall be labelled as follows:

A-WW-LL Anode According to OPSS 442 (e.g., M-17-20 Anode According to OPSS 442)

The letters shall be a minimum of 25 mm in height.

442.05.03 Petrolatum and Petroleum Wax Tape Coatings

Petrolatum and petroleum wax tape coating system components shall be according to the material requirements of AWWA C217.

442.05.04 Wires

Bond wires shall be 450 mm in length with TWU or RWU-90 black insulation with AWG #4/7 strand copper wire or, when specified, AWG #1/0 - 19 strand copper wire.

Anode wires shall be 3.0 m in length of AWG #10/7 strand copper wire having RWU-90 insulation, blue for magnesium anodes, and white for zinc anodes, and shall be silver soldered to the steel core of the anode casting.

Anode header wires for anode banks shall be AWG #10/7 strand wire with red RWU-90 insulation.

Negative wires from test stations to ground clamps or pipe shall be AWG #10/7 strand wire with RWU-90 black insulation.

Wire for corrosion monitoring probes for concrete pressure pipe shall be AWG #10/7 strand wire with RWU-90 black insulation.

Wire for connecting the watermain negative wires from the pipe joint bonding wire of concrete pressure pipe to the test station shall be AWG #4/7 strand wire with RWU-90 black insulation.

442.05.05 Test Stations

Each test station shall consist of a non-conductive housing and lid and shall be either flush-mounted or post-mounted as specified in the Contract Documents. The lid shall be supplied with a stainless steel locking bolt and an Allen key head and shall be blue in colour. The terminal board shall include 5 stainless steel terminals and one nickel plated copper bonding or shorting strap. All terminals shall have two stainless steel nuts for locking purposes.

- a) Flush-mounted test stations shall be mounted on a 300 mm length of 150 mm diameter UV stabilized polyethylene or polycarbonate pipe.
- b) Post-mounted test stations shall be mounted on a 1,500 mm length of 32 mm diameter PVC or UV stabilized polyethylene pipe and fastened securely to a suitable support.

442.05.06 Thermite Welds

The thermite weld material shall be as follows:

Thermite Molds or Welders:

- a) Shall be suitable for the wire, connection type, and orientation.
- b) Shall have a handle and lid.
- c) Shall be made of graphite or synthetic graphite, be able to withstand high temperatures, and be designed to provide an average life of not less than 50 separate exothermic welds.
- d) Shall be from the same manufacturer as the weld metal.

Thermite Powder Cartridges:

- a) Shall be suitable for the pipe material.
- b) Weld metal shall contain vanadium, but not tin.
- c) Weld metal shall be sealed in a suitable capsule and be identified with the part number and size and type of metals to be connected, such as copper to steel or copper to ductile iron.
- d) The batch control numbers shall be packaged with the product prior to shipment from the factory.

Starting Material:

- a) When used, shall consist of aluminum, copper, and iron oxide materials. It shall not contain phosphorous or any caustic, toxic, or explosive substances.

- b) When used, shall be electrical igniters that have a lead length of 1.83 m or greater and use an electric ignition system that does not use spark ignition material.

Thermite Weld Protective Barrier Covers:

- a) Shall be moulded plastic domes filled with corrosion resistant compound on a base of thick elastomeric tape.
- b) Shall use an integrated primer in its adhesive.

Thermite Weld Protective Barrier Coatings:

- a) Shall bond firmly to surfaces without the use of primers and form a tough coating resistant to oxidizing, cracking, alligatoring, checking, loosening, or scaling.
- b) Shall be composed of heavy mastic with synthetic elastomeric additives in mixed solvent.

442.05.07 Miscellaneous Materials

Ground clamps for copper water services shall be UL 467 listed for direct burial, high strength, high conductivity, and a minimum of 80% copper alloy.

Direct Bury Lugs:

- a) Shall be one piece, high impact housing, pre-filled with silicone providing waterproof and corrosion proof protection and be designed for long term direct bury applications.
- b) Shall be able to connect to header wire without cutting the header wire.
- c) Shall tighten with a screwdriver.
- d) Shall have high impact housing without sharp edges to prevent cuts or handling discomfort.
- e) Shall be designed for use with wires from #14 to #10 AWG or larger and under 50 volts.

Wire splicing kits for cathodic protection systems shall be waterproof and suitable for direct bury applications.

C Taps shall be as specified in the Contract Documents.

The solder shall be 60% tin and 40% lead mix, resin core type.

Moisture proofing shall be fast drying sealant and bonding compound specifically designed for coating electrical connections.

Insulating putty shall be dielectric, easy to handle and apply, have excellent adhesion to surfaces, and be suitable for filling voids and irregular surfaces.

Self-amalgamating tape shall be made using modified silicone rubber compound that forms a moisture-proof abrasion-resistant bond. Tape shall have high dielectric strength, adhering to itself creating an immediate permanent bond even when wet.

Rubber splicing tape shall be 25 mm wide waterproof neoprene.

Electrical tape shall be 25 mm wide PVC electrical tape, rated for 600 V with a working temperature of -10 to 90 °C, and according to CSA C22.2 No. 197.

442.07 CONSTRUCTION

442.07.01 General

The methods for corrosion protection shall be as specified in the Contract Documents.

Anodes shall be installed complete with their cardboard tube container and enclosed chemical packing.

442.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

442.07.03 Transporting, Unloading, Storage, and Handling Materials

Anodes and other materials that can be damaged by exposure to the elements shall be stored in a clean dry secured enclosure until installation.

Anodes shall not be carried or lowered by their lead wires.

442.07.04 Anode Installation

442.07.04.01 Existing Metallic Watermains - Over Pipe Method

Prior to installation, the location for each anode and test station shall be marked with a white stake or white paint on paved areas and shall be approved by the Contract Administrator.

Anodes shall be of the type and spacing specified in Table 2. The first anode at each end of the watermain shall be within 3.0 m of the end of the watermain.

Anode locations may be shifted a maximum of 3.0 m to avoid driveways and other paved areas.

Each anode site shall be excavated with an auger or a vacuum excavator to expose the top of the pipe and accommodate the anode to be installed. The diameter of the hole shall be a maximum of 500 mm.

The anode wire shall be thermite welded to the metallic pipe and the connection protected.

The excavation shall be partially backfilled with native backfill so that the anode shall reside 300 mm above the watermain.

The excavation shall be backfilled with material matching the existing subgrade that shall be manually compacted and thoroughly watered. Granular subbase and base profiles shall be reinstated above the subgrade.

442.07.04.02 Existing Metallic Watermains - Anode Bank Method

The anode bank method applies to both vertical and horizontal anode banks for the purpose of retrofitting existing metallic watermains with cathodic protection.

Anodes and anode banks shall be of the type and spacing specified in Table 3.

Anode banks shall be installed on the side of the street opposite to the watermain. Anodes shall be installed so the centre of the anode is at the same depth as the service to which they are being attached or a minimum of 2.0 m below the finished grade, whichever is greater.

Each anode site shall be excavated with an auger or a vacuum excavator to expose the top of the pipe and accommodate the anode to be installed. The diameter of the hole shall be a maximum of 500 mm.

The anode leads shall be spliced to the header wires using one of the approved wire splicing methods.

442.07.04.03 Existing Metallic Watermains - Exposed Pipe or Service Method

The exposed pipe or service method applies when an existing watermain is not cathodically protected, and when the existing watermain or water services are exposed during the course of other work (e.g., another Utility installation or watermain break repair).

Anodes to be used for this application shall be magnesium type M-32-22.

Anodes shall be installed at least 1.5 m horizontally away from the watermain pipe and as deep as the bottom of the excavation. Anodes shall be spaced as far apart in the trench as the wires and trench permit.

The anode lead shall be electrically connected to the water piping by connecting to either:

- a) A copper or lead service pipe using a ground clamp.
- b) The watermain using the thermite weld procedure.

442.07.04.04 New Metallic Watermains and Copper Services

Anodes shall be of the type and spacing specified in Table 4.

Anodes shall also be installed as follows:

- a) On the lateral piping of each hydrant.
- b) At each metallic component.

Anodes shall be installed at least 1.0 m horizontally away from the watermain or service pipes and as deep as the bottom of the pipes. The minimum distance between anodes shall be 1.0 m.

442.07.04.05 New Polyvinyl Chloride Watermains with Metallic Components

Anodes shall be of the type and spacing specified in Table 5.

Anodes shall be installed at least 1.0 m horizontally away from the metallic component and as deep as the bottom of the metallic component. The minimum distance between anodes shall be 1.0 m.

442.07.04.06 New Watermains with Metallic Components

All metallic components specified in the Contract Documents shall be protected using corrosion protection methods as specified in the Contract Documents.

442.07.05 Corrosion Monitoring for Concrete Pressure Pipe

The locations for corrosion monitoring test stations shall be as specified in the Contract Documents.

All concrete watermains shall include bonding wires connected by thermite weld to provide electrical continuity. Galvanic zinc anodes are recommended.

All concrete pressure pipe sections, including pipe within jacking and boring encasement pipe and all bevel and bend fittings shall have two electrical bonding connections on each side, located 45° off the vertical.

Corrosion test monitoring stations for concrete pressure pipe shall include three probes or pipe coupons at each station. The probes shall be connected to the test monitoring station with approved wire.

442.07.06 Test Station Installation - General

Test stations shall be installed at locations as follows:

- a) Where they do not interfere with or present a hazard to pedestrian or vehicular traffic and at the nearest property line, whenever possible.
- b) For new metallic watermains, over pipe method, and concrete pressure pipe, at each hydrant and, if there are no hydrants, start within 20 m of the project limit and locate at 150 m intervals along the watermain.
- c) At each anode bank.

Flush-mounted test stations shall be installed flush with the ground, sidewalk, or pavement surface. Post-mounted test stations shall be mounted so that the top of the cover is 600 mm above the surface.

The anode lead may be extended using an additional length of the same type of wire spliced with an approved splice connection method.

Except for corrosion monitoring applications, test station connections shall be as follows:

- a) The two negative leads shall be brought into the test station and connected to terminals 2 and 3.
- b) Terminal 1 shall be connected to Terminal with a bonding strap.
- c) No bonding strap shall be connected to terminal 3 or 4.

Sufficient wire slack of 0.5 m in the housing below the panel shall be left in the wires to prevent any stress on either during backfilling and subsequent soil settlement and for withdrawing the terminal panel, if necessary during test work.

442.07.06.01 Test Station Connections for New Metallic Watermains

The lead wire of the anode nearest to the test station shall not be welded directly to the pipe, but instead shall be brought into the test station and connected to terminal 1.

Two watermain negative wires shall be thermite welded to the crown of the watermain pipe 150 mm apart and the other ends of the wires shall be connected according to the Test Station Installation - General subsection.

442.07.06.02 Test Station Connections for Anode Banks

The header wires shall be brought into the test station and connected to terminal 1.

Two watermain negative wires shall be attached to the metallic service line, each with their own ground clamp and the other ends of the wires shall be connected according to the Test Station Installation - General subsection.

442.07.06.03 Test Station Connections for Corrosion Monitoring

Two watermain negative wires shall be connected to the concrete pressure pipe joint bonding wires with an approved splice connection method. The other ends of the wires shall be connected to terminals 1 and 2 of the test station. The three probe or pipe coupon wires shall be brought into the test station and connected to terminals 3, 4, and 5.

442.07.07 Thermite Weld Connections

All wire connections to metallic surfaces shall be made by means of a thermite weld method according to the following procedure:

- a) Remove all coating, and clean bright and thoroughly dry a 75 mm² metal welding surface .
- b) Select the proper mould for the application.
- c) Insert bared end of wire into mould. A reinforcing sleeve may be required, depending on flexibility of wire. Manufacturer's instructions shall be followed.
- d) Thermite weld the anode lead to the metallic surface in accordance with the manufacturer's instructions.
- e) Remove all slag from the weld-on wire connection and file smooth all sharp edges.
- f) The integrity of each weld shall be tested by giving a sharp pull on the lead wire.

Sufficient slack shall be left in the wires to prevent any stress on either the anode or the wire-to-pipe connection during backfilling and subsequent soil settlement.

For new watermain, and where practical for existing watermain, the anode lead wire shall be wrapped around the pipe and secured with a knot. The free end of the wire shall then be thermite welded to the watermain, metallic component, or valve.

442.07.08 Thermite Weld Protection

The cleaned metallic surfaces, thermite weld, and the exposed copper wire surfaces shall all be protected with an approved thermite weld protective barrier coating or cover. Both must overlap existing coating and insulation on wire to prevent holidays in the protection.

Coating and cover shall be installed according to the manufacturer's instructions.

442.07.09 Anode and Header Wire Splicing and Waterproofing

Wire splicing to the header wire shall be accomplished without cutting the header wire.

Wire to wire splicing shall be accomplished by one of the following methods as specified in the Contract Documents:

- a) Approved C Taps.
- b) Approved direct bury lugs with built-in waterproof protection.
- c) Soldered splices.
- d) Wire-to-wire thermite weld.

