

Was it Worthwhile?

Results of funding transportation research through partnerships

The Ontario Ministry of Transportation (MTO) has a long history of pursuing and funding transportation research through partnership arrangements. This strategy has allowed the ministry to tailor research to priority areas while leveraging research and development dollars through combining funding resources with others. Recently, the ministry analysed the efficacy of this strategy in yielding good value and return on investment.

Highway Infrastructure Innovation Funding Program (HIIFP)

The HIIFP was established in 2003 to encourage and assist Ontario universities and colleges to pursue basic and applied undergraduate and graduate research in transportation infrastructure, with possible subject topics including: Engineering Materials, Environment, Highway Design, Structures, Construction, Traffic Operations, Intelligent Transportation Systems, Geomatics, and Maintenance. HIIFP is explicitly intended to solicit innovative approaches, methodologies and outcomes to address ministry business needs, while focusing and leveraging research dollars. Any ensuing research reports are made available on the ministry's public website, through the MTO Library at: <http://www.mto.gov.on.ca/english/transrd/index.shtml>.

To date, 103 individual projects have been funded at 12 Ontario institutions. A little less than one-third of the projects are multi-year. MTO has disbursed \$4.6 million and leveraged additional funding of \$3.4 million for a total research value of \$8.0