Splicing products shall be suitable for the size of wire being spliced.

Prior to backfilling, all splices and connections without built-in waterproof protection shall be rendered waterproof by either careful application of the waterproof tape method or by use of a wire splicing kit designed for cathodic protection.

Waterproof tape method shall be performed as follows:

- a) Apply moisture proofing over connector and exposed wire.
- b) Apply insulating putty to break sharp corners at the connection.
- c) Apply tape in accordance with one of the following methods:
 - i. Two half-lapped layers of approved self-amalgamating tape overlapping the wire insulation.
 - ii. Four half-lapped layers of approved rubber splicing tape overlapping the wire insulation and apply four half-lapped layers of approved self-adhesive electrical tape.

When using splicing kits designed for cathodic protection systems, the kits shall be applied in accordance with manufacturer's instructions.

442.07.09.01 C Tap Splices

Prior to cutting the wire for splicing, the wire shall be loose to avoid stretching.

The wire shall be stripped about the length of the electrical connector using an appropriate stripping tool. The exposed copper wire shall be free of nicks or scores.

An approved C Tap shall then be placed over the exposed area of the wire. The connecting wire shall be carefully inserted into the C Tap up to the insulation and tightened using an approved compression tool specifically designed for C Taps. Vice-grips, pliers, battering with a hammer, etc. shall not be permitted.

The splice shall be inspected for exposed copper and snugness. Splices that fail inspection shall be cut and redone.

442.07.09.02 Direct Bury Lug Splices

Splices using direct bury lugs shall be performed in accordance with the manufacturer's instructions.

442.07.09.03 Soldered Splices

Soldered connections shall be performed in accordance with industry practices.

442.07.09.04 Tape Coating Systems

Petrolatum and petroleum wax tape coating systems shall be applied according to the procedures described in AWWA C217.

442.07.10 Electrical Bonding of Joints

442.07.10.01 New Metallic Pipe

All new metallic pipe joints, valves, and components shall be connected together with a bond wire to ensure complete electrical continuity throughout the metallic piping system. Bond wires shall be connected to the metallic surfaces using a thermite weld.

Bare copper bond straps, conductivity screws, and conductivity wedges shall not be used to provide electrical continuity. If bare copper bond straps are supplied with the piping, they shall be removed.

442.07.10.02 Existing Metallic Pipe

Bond wires shall be installed by thermite welding between all metallic components and across all joints that are exposed within the excavation.

Where a repair clamp is installed across a break, a bond wire shall be installed across the break after repair clamp installation.

Where a cut-out is required, a bond wire shall be installed.

442.07.11 Wire Connections to Copper Services

The anode lead shall be connected to copper services using a ground clamp. Ground clamps shall be attached to copper services in accordance with the manufacturer's instructions. Wires shall be connected to the ground clamps in accordance with the manufacturer's instructions.

442.07.12 Anode Backfilling

In all cases, the anode shall be placed in native soil, not in granular bedding material. The Contract Administrator shall inspect the anode installation prior to backfilling. Backfill shall be packed uniformly around the anode container to eliminate voids adjacent to the anode.

442.07.13 Testing and Evaluation

For applications using test stations, the following procedures shall be performed and recorded between 90 and 120 Days after the installation:

- a) Pipe potentials shall be measured with respect to a copper sulfate electrode at maximum intervals of 30 m throughout the route of the piping. The voltmeter employed to measure these potentials shall have an input impedance not less than 10 Mega Ohms.
- b) Potential measurement connection locations shall be made at the nearest test station to the electrode. The reference electrode and pipe connection locations employed for the potential measurements shall be identical for both the pre-construction and post-construction testing procedures. The electrical continuity of the piping shall be verified by comparison of pipe potential.
- c) During post construction testing, the following measurements shall be made at the test stations:
 - i. Anode output current.
 - ii. Pipe potential with anode connected.
 - iii. Pipe potential with anode disconnected.

All testing data and associated recommendations pertinent to the continued effectiveness of the cathodic protection system shall be included in a comprehensive written report. This report shall be prepared by an Engineer or a Certified Cathodic Protection Specialist, and shall be submitted to the Contract Administrator.

442.07.14 Site Restoration

Site restoration shall be according to OPSS 492.

442.07.15 Management of Excess Material

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

442.08 QUALITY ASSURANCE

The Contractor shall ensure that the anodes supplied are in accordance to this specification.

Prior to installing each shipment of anodes, the Contractor shall forward a copy of a certificate to the Owner from the anode manufacturer indicating that the shipment of anodes complies with the requirements of this specification.

The Owner may randomly select samples of anodes supplied by the Contractor for testing by an independent laboratory.

Any batch of anodes found not to be in accordance to this specification shall be replaced immediately by the Contractor. No additional work shall take place until such time that the anodes are approved and accepted by the Owner.

Any installed anodes found not to be in accordance to the required specifications shall be replaced by the Contractor.

442.09 MEASUREMENT FOR PAYMENT

442.09.01 Actual Measurement

442.09.01.01 Individual Anodes

For measurement purposes, a count shall be made of the number of each anode type installed, other than in an anode bank, and of the number of anodes supplied for testing.

442.09.01.02 Anode Banks

For measurement purposes, a count shall be made of the number of each anode bank type installed.

442.09.01.03 Test Stations

For measurement purposes, a count shall be made of the number of each test station type installed.

442.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

442.10 BASIS OF PAYMENT

442.10.01 "type" Individual Anode - Item "type" Anode Bank - Item "type" Test Station - 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 an existing unprotected watermain or service is exposed during the construction of other work, payment for the labour, Equipment, and Material for such work shall be full compensation for the excavation, backfill, and compaction required to install anodes on the exposed watermain or service.

Replacement of anodes that do not meet the requirements of this specification shall be the responsibility of the Contractor at no extra cost to the Owner.

TABLE 1
Table of Casting and Anode Weights and Dimensions

ANODE TYPE	CASTING		OVERALL PACKAGE	
	Minimum Weight kg	Nominal Length mm	Nominal Weight kg	Nominal Dimensions Diameter x Length mm
ZINC				
Z-6-12	2.7	305	7.7	127 x 510
Z-12-24	5.4	610	12.7	127 x 760
Z-24-48	10.9	1,220	24.5	127 x 1,520
MAGNESIUM				
M-9-14	4.0	340	13.0	160 x 430
M-17-20	7.7	640	22.0	160 x 760
M-32-22	14.5	560	40.0	210 x 760

TABLE 2
Anode Spacing for Over Pipe Method

Pipe Diameter mm	Anode Type	Spacing m
100	M-32-22	22.0
150	M-32-22	15.0
200	M-32-22	11.5
250	M-32-22	10.0
300	M-32-22	8.0
400	M-32-22	6.0
600	M-32-22	4.5

TABLE 3
Anodes Per Location for the Horizontal and Vertical Anode Bank Method

Pipe Diameter mm	Anode Type	Number of Anodes Per Location	Spacing m
150	M-32-22	8	70 ± 5
200	M-32-22	10	70 ± 5
250	M-32-22	12	70 ± 5
300	M-32-22	14	70 ± 5

TABLE 4
Anode Spacing for Metallic Pipe and Copper Services

Diameter mm	Anode Size	Maximum Spacing m
Less than 50 mm Copper Service	Z-12-24	20.0
50 mm Copper Service	Z-12-24	16.0
100	Z-24-48	12.0
150	Z-24-48	8.0
200	Z-24-48	6.0
250	Z-24-48	5.0
300	Z-24-48	4.0
400	Z-24-48	3.0

TABLE 5
Anode Locations and Spacing for New PVC Pipe with Metallic Components

Location	Anode Type	Maximum Spacing and Quantity
Less than 50 mm Copper Service	Z-12-24	20.0 m
50 mm Copper Service	Z-12-24	16.0 m
100 - 300 mm Metallic Fittings and Valves	Z-12-24	1 per fitting and valve
400 mm Metallic Fittings and Valves	Z-24-48	1 per fitting and valve
Hydrant Bases	Z-24-48	1 per hydrant
Tracer Wire	Z-12-24	1 per every 1,000 m of tracer wire

Appendix 442-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

The designer should specify the following in the Contract Documents:

- The test station to be flush-mounted or post-mounted. (442.05.05)
- Length of post-mounted test stations (442.05.05)
- Type of C Taps. (442.05.07)
- Methods of corrosion protection. (442.07.04.06)
- Locations of concrete pressure pipe corrosion monitoring stations. (442.07.05)
- Splice connection method. (442.07.09)

Type and spacing of anodes are dependent on the soil conditions. Soil conditions should be verified before specifying the anode type and spacing. Assumptions used for anode spacings provided for new metallic watermain are as follows:

- i. Soil resistivity of 2,000 ohm-cm.
- ii. Bitumen coatings on pipe or other components are of no value (i.e., essentially bare).
- iii. 150 mm main with copper services should require about 2 mA of cathodic protection current per lineal foot and so in 2,000 ohm-cm soil 50 mA from a 24 lb zinc anode should cover 8.0 m of pipe.
- iv. 6.0 m spacing would allow for one anode per joint so discontinuities should not be a problem.
- v. A 24 pound zinc anode has a capacity of about 1,000 ma years so the anodes should have a life of about 20 years.

The anode items are titled "*type*" Individual Anode-Item and "*type*" Anode Bank-Item. The reference to "*type*" is to indicate that the complete item title for tender should include the type of anode (i.e., zinc or magnesium) required. (442.10.01)

The test station item is titled "*type*" Test Station-Item. The reference to type is to indicate that the complete item title for tender should include the type of test station (i.e., flush-mounted or post-mounted) required. (442.10.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 1109.010	Cathodic Protection for Metallic Watermain Systems
OPSD 1109.011	Cathodic Protection for PVC Watermain Systems
OPSD 1109.012	Cathodic Protection of Existing Metallic Watermains, Exposed Service or Pipe Method
OPSD 1109.013	Anode Installation Over Pipe Method for Existing Metallic Watermains
OPSD 1109.014	Vertical Anode Bank at Service

OPSD 1109.015 Horizontal Anode Bank at Service
OPSD 1109.025 Waterproofing of Splices



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 517
NOVEMBER 2016**

(Formerly OPSS 517 November 2010)

Note: The MUNI implemented in November 2016 replaces OPSS 517 COMMON, November 2016 with no content changes.

**CONSTRUCTION SPECIFICATION FOR
DEWATERING OF PIPELINE, UTILITY, AND
ASSOCIATED STRUCTURE EXCAVATION**

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517.03	DEFINITIONS
517.04	DESIGN AND SUBMISSION REQUIREMENTS
517.05	MATERIALS - Not Used
517.06	EQUIPMENT - Not Used
517.07	CONSTRUCTION
517.08	QUALITY ASSURANCE - Not Used
517.09	MEASUREMENT FOR PAYMENT - Not Used
517.10	BASIS OF PAYMENT

APPENDICES

517-A	Commentary

517.01 SCOPE

This specification covers the requirements for dewatering procedures to stabilize the ground and keep excavations free of water during 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.

517.01.01 Specification Significance and Use

This specification has been developed for use in provincial and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and 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.

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

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
OPSS 518	Control of Water From Dewatering Operations

517.03 DEFINITIONS

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

Associated Appurtenances mean as defined in OPSS 412 and OPSS 441.

Surrounding Area means as specified by the Ministry of the Environment (MOE) or as specified in the Contract Documents.

517.04 DESIGN AND SUBMISSION REQUIREMENTS

517.04.01 Submission Requirements

The following information shall be submitted to the Contract Administrator for review at least two weeks prior to the commencement of dewatering operation:

- a) Unless provided in the Contract Documents, the permit issued by MOE for taking water from a ground water source, if required.
- b) Monitoring and contingency plans that address potential impacts to items such as, but not limited to, settlement, ground water usage and electrical and mechanical equipment failures.
- c) Stand-by power or pumping capacity or both, if required by the Contract Documents.
- d) Calibration documentation for the flow metering system.

517.07 CONSTRUCTION

517.07.01 Dewatering

A continuous dewatering operation shall be provided to keep the excavation stable and free of water. The excavation shall be monitored to ensure it remains stable and free of water.

The dewatering system shall be maintained and the surrounding area monitored for impacts to items such as, but not limited to, settlement and ground water usage. Any impacts shall be immediately reported to the Contract Administrator.

When a stand-by power or pumping system or both are required, they shall be as specified in the Contract Documents, and shall be installed on-site.

The availability, location, and use of automatic transfer switching shall be as specified in the Contract Documents.

Dewatering shall be discontinued in a manner so that disturbance of any structure or pipeline is avoided.

517.07.02 Control of Water

The control of water shall be according to OPSS 518.

517.07.03 Management of Excess Material

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

517.10 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.

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

The designer may consider including soil boring data, a geotechnical report, a subsurface report, or a soils report in the Tender Documents.

The designer should specify the following in the Contract Documents:

- Surrounding area. (517.03)
- Stand-by power or pumping capacity or both. (517.04.01)
- When required, stand-by power or pumping system or both. (517.07.01)
- Availability, location, and use of automatic transfer switching, based on site conditions, impacts, and risk assessment. (517.07.01)

Due to the time required, the designer should consider obtaining the dewatering permit to avoid delays. (517.04)

The need for a specific dewatering scheme should be determined. If a specific dewatering scheme is necessary, it should be specified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR CONTROL OF WATER FROM DEWATERING OPERATIONS

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518.06	EQUIPMENT - Not Used
518.07	CONSTRUCTION
518.08	QUALITY ASSURANCE - Not Used
518.09	MEASUREMENT FOR PAYMENT - Not Used
518.10	BASIS OF PAYMENT

APPENDICES

518-A	Commentary

518.01 SCOPE

This specification covers the requirements for the control of water from dewatering operations prior to discharge to the environment and sewer systems. This specification does not apply to the management of contaminated water.

518.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

518.01.02 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.

518.02 REFERENCES

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

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

Ontario Provincial Standard Specifications, Construction

OPSS 805 Temporary Erosion and Sediment Control Measures

518.03 DEFINITIONS

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

Dewatering Operation means pumping, baling, temporary ditching, or vacuum removal of uncontaminated groundwater, rain water, melt water, stormwater, surface run-off, water pipe leakage from excavations and trenches or within sheeted cofferdams to improve the soil stability or for other construction purposes.

Vegetated Discharge Area means a sloped, open area of land with existing vegetation suitable to prevent erosion.

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 environment and sewer systems.

518.07 CONSTRUCTION

518.07.01 Discharge of Water

Water from dewatering operations shall be directed to a sediment control measure and/or a vegetated discharge area according to OPSS 805 prior to discharge to the environment.

When water is discharged from a sediment control measure or a vegetated discharge area to the environment, it shall be done in a manner that does not cause erosion or other damage to adjacent lands.

Owner approval shall be obtained prior to discharge of water to a sewer system.

All other required approvals for dewatering operations shall be obtained and/or complied with prior to and during discharge of water.

518.07.02 Discharge to Sediment Control Measures

The installation, maintenance, and removal of temporary erosion and sediment control measures shall be according to OPSS 805 and as specified in the Contract Documents.

518.07.03 Discharge to Vegetated Discharge Areas

Equipment and materials not related to dewatering shall not be used or stored in vegetated discharge areas.

518.07.04 Discharge to the Environment

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.

518.07.05 Management of Excess Material

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

518.07.06 Protection of Waterbodies and Waterbody Banks

Protection of waterbodies and waterbody banks shall be according to the Contract Documents.

518.10 BASIS OF PAYMENT

Payment at the Contract price for the appropriate tender items associated with dewatering shall include 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 518-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

The designer should be aware that this specification does not apply to contaminated water sources.

The designer should specify the following in the Contract Documents:

- Construction requirements for sediment control measures. (518.07.02)
- Types of erosion and sediment control measures. (518.07.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 219.100 Light-Duty Straw Bale Barrier
OPSD 219.110 Light-Duty Silt Fence Barrier
OPSD 219.120 Light-Duty Fibre Roll Barrier
OPSD 219.130 Heavy-Duty Silt Fence Barrier
OPSD 219.131 Heavy-Duty Wire-Backed Silt Fence Barrier
OPSD 219.150 Sandbag Barrier
OPSD 219.160 Fibre Roll Grade Breaks
OPSD 219.180 Straw Bale Flow Check Dam
OPSD 219.191 Fibre Roll Flow Check Dam
OPSD 219.200 Sandbag Flow Check Dam
OPSD 219.210 Temporary Rock Flow Check Dam V-Ditch
OPSD 219.211 Temporary Rock Flow Check Dam Flat Bottom Ditch
OPSD 219.220 Sediment Trap In Ditch
OPSD 219.230 Temporary Slope Drain For Sediment Trap
OPSD 219.231 Temporary Berm Barrier
OPSD 219.240 Sediment Trap for Dewatering
OPSD 219.260 Turbidity Curtain
OPSD 219.261 Turbidity Curtain Seam Detail



CONSTRUCTION SPECIFICATION FOR REMOVAL OF ELECTRICAL EQUIPMENT AND MATERIALS

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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 has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and 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.

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

Due care shall be exercised when removing electrical equipment and materials for salvage. Equipment and materials damaged through improper handling or through loss after removal shall be repaired or replaced.

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.

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 Contract limits 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 Materials to do the work.

Work required to salvage and transport liquid type transformers shall be paid as Extra 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

The design should specify the following in the Contract Documents:

- Electrical equipment and materials for demolition, salvage, and removal. (610.07.01)
- Subject waste management requirements. (610.07.07)
- Storage sites for transformers without PCBs. (610.07.07)
- Salvage requirements for equipment and material removed from temporary installations. (610.07.08)
- Salvaged equipment and material unloading sites. (610.07.09.03)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



**CONSTRUCTION SPECIFICATION FOR
INSTALLATION OF SECTIONAL STEEL
HIGH MAST LIGHTING POLES**

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630.05	MATERIALS
630.06	EQUIPMENT - Not Used
630.07	CONSTRUCTION
630.08	QUALITY ASSURANCE
630.09	MEASUREMENT FOR PAYMENT
630.10	BASIS OF PAYMENT

APPENDICES

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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

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

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

The Contractor shall submit installation drawings, calculations, and procedures 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 an in-depth training course 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 given.

630.05 MATERIALS

630.05.01 Sectional Steel High Mast Lighting Poles

Sectional steel high mast lighting poles shall be according to OPSS 2471.

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 Drawing 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:

- 35% for delivery of all high mast lighting poles and equipment
- 5% for certificate of training
- 20% for installation of all high mast lighting poles and equipment
- 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

The designer should specify the following in the Contract Documents:

- Tolerances for the assembled sectional steel high mast pole. (630.07.02.01)
- Base plate positioning, door orientation, and pole orientation. (630.07.02.03)
- High mast lighting equipment installation requirements. (630.07.02.04)
- Pre-installation testing and inspection requirements. (630.07.03.01)
- Raising and lowering equipment requirements. (630.07.03.02.01)
- Torque limiter requirements. (630.07.03.02.01)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 2450.011	High Mast Lighting Pole, 25, 30, and 35 m 8-Sided Pole
OPSD 2450.021	High Mast Lighting Pole, 40 and 45 m 12-Sided Pole
OPSD 2453.000	High Mast Lighting Pole, Luminaire and Handhole Orientation
OPSD 2453.001	High Mast Lighting Pole, Luminaire and Handhole Orientation for Median Mounted Poles
OPSD 2453.010	High Mast Lighting Pole, Cable Holder and Storage Hook Details
OPSD 2453.020	High Mast Lighting Pole, Handhole Cover Hinges, Latches, and Padlock
OPSD 2453.050	High Mast Lighting Pole, Nameplate Details
OPSD 2453.060	High Mast Lighting Pole, Flood Light Luminaire Mounting Details
OPSD 2453.070	High Mast Lighting Pole, Luminaire Support Ring
OPSD 2453.080	High Mast Lighting Pole, Head Frame and Ring Assembly
OPSD 2453.090	High Mast Lighting Pole, Shroud
OPSD 2453.091	High Mast Lighting Pole, Shroud Details
OPSD 2453.140	High Mast Lighting Pole, Internal Drive Raising and Lowering Equipment - List of Components
OPSD 2453.150	High Mast Lighting Pole, Internal Drive Raising and Lowering Equipment - Layout
OPSD 2453.160	High Mast Lighting Pole, Internal Motor and Winch Details
OPSD 2453.170	High Mast Lighting Pole, Internal Drive Raising and Lower Equipment, 347/600V, 3-Phase, Wiring Diagram
OPSD 2453.180	High Mast Lighting Pole, Internal Drive Raising and Lower Equipment, 120/240V, 1-Phase Wiring Diagram
OPSD 2453.190	High Mast Lighting Pole, External Drive Raising and Lowering Equipment - List of Components
OPSD 2453.200	High Mast Lighting Pole, External Drive Raising and Lowering Equipment - Layout

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OPSD 2453.210	High Mast Lighting Pole, External Drive Raising and Lower Equipment, 347/600V, 3-Phase, Wiring Diagram
OPSD 2453.220	High Mast Lighting Pole, External Drive Raising and Lower Equipment, 120/240V, 1-Phase, Wiring Diagram



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 706
NOVEMBER 2016**

(Formerly OPSS 706 2010)
(Formerly OPSS 543, December 1990)

Note: The MUNI implemented in November 2016 replaces OPSS 706 COMMON, November 2010 with no content changes.

**CONSTRUCTION SPECIFICATION
FOR TRAFFIC CONTROL SIGNING**

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706.01	SCOPE
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706.10	BASIS OF PAYMENT

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706-A	Commentary

706.01	SCOPE

This specification covers the requirements for traffic control signing during construction.

706.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification

correspond to those used by many municipalities and 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.

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

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

Canadian General Standards Board (CGSB)

CGSB 62-GP-11M, May 1978 - Marking Material, Retroreflective Enclosed Lens, Adhesive Backing

Authority Publications - Ministry of Transportation of Ontario:

Traffic Control Manual for Roadway Work Operations - Field Edition

Manual of Uniform Traffic Control Devices, M.U.T.C.D.

706.03 DEFINITIONS

Construction Signs means all traffic control signs and associated devices identified in Part A, Division 5, Temporary Conditions, M.U.T.C.D. Manual, including vehicles and sign trailers, required to support signs and equipment to supply sign lighting, excluding the contract identification sign and highway number markers.

Manual means the "Traffic Control Manual for Roadway Work Operations", Field Edition and the Manual of Uniform Traffic Control Devices, M.U.T.C.D.

706.05 MATERIALS

706.05.01 Reflective Surfaces

Reflective materials and surfaces shall conform to M.U.T.C.D.

706.05.02 Signs

All details with respect to materials, dimensions and other requirements except reflectivity, shall conform to the M.U.T.C.D.

706.07 CONSTRUCTION

706.07.01 Traffic Control Signing

Traffic control signing shall include the work of supplying, locating, relocating, erecting, operating and maintaining construction signs, and shall conform to the Manual unless otherwise specified. The contract identification signs will be supplied, erected, and maintained by the Authority.

Signs shall be in place before work affecting traffic begins, shall be well maintained to be effective at all times, shall remain operational throughout the duration of the operation requiring signs, including the shutdown period, and shall be removed upon completion of the operation.

Ramps or roadways identified in the contract for complete closure shall be signed conforming to the M.U.T.C.D.

706.07.02 Existing Signing

Any existing signs removed by the Contractor to accommodate construction shall be kept operational by placement on a temporary support and shall be reinstalled conforming to the M.U.T.C.D after the work operation is complete. Temporarily relocated existing signs shall be kept at the same height, offset and basic location from traffic as before removal.

706.07.03 Seasonal Shutdown

During seasonal shutdown, the Authority will take responsibility for the maintenance, including replacement, of construction signs unless otherwise specified.

Responsibility for the maintenance of construction signs during seasonal shutdown will not be assumed by the Authority until the signing has been inspected, sign installation deviations from the Manual corrected and signing approved in writing by the Authority.

Construction signs placed, replaced or repaired by the Authority during seasonal shutdown will become the property of the Contractor.

Upon resumption of operations, the Contractor shall review and provide written acceptance of the signing; deviations from the Manual shall be noted and these will be corrected by the Authority. Once deviations are repaired, the Contractor shall resume responsibility as specified herein.

706.10**BASIS OF PAYMENT****706.10.01****Traffic Control Signing - Lump Sum 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.

For progress payment, fifty percent of the contract price will be paid upon the supply and installation of the complete initial traffic control signing plan. The balance will be prorated over the balance of the working period.

Appendix 706-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

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



CONSTRUCTION SPECIFICATION FOR STEEL BEAM GUIDE RAIL AND CABLE GUIDE RAIL

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721.02	REFERENCES
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721.04	DESIGN AND SUBMISSION REQUIREMENTS - Not Used
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721.06	EQUIPMENT - Not Used
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721.10	BASIS OF PAYMENT

APPENDICES

721-A	Commentary

721.01	SCOPE

This specification covers the requirements for the installation of steel beam guide rail and cable guide rail systems.

721.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

721.01.02 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.

721.02 REFERENCES

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

Ontario Provincial Standard Specifications, Material

OPSS 1350 Concrete - Materials and Production
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-M92 (R2003) Hot Dip Galvanizing of Irregularly Shaped Articles
O56-10 (R2015) Round Wood Piles

ASTM International

A 36/A 36M-14	Carbon Structural Steel
A 780/A 780M-09 (2015)	Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
D 4956-16a	Retroreflective Sheeting for Traffic Control

721.05 MATERIALS

721.05.01 Cable Guide Rail

Guide rail cable, fittings, cable clamps and nails, and steel sections for anchor blocks shall be according to OPSS 1503.

Guide rail posts shall be clean peeled according to CAN/CSA O56, and according to OPSS 1601.

Precast concrete anchor blocks shall be according to OPSS 1503.

Reflectorized strips on 0.5 mm thick aluminum sheet shall be according to OTM Book 11 and as specified in the Contract Documents.

721.05.02 Steel Beam Guide Rail

Steel beam guide rail 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 A 36.

Reflectors shall have a minimum reflective surface of 100 x 100 mm; high intensity retroreflective sheeting according to ASTM D 4956, Type VII; colour according to OTM Book 11; and flexibility to bend 90 degrees from vertical and self restore.

721.05.03 Fabricated Steel Bases

Fabricated steel bases shall be according to OPSS 1503.

721.05.04 Concrete

Concrete shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

721.07 CONSTRUCTION

721.07.01 General

Guide rail systems shall be installed plumb and to the alignment and grade as 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 or anchor block 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 A 780.

Flame cutting shall not be permitted.

721.07.02 Cable Guide Rail

721.07.02.01 Installation

Cable guide rail shall be installed as specified in the Contract Documents.

Wooden posts shall be installed to the specified depth with the larger end of the post in the ground.

Cable shall be attached to guide rail posts using cable clamps and nail fasteners.

Cable mounting height shall be measured from the top of final shoulder grade at the post face. Cable height shall be adjusted to provide a smooth installation.

Cables shall be tensioned so that the sag between posts shall be a maximum of 6 mm.

Cable splices occurring on the same cable shall be spaced a minimum length of 15 m apart.

There shall be only one cable splice per panel, regardless of the number of cables in the system.

721.07.02.02 Anchor Blocks

Precast or cast-in-place cubical or cylindrical anchor blocks shall be installed as specified in the Contract Documents, regardless of the material encountered.

In porous or crumbly soil, forms for cast-in-place anchors shall be used to prevent contamination of the concrete. Forms may be left in place or removed.

Earth backfill and granular materials shall be compacted according to OPSS 501.

721.07.02.03 Reflectorized Strips

Reflectorized strips shall be installed:

- a) starting at the second post from the approach end.
- b) at a maximum interval of every fifth post on tangent.
- c) at a maximum interval of every third post on curves.
- d) ending on the second to last post.

The reflectorized strip shall be fastened on posts as specified in the Contract Documents using two 50 mm aluminum nails.

721.07.02.04 Adjust Cable Guide Rail

Cable guide rail shall be adjusted at locations as specified in the Contract Documents.

Cable guide rail adjustment shall be as specified in the Contract Documents and include:

- a) the removal of the following:
 - i. staples and spacers or cable clamps and nails
 - ii. reflectorized strips
 - iii. cables as salvage
- b) the installation of the following:
 - i. salvaged cables
 - ii. new cable clamps and nails
 - iii. new reflectorized strips

To facilitate cable tensioning, one new turnbuckle assembly shall be installed on each cable between each set of adjacent anchor blocks. Cables shall be tensioned so that the sag between posts shall be a maximum of 6 mm.

721.07.02.05 Cable Guide Rail Post Replacement

Existing cable guide rail posts shall be removed and replaced with new cable guide rail posts at locations as specified in the Contract Documents and installed as specified in the Cable Guide Rail Installation clause. The Contractor shall confirm the locations with the Contractor Administrator prior to commencing the removal of existing posts.

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.

Each steel beam guide rail installation may incorporate either steel posts with either plastic or routed wooden blocks or wooden posts with wooden blocks, but not both. Wooden posts shall only be permitted within steel post installations when wooden posts are specified for guide rail end treatments. Extension of an existing wooden post installation using steel posts shall only be permitted when the extension length is greater than 100 m.

Different types of plastic and wooden blocks shall not be used 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 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 N·m. 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.

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 face of steel beam guide rail is more than 300 mm beyond the gutter line.
- b) Vertically at the gutter line, when face of steel beam guide rail is 300 mm or less beyond the gutter line.

721.07.03.02 Reflectors

Reflectors shall be installed:

- 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) as specified in OTM Book 11, Table 4, on curves.
- 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 Guide Rail 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 as 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 Steel Beam Guide Rail 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.

721.07.04 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 Cable Guide Rail

Measurement of cable guide rail shall be by length in metres along the centreline of the system from centre of anchor block to centre of anchor block at each end of an installation. No additions shall be made for the overlapping length of cable at intermediate anchor blocks.

721.09.01.02 Adjust Cable Guide Rail

Measurement of adjust cable guide rail shall be by length in metres along the centreline of the system from centre of anchor block to centre of anchor block at each end of an installation. No additions shall be made for the overlapping length of cable at intermediate anchor blocks.

721.09.01.03 Cable Guide Rail Post Replacement

For measurement purposes, a count shall be made of the number of cable guide rail post replacement installed.

721.09.01.04 Anchor Blocks

For measurement purposes, a count shall be made of the number of anchor blocks installed.

**721.09.01.05 Single Rail Steel Beam Guide Rail
Single Rail Steel Beam Guide Rail with Channel
Double Rail Steel Beam Guide Rail
Steel Beam Barricade**

Measurement of steel beam guide rail shall be by length in metres along the centreline of the system from end to end of each steel beam guide rail installation and does not include the terminal systems.

**721.09.01.06 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 and includes the end treatments and terminal systems.

721.09.01.07 Steel Beam Guide Rail Structure Connections

For measurement purposes, a count shall be made of the number of steel beam guide rail structure connections installed.

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 Cable Guide Rail - Item
Adjust Cable Guide Rail - Item
Cable Guide Rail Post Replacement - Item
Anchor Blocks - Item
Single Rail Steel Beam Guide Rail - Item
Single Rail Steel Beam Guide Rail with Channel - Item
Double Rail Steel Beam Guide Rail - Item
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
Steel Beam Guide Rail Structure Connections – Item
Steel Beam Barricade – 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 steel beam guide rail structure connections, payment at the Contract price for single rail steel beam guide rail with channel shall include full compensation for all labour, Equipment, and Material to do the work of connecting steel beam guide rail to a structure.

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.

Appendix 721-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

The designer should specify the following in the Contract Documents:

- Guide rail system locations. (721.07.01)
- Cable guide rail to be adjusted. (721.07.02.04)
- Cable guide rail post to be replaced. (721.07.02.05)
- Steel beam guide rail to be adjusted. (721.07.03.04)

Leaving end treatment should be used on divided highways and ramps, when the leaving end of the installation is located beyond the clear zone for opposing traffic.

Height adjustments for steel beam guide rail with wooden post shall be a minimum of 50 mm.

Cable Guide Rail Adjustment:

Mounting height tolerances for cable guide rail (CGR) are provided in the MTO Roadside Safety Manual. The purpose of the Adjust Cable Guide Rail item is to allow for the adjustment of the mounting height of an existing CGR installation. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as the existing mounting height.

When adjusting CGR systems, the posts remain in their current location and the cables are reinstalled at the new mounting height. If the CGR was installed according to OPSD 913.130, there should be approximately 150 mm of space available for adjustment assuming that this is the first adjustment. Cables are not to be installed within 200 mm of the top of the posts. This ensures that the cables do not interfere with the reflectorized strip.

The Adjust Cable Guide Rail tender item also includes the removal and replacement of cable clamps and nails, the installation of one new turnbuckle per cable between anchor blocks, and the installation of new reflectorized strips.

When the evaluation of the existing CGR indicates that the posts are in unsound condition, out of plumb, or cannot meet the mounting height tolerance, it may be necessary to replace some or all of the posts. The Cable Guide Rail Post Replacement tender item can be used to replace existing cable guide rail posts when the remainder of the components (i.e., cables and anchor blocks) are in satisfactory condition.

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Steel Beam Guide Rail Adjustment:

Mounting height tolerances for steel beam guide rail (SBGR) are specified in OPSS 721. There are three tender items available for adjustment of SBGR. The purpose of these items is to allow for the adjustment of the mounting height of an existing SBGR installation on wooden or steel posts. Generally, adjustment is necessary at locations where the pavement rehabilitation strategy will raise the existing ground elevation adjacent to an existing guide rail installation. An evaluation of the existing guide rail will provide the designer with an inventory of the type of existing guide rail systems as well as existing mounting height. Existing SBGR installations may consist of the following configurations:

a) Wooden posts with wooden offset blocks:

Although still installed today, these systems were used primarily in the years prior to implementation of SBGR on steel posts in 1995. When adjusting these systems, the posts remain in their current location, but the offset block and rail (and channel, where necessary) are reinstalled at the new mounting height. If the guide rail was installed according to OPSD 912.140, there should be approximately 150 mm of space available for adjustment assuming this is the first adjustment. The evaluation of existing guide rail should determine whether the existing installation can accommodate the proposed change in height.

b) Steel post with steel offset blocks:

Steel post systems have been the most common since they were first implemented in 1995 mainly due to their relative ease of handling and installation. Steel offset blocks were used exclusively with steel post systems from 1995 through 2002 when the standard was revised to specify routed wooden blocks. When they are adjusted, existing steel post systems with steel offset blocks will be retrofitted with routed wooden or plastic offset blocks. This requires the punching of a new hole to accommodate the wooden or plastic offset block.

c) Steel posts with wooden or plastic offset blocks:

From 2003 through the early 2008, steel post systems were installed exclusively with routed wooden offset blocks. In 2008, plastic offset blocks were implemented as an alternative to the routed wooden offset blocks. Since that time, steel post systems with plastic offset blocks have been the most common steel beam system.

Selection of the appropriate tender item for each installation will ensure that the Contractor will address the unique adjustment requirements of each system configuration.

Tender items for adjustment include the removal and replacement of existing hardware including bolts, washers, and nuts as well as the installation of new reflectors. For SBGR with steel offset blocks, replacement of steel offset blocks with plastic or wooden offset blocks is included.

Existing end terminals and treatments should be reviewed when SBGR is being considered for adjustment.

Existing end terminals may consist of eccentric loader terminal (ELT) systems, extruder terminal (ET) systems, or sequential kinking terminal (SKT) systems:

a) ELT Systems:

- Consider replacement of ELT installations that are greater than or equal to 5 years in age with a new steel beam energy attenuating terminal (SBEAT) system. If the ELT system is located on a horizontal curve with a radius of less than 190m, a new ELT should be installed.

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b) SBEATs:

- Existing ET and SKT systems consist of several different variations on wooden and steel posts.
- Consider replacement of ET and SKT system installations on wooden posts with a new SBEAT System.
- ET and SKT systems on steel posts that are in good condition may be adjusted.

Existing leaving end treatments consisting of buried leaving end treatments (formerly OPSD 912.233) or upright fishtail ends:

- a) Buried leaving end treatments are a challenge to adjust and could be replaced with a standard leaving end treatment according to OPSD 912.235. This would require the removal of 16 m of existing SBGR and subsequent installation of 4 m of new SBGR according to OPSD 912.235.
- b) Existing upright fishtail type end treatments typically have been installed based on the extension requirements for unanchored guide rail in accordance with Table 3.4.2 in the MTO Roadside Safety Manual. When replacing an upright fishtail end treatment with a standard leaving end treatment, ensure that after removal of the unanchored end beyond the hazard that the 4 m of new SBGR in accordance with OPSD 912.235 extends beyond the hazard by 4 m.
- c) Where an existing buried end treatment or upright fishtail end treatment is on the leaving end of a SBGR installation located on an undivided highway or at a location on a divided highway where the end of the SBGR is located within the clear zone for opposing traffic, the treatment should be considered for replacement with an end terminal.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 912.130	Guide Rail System, Steel Beam, Steel Post With Offset Block Assembly, Installation - Single Rail
OPSD 912.140	Guide Rail System, Steel Beam, Wooden Post Assembly, Installation - Single Rail
OPSD 912.141	Guide Rail System, Steel Beam, Wooden Post Assembly, Installation - Double Rail
OPSD 912.234	Guide Rail System, Steel Beam, End Treatment, Installation - Leaving End Collector Median
OPSD 912.235	Guide Rail System, Steel Beam, Leaving End Treatment, Installation
OPSD 912.240	Guide Rail System, Steel Beam, Treatment at Culverts With Minimal Cover Installation - Single Rail
OPSD 912.380	Guide Rail System, Steel Beam, Permanent Transition Installation, Channel Termination, Median
OPSD 912.430	Guide Rail System, Steel Beam, Structure Connection
OPSD 912.480	Guide Rail System, Steel Beam, Permanent Connection Installation, Single Steel Beam to Concrete Barrier
OPSD 912.481	Guide Rail System, Steel Beam, Permanent Connection Installation, Double Steel Beam to Concrete Barrier
OPSD 912.530	Guide Rail System, Steel Beam, Structure Approach Treatment, Installation - Rural Highway
OPSD 912.531	Guide Rail System, Steel Beam, Installation - Entrances and Intersecting Roadways
OPSD 913.130	Guide Rail System, Cable, Installation – Shoulder
OPSD 973.130	Fence, Steel Beam, Barricade, Installation



CONSTRUCTION SPECIFICATION FOR ENERGY ATTENUATORS

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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 municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

When a specific energy attenuator system is specified in the Contract Documents, there shall not be an option of substitution for the energy attenuator system.

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 New Concrete Pads

The concrete pad shall be as specified by the manufacturer.

723.07.03.02 Existing Concrete Surface

Existing 200 mm minimum thick concrete surfaces, pads, or precast pads may be used to support the energy attenuator.

723.07.03.03 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.

723.07.03.04 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.

723.07.03.05 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.

723.07.03.06 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.

723.07.03.07 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.

723.07.03.08 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 Box Beam Bursting Energy Absorbing Terminal System - Permanent Quadguard System - Permanent Quadguard Wide System - Permanent Quadguard Extra Wide System - Permanent Quadguard Super Wide System - Permanent QuadTrend System - Permanent Smart System - Permanent TRACC System - Permanent TAU-II System - Permanent TAU-II Wide System - Permanent TAU-II Extra Wide System - Permanent

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 ABSORB 350 System - Temporary ACZ-350 System - Temporary Quadguard System - Temporary Quadguard Wide System - Temporary Quadguard Extra Wide System - Temporary Quadguard Super Wide System - Temporary SLED System - Temporary Smart System - Temporary TAU-II System - Temporary TAU-II Wide System - Temporary TAU-II Extra Wide System - Temporary TRACC System - Temporary

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 ABSORB 350 System - Relocation ACZ-350 System - Relocation

Quadguard System - Relocation
 Quadguard Wide System - Relocation
 Quadguard Extra Wide System - Relocation
 Quadguard Super Wide System - Relocation
 SLED System - Relocation
 Smart System - Relocation
 TAU-II System - Relocation
 TAU-II Wide System - Relocation
 TAU-II Extra Wide System - Relocation
 TRACC System - Relocation

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
 Box Beam Bursting Energy Absorbing Terminal System - Permanent - Item
 Quadguard System - Permanent - Item
 Quadguard Wide System - Permanent - Item
 Quadguard Extra Wide System - Permanent - Item
 Quadguard Super Wide System - Permanent - Item
 QuadTrend System - Permanent - Item
 Smart System - Permanent - Item
 TAU-II System - Permanent - Item
 TAU-II Wide System - Permanent - Item
 TAU-II Extra Wide System - Permanent - Item
 TRACC System - Permanent - 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
 ABSORB 350 System - Temporary - Item
 ACZ-350 System - Temporary - Item
 Quadguard System - Temporary - Item
 Quadguard Wide System - Temporary - Item
 Quadguard Extra Wide System - Temporary - Item
 Quadguard Super Wide System - Temporary - Item
 SLED System – Temporary - Item
 Smart System - Temporary - Item
 TAU-II System - Temporary - Item

TAU-II Wide System - Temporary - Item
TAU-II Extra Wide System - Temporary - Item
TRACC System - Temporary - 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
ABSORB 350 System - Relocation - Item
ACZ-350 System - Relocation - Item
Quadguard System - Relocation - Item
Quadguard Wide System - Relocation - Item
Quadguard Extra Wide System - Relocation - Item
Quadguard Super Wide System - Relocation - Item
SLED System - Relocation - Item
Smart System - Relocation - Item
TAU-II System - Relocation - Item
TAU-II Wide System - Relocation - Item
TAU-II Extra Wide System - Relocation - Item
TRACC System - 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.

TABLE 1
Energy Attenuator, Permanent

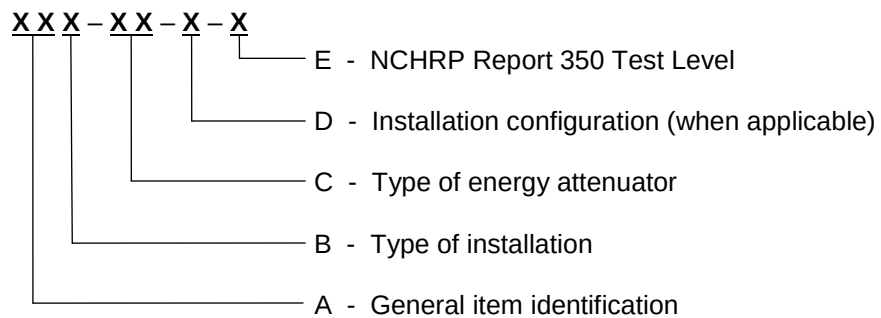
Energy Attenuator	NCHRP Report 350 Test Level		Permanent Installation					
	TL-2	TL-3	Narrow (NA)	Wide (WI)	Extra Wide (EW)	Super Wide (SW)	High Exposure (HE)	Single- Sided (SS)
BB-BEAT	No	Yes	No	No	No	No	No	Yes
Quadguard System	Yes	Yes	Yes	No	No	No	No	No
Quadguard Wide System	Yes	Yes	No	Yes	No	No	No	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
Smart System	Yes	Yes	Yes	No	No	No	Yes	No
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

TABLE 2
Energy Attenuator, Temporary

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)
ABSORB 350 System	Yes	Yes	Yes	No	No	No	No	No
ACZ 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
SLED System	Yes	Yes	Yes	No	No	No	No	No
Smart System	Yes	Yes	Yes	Yes	No	No	No	Yes
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
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 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

The designer should specify the following in the Contract Documents:

- Energy attenuator system locations using the notation shown in Table 3. (723.07.01)
- Relocation of energy attenuators using the notation shown in Table 3. (723.07.01 and 723.07.03.06)

The designer should specify whether each system is TL-2 or TL-3 configuration. TL-2 configurations are required for low-speed installations with posted speeds of less than 70 km/h. TL-3 configurations are required for high-speed installations with posted speeds of 70 km/h and greater. Single-sided systems are only available in a TL-3 configuration. (723.07.01)

A permanent energy attenuator installation should include a new concrete pad (723.07.02.01). If an existing concrete surface or pad can be used to support the system, it should be specified in the Contract Documents (723.07.02.02). The designer should confirm that the existing concrete surface or pad is in good condition and will provide a smooth operating surface for the system.

The designer should confirm that one of the following foundation options is available for each temporary energy attenuator installation (723.07.03):

- a) Existing concrete surface:
 - minimum 200 mm deep, 28 MPa minimum compressive strength
- b) Asphalt over compacted granular:
 - minimum 150 mm asphalt over 150 mm minimum compacted granular
 - the asphalt must extend a minimum of 500 mm beyond the anchor bolts
- c) Asphalt over concrete
 - minimum 75 mm asphalt over 75 mm minimum concrete, 28 MPa minimum compressive strength

The designer should confirm that the existing surface is in good condition and will provide a smooth operating surface for the system.

When a single-sided system is connected to existing concrete barrier as specified in the Contract Documents, the designer should include payment in the Contract Documents for the removal of the 4.0 m section of existing concrete barrier and placement of a new 4.0 m section adjacent to each system. (723.07.02.03)

Single-sided systems shall be installed with grading according to OPSS 202.033. Single-sided systems should not be installed in a location where backside hits towards the concrete barrier are possible (e.g., in gore areas), or in a narrow median where backside opposite direction hits are possible. The area behind and beyond the end terminal should be traversable and free of fixed objects. The minimum recommended rectangular area should be 6 m wide, measured behind and perpendicular to the back of the rail, by 22 m long, measured from the front face of the system and parallel to the system. (723.07.02.03)

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When the reduced exposure tender item is selected, the designer should confirm that the following requirements for water filled energy attenuator systems are satisfied (723.07.03.04):

- a) Water filled energy attenuator systems shall be installed at an offset of not less than 1.0 m from the edge of the travelled way.
- b) When installed adjacent to an existing guide rail system, the clearance shall be less than or equal to 0.3 m or greater than or equal to 3.0 m. Otherwise, the area behind and beyond the water filled energy attenuator system shall be traversable and free of fixed objects. The minimum recommended rectangular area shall be 6 m wide, measured behind and perpendicular to the back of the system, by 22 m long, measured from the front face of the system and parallel to the system.
- c) At a minimum, the first 16 m of temporary concrete barrier shall be placed tangential to the water filled energy attenuator system.

When the item for payment is Energy Attenuator, the designer should not include any drawings for specific energy attenuators in the Contract Documents.

Wherever possible, the designer should eliminate the use of curb with gutter in advance of and along the length of end treatments and crash cushions. See MTO Roadside Safety Manual for additional information.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 202.033	Roadway Widening, Single Sided Energy Attenuating Terminals, Approach End
OPSD 922.131	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Barrier
OPSD 922.133	Energy Attenuator, Crash Cushion, QuadTrend System, Installation - Concrete Pad and Rear Cable Anchor Block
OPSD 923.001	Energy Attenuator, Crash Cushion, Narrow Systems, Component - Reinforced Concrete Pad
OPSD 923.002	Energy Attenuator, Crash Cushion, Component - Anchor Assembly
OPSD 923.004	Energy Attenuator, Crash Cushion, Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.005	Energy Attenuator, Crash Cushion, Extra Wide Systems, Component - Reinforced Concrete Pad
OPSD 923.006	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Component - Reinforced Concrete Pad
OPSD 923.010	Energy Attenuator, Crash Cushion, Narrow Systems, Component – Reinforced Precast Concrete Pad for Permanent Installation
OPSD 923.011	Energy Attenuator, Crash Cushion, Component – Reinforced Precast Concrete Pad for Modified Temporary Concrete Barrier
OPSD 923.180	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Temporary, Unidirectional
OPSD 923.181	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Temporary, Bidirectional
OPSD 923.182	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Permanent, Unidirectional
OPSD 923.183	Energy Attenuator, Crash Cushion, Quadguard System, Installation - Permanent, Bidirectional

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OPSD 923.184	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Temporary, Unidirectional
OPSD 923.185	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Temporary, Bidirectional
OPSD 923.186	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Permanent, Unidirectional
OPSD 923.187	Energy Attenuator, Crash Cushion, Quadguard Wide System, Installation - Permanent, Bidirectional
OPSD 923.188	Energy Attenuator, Crash Cushion, Quadguard Extra Wide System, Installation - Temporary, Unidirectional
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OPSD 923.194	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Permanent, Unidirectional
OPSD 923.195	Energy Attenuator, Crash Cushion, Quadguard Super Wide System, Installation - Permanent, Bidirectional
OPSD 923.280	Energy Attenuator, Crash Cushion, TRACC System, Installation - Temporary, Unidirectional
OPSD 923.281	Energy Attenuator, Crash Cushion, TRACC System, Installation - Temporary, Bidirectional
OPSD 923.282	Energy Attenuator, Crash Cushion, TRACC System, Installation - Permanent, Unidirectional
OPSD 923.283	Energy Attenuator, Crash Cushion, TRACC System, Installation - Permanent, Bidirectional
OPSD 923.380	Energy Attenuator, Crash Cushion, TAU-II System, Installation - Temporary, Unidirectional
OPSD 923.381	Energy Attenuator, Crash Cushion, TAU-II System, Installation - Temporary, Bidirectional
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OPSD 923.386	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Unidirectional
OPSD 923.387	Energy Attenuator, Crash Cushion, TAU-II Wide System, Installation - Permanent, Bidirectional
OPSD 923.388	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Unidirectional
OPSD 923.389	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Temporary, Bidirectional
OPSD 923.390	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Unidirectional

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OPSD 923.391	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Temporary, Bidirectional
OPSD 923.392	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Unidirectional
OPSD 923.393	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-2, Installation - Permanent, Bidirectional
OPSD 923.394	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Unidirectional
OPSD 923.395	Energy Attenuator, Crash Cushion, TAU-II Extra Wide System - TL-3, Installation - Permanent, Bidirectional
OPSD 923.480	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Unidirectional
OPSD 923.481	Energy Attenuator, Crash Cushion, Smart System, Installation - Temporary, Bidirectional
OPSD 923.482	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Unidirectional
OPSD 923.483	Energy Attenuator, Crash Cushion, Smart System, Installation - Permanent, Bidirectional
OPSD 923.530	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Layout
OPSD 923.531	Energy Attenuator, Crash Cushion, Box Beam Bursting Energy Absorbing Terminal, Installation - Impact Head and Post
OPSD 924.131	Energy Attenuator, Crash Cushion, ABSORB 350 System, Installation - Temporary Concrete Barrier
OPSD 924.135	Energy Attenuator, Crash Cushion, ACZ-350 System, Installation - Temporary Concrete Barrier
OPSD 924.141	Energy Attenuator, Crash Cushion, SLED System, Installation – Temporary Concrete Barrier
OPSD 984.203	Energy Attenuator, Crash Cushion, Delineation, Installation - Temporary
OPSD 984.204	Energy Attenuator, Crash Cushion, Delineation, Installation - Permanent



CONSTRUCTION SPECIFICATION FOR STANDARD HIGHWAY FENCE

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771-A	Commentary

771.01 SCOPE

This specification covers the requirements for the installation of highway fence, brace panels, and gates.

771.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

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

771.01.02 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.

771.02 REFERENCES

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

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

B 209-10 Aluminum Alloy Sheet and Plate

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. The Contractor may be required to travel around obstructions.

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 949-12-9 and 948-12-9.75 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 949-12-9 and 948-12-9.75 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.

771.10.02 Removals and Replacements

Costs associated with any required removals and replacements of defective workmanship or materials shall be the Contractor's responsibility at no additional cost to the Owner.

Appendix 771-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

The designer should specify the following in the Contract Documents:

- Highway fence locations. (771.07.03.01)
- Brace panel locations. (771.07.03.03) Brace panels are computed in accordance with the following requirements:
 - a) At cross fences (separating property owners) - 3 panels required; one forming part of the cross fence, and two installed as part of the highway fence.
 - b) At cross fences (not separating property owners) - 1 panel is required to be installed on the cross fence at the straining post.
 - c) At all horizontal angles exceeding 22 degrees - 2 panels.
 - d) On all curves of radius 900 m or less - 2 panels at each end of curve and plus 2 panels at midpoint.
 - e) Gate locations and openings - 2 panels at each site in fence.
 - f) At all vertical angles exceeding 22 degrees - 2 panels.
 - g) At crossings of watercourses (maximum span: 6 m) - 2 panels.
 - h) Terminals - 1 panel per terminal.
 - i) Existing fence (adjacent to a removed section) - 1 panel per terminal.
 - j) New fence - on clear fence runs with none of the above cases - 2 panels at approximately 200 m intervals, with a maximum interval of 230 m.
- Gate locations, types, and sizes. (771.07.05)

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

OPSD 971.101	Fence, Highway, In Earth, Shale, Loose Rock, or Friable Rock, Installation
OPSD 971.102	Fence, Highway, In Solid Rock, Installation
OPSD 971.103	Fence, Highway, Installation Details



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 909
NOVEMBER 2016**
(Formerly OPSS 909, April 2012)

Note: The MUNI implemented in November 2016 replaces OPSS 909 COMMON, April 2012 with no content changes.

**CONSTRUCTION SPECIFICATION FOR
PRESTRESSED CONCRETE - PRECAST MEMBERS**

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909-A	Commentary

909.01 SCOPE

This specification covers the construction requirements for fabrication, delivery, and erection of concrete members with steel reinforcement.

909.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and 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.

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

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 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 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1442	Epoxy Coated 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-433 Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration

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 *
 - A23.4-09 Precast Concrete Material and Construction
 - G40.20/G40.21-04 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
 - G164-M92 (R2003) Hot Dip Galvanizing of Irregularly Shape Articles
 - G189-1966 (R2003) Sprayed Metal Coatings for Atmospheric Corrosion Protection
 - S6-06 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 A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete]

ASTM International

- B 633-07 Electrodeposited Coatings of Zinc on Iron and Steel
- C 171-07 Sheet Materials for Curing Concrete

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 members are cast.

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.

Design Proposal means a Contractor's submission of proposed changes, when engineering design is required.

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

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 the members of the same member type, cast during 7 consecutive Days.

Member means a precast concrete prestressed girder.

Member Type means a member differentiated by its cross-section shape such as Box, I, or T.

Post-Tensioning means a method of prestressing in which tendons are tensioned after the concrete has reached a predetermined strength.

Precaster means the party who produces the members.

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 tendons are tensioned before the concrete is placed.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Repair Proposal means a Contractor's submission when repairs to the members are required.

Strand means a group of wires laid helically over a central core-wire.

Sweep means the lateral deviation from straightness of a member 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 Permissible Changes to Prestressing of Members

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 member 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 Permissible Changes to Reinforcing of Members

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, as long as 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 tendons.
- 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 member may be adjusted to account for elastic shortening.

909.04.01.03 Temporary Bracing

Temporary bracing for members 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 members are to be permanently connected within the same construction season. If the members are not to be permanently connected within the same construction season, the return period to be used in the design shall be 25 years.

909.04.02 Submission Requirements

909.04.02.01 Working Drawings

The Contractor shall submit 3 sets of fabrication Working Drawings, including supporting documentation, to the Contract Administrator at least 7 Days prior to commencement of fabrication of the members, 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, 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 and the Owner, as stated elsewhere in the Contract Documents, shall be satisfied prior to commencement of the Work.

The Working Drawings shall include the following information:

- a) Member 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) All other applicable details.

The supporting documents shall include the following information:

- a) 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 member capacities.
- b) Handling and erection procedures, including calculations and lifting point locations.
- c) Details of bracing installed to provide adequate support and stability to the member 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 requirements of OPSS 1350.

909.04.02.03 Concrete Plant Certification

The precast concrete plant certificate verifying compliance with the certification requirements of the Canadian Standards Association (CSA) under the category Precast Concrete Products-Structural, Prestressed; or the Canadian Precast/Prestressed Concrete Institute (CPCI), Group B, Products and Group BA, Bridge Products with Architectural Finishes, Category B4, shall be submitted to the Contract Administrator as part of the concrete mix design submission.

Documentation verifying certification of the concrete production facility by the Ready-Mixed Concrete Association of Ontario shall be submitted when concrete is supplied by an external concrete supplier.

909.04.02.04 Control of Concrete Temperature

One week prior to the commencement of fabricating the members, 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 members, prior to shipping the members. The report shall contain the following information:

- a) List of members in the shipment, including their ID 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 used for temperature variation.
- d) Temperature control records, including location of thermocouple wires.
- e) Summary of material test results for plastic concrete: air content, slump, and concrete temperature.
- f) Summary of material test results for hardened concrete: transfer strength, confirmation of the projected 28-Day compressive strength, and air void system parameters. If test results are not available at the time of shipping, they may be submitted within 4 Business Days following completion of testing.
- g) Summary of all measurements and inspections required herein, including the concrete cover, crack measurement summary, tolerances, and surveys for geometric control.
- h) Documentation that the Contractor identified, evaluated, and corrected all repairable defects, as detailed under the clause on Repair of Defects and Deficiencies Repairable by Standard Methods.
- i) 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 members and required testing have been carried out in general conformance with the sealed and signed Working Drawings, supporting documents, and Contract Documents.

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 respond to the Contractor within 10 Business Days of receiving the proposal.

909.05 MATERIALS

909.05.01 Bearing Plate

The bearing plate shall meet the requirements of CSA G40.20/G40.21, Grade 300W or greater.

Anchor studs shall be a headed type and meet the requirements of CSA W59 M and shall be welded to the bearing plates prior to galvanizing.

All surfaces shall be hot dipped galvanized and meet the requirements of CAN/CSA G164 or shall be zinc metallised 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 and production shall be according to OPSS 1350 with the following exceptions 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 with the exception that the maximum nominal size of coarse aggregate shall not exceed 19.0 mm.
- e) Slag aggregate shall not be used.
- f) Superplasticizer may be added to the mix at time of batching for all types of concrete.

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 meet the requirements of OPSS 1213.

909.05.06 Formwork

All formwork shall be according to OPSS 919 and CAN/CSA A23.4. Forms shall be fabricated to meet the dimensional tolerances and finishes required herein.

909.05.07 Hardware

All hardware shall be non-corroding or be galvanized according to CAN/CSA G164.

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 C 171 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 pre-qualified list of concrete patching materials. The list of proprietary patching material shall be obtained from the Contract Administrator.

909.05.11 Steel Reinforcement

Steel reinforcement shall be according to OPSS 905, OPSS 1440, and OPSS 1442.

909.05.12 Strand Splices

Strands shall not be spliced.

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 and shall be capable of recording temperature and instantaneously displaying the temperature.

909.07 CONSTRUCTION

909.07.01 General

The Contractor shall notify the Contract Administrator in writing at least 7 Days prior to commencement of fabrication.

Each member shall be identified with a unique number and the date of casting. The information shall be marked on the members and shall remain visible for the duration of construction. When the information is stencilled, indelible ink or paint shall be used.

909.07.02 Precast Plant Certification

Members shall be fabricated by a plant certified by the Canadian Standards Association (CSA) under the category Precast Concrete Products-Structural, Prestressed; or by the Canadian Precast/Prestressed Concrete Institute (CPCI), Group B, Products and Group BA, Bridge Products with Architectural Finishes, Category B4.

909.07.03 Pretensioning

Tendons 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 tendon is uniform.

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.

909.07.05 Steel Reinforcement

The placement of steel reinforcement shall be according to OPSS 905, with the exception or addition or both of the placing tolerances listed below:

- a) Vertical position of prestressing tendons: + 5/-10 mm
- b) Length of debond on prestressing tendons: ± 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

909.07.06 Formwork

Formwork shall be according to OPSS 919.

909.07.07 Placing of Sheaths and Anchorages

When members 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.

909.07.08 Placing Concrete

The temperature of formwork, steel reinforcement, or the material on which the concrete is to be placed shall not exceed 30 °C.

The placing of concrete shall be according to OPSS 904, with the exception that the temperature of the formwork, steel reinforcement, or the material on which the concrete is to be placed shall be at a minimum temperature of 5 °C, prior to the placing operation. After discharging of concrete has started, one addition of superplasticizer shall be allowed, provided there is sufficient remaining time for mixing and testing. The slump and air content shall be re-tested if the mix is re-dosed.

During the placing operation, all exposed concrete surfaces shall be covered with water saturated burlap, within 2 to 4 m of the concrete reaching the top of the forms.

909.07.09 Concrete Finishing

The top surface of prestressed members, against which new concrete is to be placed, shall be intentionally roughened while it 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 members:

- a) Top portion of members containing laitance.
- b) The portion of the sides and end of the member against which new concrete is to be placed.

909.07.10 Control of Temperature

During production and during moist curing, moisture retention, and protection periods, the following temperature requirements shall be met:

- a) The concrete temperature shall not exceed 70 °C.
- b) The concrete temperature shall not fall below 10 °C before the concrete has reached 75% of the specified 28-Day compressive strength.
- c) The temperature difference between the concrete temperature of the member, and the conditions to which it is to be exposed shall not exceed 20 °C along any part of the member.

909.07.10.01 Temperature Records

Thermocouples, data loggers, handhelds units, and associated hardware shall be used to monitor the temperature of the member and the ambient conditions to which the member is exposed.

A sufficient number of thermocouples and thermocouple wires shall be installed to ensure compliance with the standard. As a minimum, thermocouples shall be installed to measure the following:

- a) Air temperature that the member is exposed or is to be exposed to.
- b) Concrete temperatures at the following locations:

For I-members

- i. In the middle of the web, 1 m from each end of the member.
- ii. In the middle of the web at mid-span.
- iii. In the middle of the bottom flange at mid-span.

For Box-members

- i. In the middle of the solid section at each end of the member.
- ii. In the middle of the bottom slab at mid-span.

Recording of the concrete temperatures shall begin at the start of the placing operation and continue until the moist curing, moisture retention, and protection periods are complete. For each member, the listed temperatures shall be recorded at intervals of 30 minutes or less.

The Contract Administrator shall be provided with necessary access, instrumentation, and equipment to verify temperature readings instantaneously. The thermocouples and data loggers shall be left in place until the end of the monitoring period.

909.07.11 Curing and Protection

909.07.11.01 Curing - General

Moist curing shall be applied for 48 hours followed by a 48-hour moisture retention period.

Concrete containing silica fume shall be moist cured for 7 Days, regardless of the ambient conditions.

During the moist curing and moisture retention period, the members may be exposed to ambient conditions for no more than a cumulative total of 3 hours for the purposes of form removal, release of strands at transfer strength, filling of bug holes, inspection, removal from the bed, and storage.

909.07.11.02 Moist Curing

During the first 48 hours after concrete placement, exposed surfaces shall be moist cured by any of the methods described below.

- a) Saturated burlap.
- b) Water spray or misting.
- c) Steam.
- d) Other means of maintaining 100% relative humidity next to the concrete surface.

Surfaces covered by the forms are not considered exposed. If forms are removed within the first 48 hours, all concrete surfaces shall be immediately moist cured by the positive addition of moisture for the duration of the 48 hours, according to the methods noted above.

Spray or steam to raise the ambient temperature above 30 °C, shall not be applied until after the concrete has attained its initial set. Steam, heat, or forced air shall not be directed on the concrete, forms, reinforcing steel or tendons. There shall be free circulation of steam, heat, and forced air around the top, sides, and ends of the members. The members shall be heated evenly. Concrete surfaces shall not be exposed to combustion gases.

All water shall be removed from and precautions taken to prevent the re-entrance of water into, the sheaths or any internal voids.

909.07.11.03 Moisture Retention

After moist curing has been completed, member surfaces shall be completely covered by moisture vapour barrier to protect members from moisture loss for a period of 48 hours.

At the option of the Contractor, moist curing methods may be continued during this period.

909.07.11.04 Protection from Cold

Prior to full exposure and after the moist curing and moisture retention periods, members that are to be exposed to temperatures less than 5 °C shall be protected from moisture loss for a minimum of an additional 3 Days. The protection period shall be extended beyond 3 Days, if required to meet the Control of Temperature clause.

All members must be dry prior to exposing them to temperatures below 0 °C.

909.07.12 Transfer of Prestressing Force

The prestressing force shall not be transferred to the members until the transfer strength specified in the Contract Documents has been reached. The prestressing force shall be transferred gradually and in a sequence that ensures eccentricities are kept to a minimum.

909.07.13 Treatment at Ends of Members

The prestressing tendons at ends of members that are to be encased in concrete shall be cut off 25 mm beyond the ends of the beams. The prestressing tendons at the end of members that are not to be encased in concrete shall be cut back to recess the cable 25 mm from the end of member. The recess shall be cleaned, filled with a proprietary patching material, and the ends of the members coated with elastomeric coating.

909.07.14 Quality Control

909.07.14.01 General

The Contractor shall carry out sufficient quality control testing and inspection to ensure that the concrete meets the requirements of the Contract Documents.

909.07.14.02 Sampling and Testing of Plastic Concrete

The Contractor shall be responsible for all aspects of sampling and testing of the plastic concrete for slump, air content, and temperature according to OPSS 1350. The results of these tests shall be recorded. The minimum frequency of testing shall be at least once for each load of concrete delivered by a truck mixer, or once for every 7 m³ of concrete for non-truck mixers until satisfactory control is established.

Satisfactory control is established when three consecutive tests of concrete are within the specified requirements, without field adjustments. If any field adjustments are required, testing shall continue until three consecutive tests meet the requirements with no field adjustments.

After satisfactory control has been established, testing shall be carried out on every third load delivered by a truck mixer, or at a delivery frequency of 21 m³ of concrete for non-truck mixers.

Sampling and testing of slump, air content, and temperature of plastic concrete, and casting of cylinders for determination of hardened concrete properties shall be carried out by a person holding either of the following certifications:

- a) CCIL Certified Concrete Testing Technician
- 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.

909.07.14.03 Transfer Strength

The Contractor shall demonstrate that the transfer strength specified in the Contract Documents has been achieved prior to transfer of prestressing force.

The Contractor, when requested by the Owner, shall participate in standard cylinder correlation strength testing programs conducted by the Ministry of Transportation.

909.07.14.04 Concrete Cover Measurement

The Contractor shall carry out, at the precaster's facility, a cover meter survey on all members until satisfactory control is established. For each lot, satisfactory control shall be established when three consecutive members of the same design are within the specified tolerances. After satisfactory control has been established, testing shall be carried out on every fifth member. If testing indicates that cover measurements for a member do not meet the tolerances specified in Table 1, testing shall resume on each member until satisfactory control is re-established.

Readings shall be taken at locations 300 mm from both ends, at mid-span, and at intervals not exceeding 5 metres along the length of the member.

For I-members, 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.
- d) Underside of member, located at 150 mm from both edges of flange.

For box members, 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 member, located at 400 mm from both edges of flange.

909.07.14.05 Dimensional Measurements

The Contractor shall carry out measurements on each member to determine compliance with tolerance requirements. Members shall meet the tolerances specified in Table 1.

909.07.15 Sampling for Quality Assurance

Concrete shall be sampled on a lot basis.

909.07.15.01 General

The Contractor shall be responsible for all aspects of preparation, storage, and transportation of cylinders to determine compressive strength, air void system parameters, and rapid chloride permeability. Cylinders shall be 100 mm in diameter and 200 mm long. Samples shall be taken after all field adjustments have been made to the load of concrete.

Concrete cylinders shall be cast, cured, handled and transported according to CSA A23.2-3C. The specimens shall be delivered to the ministry's regional quality assurance laboratory, as directed by the Contract Administrator.

Moulds shall be according to CSA A23.2-1D, with a lid. The lids shall be chemically and physically compatible with the concrete and shall provide a watertight seal for the moulds.

909.07.15.02 28-Day Compressive Strength

The Contractor shall cast one set of acceptance and at his discretion cast one set of referee cylinders for each lot. Both sets of cylinders shall be cast from the same batch of concrete.

One set shall consist of three cylinders.

Test information shall be recorded on MTO form PH-CC 322. The forms shall be submitted with the concrete cylinders.

909.07.15.03 Air Void System and Rapid Chloride Permeability

The Contractor shall cast 1 cylinder from each lot for determination of air void system parameters of hardened concrete and 2 cylinders from each lot for determination of rapid chloride permeability. Each cylinder shall be cast from concrete from a different member in the lot.

909.07.15.04 Sampling of Steel Reinforcement

The Contractor shall retain samples of steel reinforcement according to OPSS 905 for the duration of the Contract and deliver them to the Owner when requested. Samples shall be delivered by the Contractor to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15, Building C
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

909.07.16 Access for Quality Assurance

The Contractor shall supply electrical power, scaffolding, protection from the weather, and unhindered access to Owner's representatives for inspection and testing of all fabrication, delivery, and erection of prestressed concrete precast members.

For the purposes of cover meter and dimensional measurements, the Contractor shall clear all debris and obstructions and provide the Owner's representative with access.

909.07.17 Delivery

The Contractor shall notify the Contract Administrator in writing, 3 Days prior to delivery of the members.

Delivery shall include transportation and storage of the members. Transportation and storage shall be according to CAN/CSA A23.4. The work shall consist of loading of the members, delivery, unloading, and storage at the storage site and shall include temporary works for access.

Members 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.

Members shall be handled and transported with their webs in a vertical plane, and the points of support during lifting, storing, and transporting shall be according to the Working Drawings.

Members, when stored shall be stored in such a manner to avoid excessive stress or other damage.

Advertising by means of removable signing is permitted on elements only while in transit to the storage site. Any permanent markings on a surface that would be visible after erection shall not be permitted.

909.07.18 Erection

The Contractor shall notify the Contract Administrator in writing of the erection date at least 3 Days prior to the commencement of field erection operations. Erection shall be according to CAN/CSA A23.4.

The work shall consist of erection and stabilization of the members during construction. Members shall be lifted and placed in a manner to ensure they are not overstressed, unstable, or unsafe at any time.

The Contractor shall keep a copy of the Working Drawings on the site and accessible to the Contract Administrator during erection of the members.

The erection tolerance of members shall be ± 15 mm on the bearing in both the longitudinal and transverse directions.

For box members 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 members shall not exceed 70 mm with 35 mm maximum on either side.

The forces resulting from the lifting devices acting on the members shall not be inclined to the vertical at an angle greater than 30 degrees. All lifting devices for members shall be removed prior to the deck being poured.

CPCI girders and other members that may experience stability problems during construction shall be braced individually by attaching each end to the respective substructure element, immediately upon erection.

909.07.19 Repair of Defects and Deficiencies Repairable by Standard Methods

The Contractor shall repair any individual member having one or more of the defects and deficiencies identified in Table 2, 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 are located in the same area in the member, the contractor needs to submit a repair proposal. All causes, preventative actions, and corrective actions, including repair methods and materials used shall be documented.

909.07.19.01 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.

909.07.20 Certificate of Conformance

Within 5 Business Days of erecting all the members within a stage, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate shall identify the members 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.

909.07.21 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 members shall be according to the requirements of this specification, including satisfactory completion of all repairs, if applicable. Members not meeting the requirements of the Contract Documents shall be deemed unacceptable and shall not be included in the Work.

909.08.02 Acceptance of Concrete Compressive Strength

A 28-Day concrete compressive strength of a lot shall be considered acceptable when it meets all of the following:

- a) The average of the three individual compressive strength tests shall be equal to or greater than the specified strength.
- b) No individual cylinder test shall be more than 4.0 MPa below the specified strength.

Unacceptable lots shall be removed and replaced.

Compressive strength shall be determined according LS-426 for concrete with silica fume and high strength concrete and according to LS-407 for all other concrete.

The compressive strength result of the lot shall be the average of the set of three acceptance cylinders rounded to one decimal place.

The individual test results shall be forwarded to the Contractor as they become available.

909.08.02.01 Referee Testing Compressive Strength

If the Contractor has submitted a set of referee cylinders, an individual test result may be questioned by the Contractor within 5 Business Days of receiving the test result. The Contractor shall notify the Owner of his intention to referee test.

The lot shall be re-evaluated as based on the test result from the referee compressive strength cylinders representing the lot and the referee test result shall replace the original test result. The referee test result shall be binding.

909.08.03 Acceptance of Air Void System in Hardened Concrete

One half of a cylinder shall be tested to determine the acceptability of the lot. The cylinder shall be tested according to LS-432. The other half of the cylinder shall be retained by the Owner for audit purposes.

Individual test results shall be forwarded to the Contractor, as they become available.

For a lot to be considered acceptable, the cylinder shall have an air content of 3.0% or more and a spacing factor of 0.200 mm or less. Acceptable lots shall be subject to full payment.

Lots with a spacing factor between 0.200 mm and 0.250 mm shall be repaired as identified in Table 2.

Lots with a spacing factor exceeding 0.250 mm shall be rejected and replaced at the Contractor's expense.

909.08.03.01 Referee Testing of Air Void System in Hardened Concrete

Referee testing of air void system parameters shall be according to OPSS 1350.

909.08.04 Acceptance of Rapid Chloride Permeability

Rapid chloride permeability testing shall be according to LS-433. Acceptance of rapid chloride permeability shall be based on the result obtained on the cylinders representing 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 and shall be repaired as identified in Table 2. 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 and shall be repaired as identified in Table 2. Lots containing silica fume with rapid chloride permeability results exceeding 2,000 coulombs shall be rejected and replaced.

909.08.04.01 Referee Testing of Rapid Chloride Permeability

Referee testing of rapid chloride permeability testing for all concrete shall be carried out according to the high performance concrete requirements of the OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete clause. The reference to cores in OPSS 1350 shall be interpreted to mean cylinders.

909.08.04.02 Referee Testing Cost of Rapid Chloride Permeability

The cost of rapid chloride permeability testing for all concrete shall be according to OPSS 1350 Acceptance of Rapid Chloride Permeability for Silica Fume Overlays and High Performance Concrete clause.

909.08.05 Dimensional Verification and Concrete Cover Measurements

The Contract Administrator shall carry out measurements to confirm compliance with tolerance requirements of Table 1. Members exceeding the tolerances specified in Table 1 shall be rejected and not incorporated into the Work.

909.08.06 Defects and Deficiencies

909.08.06.01 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.

909.08.06.02**Defects and Deficiencies Repairable by Standard Methods**

Any individual member having one or more of the defects and deficiencies listed in Table 2 shall be deemed unacceptable and the member 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 member, the Contractor shall be required to submit a proposal for repair for acceptance according to the All Other Defects and Deficiencies clause.

909.08.06.03**Defects and Deficiencies Causing Rejection**

A member having any one of the following defects and deficiencies shall be rejected and shall not be incorporated into the Work:

- 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 member ends are 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 member ends are encased in concrete.
- d) If there is a crack in the bottom flange that extends through to the opposite face.
- 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.

909.08.06.04**All Other Defects and Deficiencies**

For members with defects or deficiencies that are not identified as rejectable or included in the list of defects and deficiencies repairable by standards methods in Table 2, or when more than one of the defects or deficiencies listed in Table 2 are located in the same area in the member, the Contractor shall submit a proposal for repair to the Contract Administrator for acceptance.

If the repair proposal is deemed acceptable, the members shall be repaired according to the proposal. The Contractor shall not carry out any repairs without the acceptance of the proposal. If the repair proposal is deemed unacceptable, the members shall be rejected and shall not be incorporated into the Work.

The repair proposal, signed and sealed by an Engineer, shall include as a minimum:

- a) Description of the member 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 member 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 member 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 erection.

909.10 BASIS OF PAYMENT

909.10.01 Prestressed Concrete Members (Type) Fabrication - Item Prestressed Concrete Members 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.

Members 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 members.

909.10.02 Payment Adjustment for Rapid Chloride Permeability

For concrete members containing silica fume, lots of members with an average value of rapid chloride permeability exceeding 1,500 Coulombs and less than or equal to 2,000 Coulombs shall be accepted with a payment reduction in addition to the repair method required in Table 2. The payment reduction shall be calculated and applied as follows:

- a) The price for the fabrication items in the Contract shall be converted to an equivalent price per meter length for each member type in the lot.
- b) P_r , the percent payment reduction factor for each lot = 10%
- c) For each member type in the lot, the payment reduction = $(P_r) \times (\text{Equivalent price per meter length}) \times (\text{Length of Members})$.
- d) Total payment reduction for each lot is the sum of the individual payment reductions for each member type calculated in 'c'.

909.10.03 Prestressed Concrete Members (Type) Delivery - Item Prestressed Concrete Members 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 Members (Type) Erection - Item Prestressed Concrete Members Containing Silica Fume (Type) Erection - 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 member	± 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 Members Without Voids	Flange depth ± 5 mm Web width $-5/+10$ mm
Flange Depth and Web Width for Members With Voids	Flange depth ± 10 mm Web width ± 10 mm
Width: Flanges and Box Members	± 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 members spaced apart Between adjacent members placed side-by-side	25 mm 15 mm
Hold-Down Position Along Length	± 300 mm
Void and Diaphragm Position Along Length	± 25 mm
Concrete Cover Over Reinforcing Steel	Unless otherwise specified in the Contract Documents, the tolerance for concrete cover over reinforcing steel 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
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.	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 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	Any cover readings less than 25 mm and greater than or equal to 20 mm	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings.
Compressive Strength	Any lot with 28-Day compressive strength lower than specified, but not more than 4.0 MPa lower than specified.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Rapid Chloride Permeability	Any lot of concrete containing silica fume with rapid chloride permeability value exceeding 1,000 and less than or equal to 2,000 Coulombs and lots of all other concrete with rapid chloride permeability value exceeding 2,500 and less than or equal to 3,500 Coulombs.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
Air Void System Parameters	Any lot with spacing factor greater than 0.200 mm, but less than or equal to 0.250mm.	The entire surface of the member shall be sealed, except areas against which new concrete is to be placed or in contact with bearings
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.

Appendix 909-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

Several revisions have been made to the technical information of OPSS 909. It is recommended that the designer and the users read the specification in its entirety to become familiar with the differences and necessary requirements for municipal use.

The designer should specify the following in the Contract Documents:

- Concrete compressive strength. (909.05.03)
- Concrete strength at transfer. (909.07.12, 909.07.14.03)

Subsection 909.07.15, Sampling for Quality Assurance, requires concrete cylinders taken to determine compressive strength, air void system parameters, and rapid chloride permeability to be delivered to the ministry's quality assurance laboratory and samples of steel reinforcement to be delivered to the MTO Concrete Section. For municipal contracts, the designer should write a special provision to delete the delivery locations for samples currently in this specification, and identify the appropriate quality assurance laboratory locations for sample delivery.

Clause 909.07.15.02 requires the use of MTO form PH-CC-322 for reporting concrete test information. If a form other than MTO form PH-CC-322 is to be used for submission purposes, the alternate form should be invoked by reference in the Contract Documents and a special provision should be written to delete the MTO form from the specification.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.



**ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION**

**METRIC
OPSS.MUNI 922
NOVEMBER 2016**

(Formerly OPSS 922, November 2009)

Note: The MUNI implemented in November 2016 replaces OPSS 922 COMMON, November 2009 with no content changes.

**CONSTRUCTION SPECIFICATION FOR
INSTALLATION OF BEARINGS**

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922.01 SCOPE

This specification covers the construction requirements for the installation of bearings.

922.01.01 Specification Significance and Use

This specification has been developed for use in provincial- and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

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

922.01.02 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.

922.02 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.

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

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

Ontario Provincial Standard Specifications, Material

OPSS 1202 Bearings - Elastomeric Plain and Steel Laminated
OPSS 1203 Bearings - Rotational and Sliding Surface

CSA Standards

A23.1-04/A23.2-04 Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete

ASTM International

C 928-05 Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs

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.

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.

Engineer means a Professional Engineer licensed by the Professional Engineers Ontario to practice in the province of Ontario.

Product Drawings means drawings prepared by the manufacturer that have been approved by the Owner for use with the product.

Quality Verification Engineer (QVE) means an Engineer retained by the Contractor qualified to provide the services specified in the Contract Documents.

Superstructure means all parts of a bridge above the bearings.

922.04

DESIGN AND SUBMISSION REQUIREMENTS

922.04.01

Submission Requirements

922.04.01.01

Layout and Installation Drawings

922.04.01.01.01

General

The Contractor shall submit 3 sets of bearing layout and installation drawings to the Contract Administrator at least 1 week prior to commencement of bearing installation, for information purposes only. An Engineer's seal and signature shall be affixed on the layout and installation drawings verifying that the drawings are consistent with the Contract Documents.

The Contractor shall have a copy of these drawings at the site prior to and during site installation of the bearings.

922.04.01.01.02

Elastomeric Bearings

The layout and installation 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.

922.04.01.01.03 Rotational and Sliding Surface Bearings

The layout and installation 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.

922.04.01.02 Jacking

When jacking of the superstructure is specified in the Contract Documents, the Contractor shall submit 3 sets of the jacking drawings to the Contract Administrator at least 1 week prior to commencement of jacking, for information purposes only. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges. An Engineer shall affix his or her seal and signature on the jacking drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

When jacking is not specified in the Contract Documents, the Contractor shall submit 5 sets of the jacking proposal drawings to the Contract Administrator at least 3 weeks prior to the commencement of jacking, for approval. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges and, where necessary, the details of support for the jacks. Proposals shall bear the seals and signatures of the design and checking Engineers.

A copy of each jacking proposal drawing shall be returned as one of the following:

- a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawing by the Contractor.
- b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by an Engineer stating the drawings have been revised according to the noted comments.
- c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

When another authority is involved with the Contract, all submissions shall be made at least 5 weeks prior to the commencement of work.

The Contractor shall have a copy of the jacking drawings or the approved jacking proposal drawings at the site prior to and during the jacking operation.

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 shall be cement based, non-shrink, non-staining, and approved by the Owner.

Grout shall have a minimum nominal 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 by the Contractor 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.

Grouting operations shall be according to the manufacturer's recommendations, except that 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.

922.07.02 Bearing Seats

The bearing seats shall be finished level and to an elevation established by subtracting the thickness of the bearings supplied from the top of bearing elevations specified in the Contract Documents. For elastomeric bearings, the finish of the concrete surface shall be smooth and not vary more 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 more 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 be intentionally roughened such that the surface has an equivalent to trowel finish. All surface areas shall be inspected and deemed acceptable by the Contract Administrator prior to installation of bearings.

922.07.03 Alignment

The longitudinal and transverse centrelines of the bearings shall be installed within ± 3 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.

922.07.04 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.

Where coring of the bearing seats to receive anchors is permitted, care shall be taken to ensure that the coring is done without damaging or cutting the steel reinforcement. Where permitted, coring shall not commence earlier than 3 weeks prior to bearing installation. In lieu of coring, the holes may be formed.

The holes shall be protected against entry of moisture and shall be completely filled with grout, when the anchors are installed.

922.07.05 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.

The thickness of the grout bedding for rotational and sliding surface bearings shall be $12 \text{ mm} \pm 3 \text{ mm}$. 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.

Elastomeric bearings shall not be placed directly on grout.

922.07.06 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	$\pm 5 \text{ mm}$
Steel plate girders	0 to + 3.0 mm
Steel and precast concrete box girders	0 to + 2.0 mm

922.07.07 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.

922.07.08 Jacking

Jacking operations shall be carried out under the direct supervision of an Engineer.

The lifting or lowering of the structure shall be carried out in one uniform and synchronized jacking operation. At no time during jacking operations shall the difference between any of the jacking points be more than 3 mm at the same abutment or pier cap.

When jacking is required in order to adjust the bearings, the structure shall be jacked the minimum amount required to allow the bearings to come back to a vertical position.

922.07.09 Quality Control

922.07.09.01 Certificate of Conformance

A completed Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the work. The Qualification Verification Engineer's seal and signature shall be affixed on the completed Certificate of Conformance confirming that the following are in general conformance with the requirements of the layout and installation drawings, Working Drawings, product drawings, and Contract Documents for the bearings:

- a) Fabrication
- b) Installation
- c) Adjustments, when applicable

922.07.09.02 Sampling and Supplying of Bearings

After the bearings have been fabricated, the Contractor shall notify the Contract Administrator in writing of the identification and availability of the bearings.

Where strip bearings have been specified for precast boxes placed side-by-side, each bearing strip 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.

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 selected by the Contract Administrator from all the bearings of each size and thickness fabricated for the Contract. The Contract Administrator shall advise the Contractor in writing which bearings have been selected for testing. The Contractor shall deliver these bearings to the location specified in the Contract Documents.

922.07.09.03 Grout Testing

Three 7-Day compressive strength cubes shall be made and tested according to ASTM C 928 for each day that grout is being placed.

For early strength testing, additional cubes shall be tested.

922.08 QUALITY ASSURANCE

922.08.01 Testing

The Contractor shall allow 60 Days from the time of submission of elastomeric bearings for the Owner's testing program.

The number, type, and size of elastomeric bearing samples to be selected for destructive testing shall be as specified in the Contract Documents.

922.08.02 Rejection

If a sample plain elastomeric bearing fails, all plain elastomeric bearings represented by that sample shall be rejected.

If the number of laminated elastomeric bearings specified is less than 10, failure of the sample bearing shall mean that all laminated elastomeric bearings are rejected.

If the number of laminated elastomeric bearings specified is 10 or more, failure of a sample bearing shall mean that all laminated elastomeric bearings of that size and thickness are rejected.

Rejected bearings, whether installed or not, shall be removed from the job site. Bearings supplied as replacements for rejected bearings shall be sampled, tested, and approved or rejected on the same basis as the original bearings.

922.09 MEASUREMENT FOR PAYMENT

922.09.01 Bearings

For measurement purposes, a count shall be made of the number of the bearings installed and of the bearings supplied for destructive testing. Alternatively, bearings may be a lump sum item.

922.10 BASIS OF PAYMENT

922.10.01 Bearings - 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 bearings are a lump sum item, payment at the Contract price for the tender item Bearings shall include full compensation for the bearings supplied for destructive testing.

Appendix 922-A, November 2009 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

The designer should specify the following in the Contract Documents:

- When jacking of a structure is required. (922.04.01.02)
- Type of bearing. (922.05.01)
- Top of bearing elevation. (922.07.02)
- Bearing location. (922.07.03)
- Bearing anchor dimensions and material. (922.07.04)
- Bearing anchor hole dimensions. (922.07.04)
- Number of sample bearings and delivery location of samples for testing. (922.07.09.02)
- Number, type, and size of elastomeric bearings for destructive testing. (922.08.01)

OPSS 922 contains information that is not used by municipalities in their Contracts. To ensure completeness of the municipal Contract Documents, the designer should invoke Appendix 922-B. The appendix contains information that modifies OPSS 922 so it can be used by a municipality in its Contracts.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.

Appendix 922-B, November 2009

FOR USE IN MUNICIPAL CONTRACTS, WHEN REFERENCED IN THE CONTRACT DOCUMENTS

Note: This is a non-mandatory Additional Information Appendix intended to provide supplementary requirements for the OPS specification in a municipal contract, when the appendix is invoked by the Owner. It is written in mandatory language to permit invoking it by reference in the Contract Documents. If the appendix has not been invoked by reference in the Contract Documents, it does not apply.

Supplementary Requirements for Using OPSS 922 in Municipal Contracts

OPSS 922, Installation of Bearings, is amended as follows:

922.03 DEFINITIONS

Section 922.03 is amended by the deletion of the definitions for Certificate of Conformance and Quality Verification Engineer.

922.04.01.01.01 General

Clause 922.04.01.01.01 is deleted in its entirety and replaced by the following:

The Contractor shall submit 5 sets of bearing layout and installation drawings to the Contract Administrator at least 3 weeks prior to commencement of bearing installation, for information purposes only. An Engineer shall affix his or her seal and signature on the layout and installation drawings verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

The Contractor shall have a copy of these drawings at the site prior to and during site installation of the bearings.

922.04.01.02 Jacking

Clause 922.04.01.02 is deleted in its entirety and replaced by the following:

When jacking of the superstructure is specified in the Contract Documents or is required due to the Contractor's method of construction, the Contractor shall submit 5 sets of the jacking or jacking proposal drawings to the Contract Administrator at least 3 weeks prior to the commencement of jacking, for review. The submission shall include the method and location, type, and capacity of jacks to be used; the type and location of the gauges; and the calibration certificates for both the jacks and gauges and, where necessary, the details of support for the jacks.

All jacking drawings shall bear the seal and signature of an Engineer verifying that the drawings are consistent with the Contract Documents and sound engineering practices.

Proposals shall bear the seals and signatures of the design and checking Engineers.

Appendix 922-B

922.04.01 Design and Submission Requirements

Subsection 922.04.01 is amended by the addition of the following:

922.04.01.03 Return of Submissions

Two copies of each submission shall be returned as one of the following:

- a) Stamped with the wording that allows for permission to construct. In this case, work can commence on receipt of the drawings by the Contractor.
- b) Stamped with the wording that allows for permission to construct as noted. In this case, work can start on receipt of the drawings by the Contractor. The drawings shall be updated as noted and shall be sealed and signed by an Engineer stating the drawings have been revised according to the noted comments.
- c) Showing only required changes. In this case, the drawings shall be updated as required and the submission process repeated.

When another authority is involved with the Contract, all submissions shall be made at least 5 weeks prior to the commencement of work.

The Contractor shall have a copy of the stamped updated or accepted drawings at the site during any jacking operation.

922.07.09.01 Certificate of Conformance

Clause 922.07.09.01 is deleted in its entirety.

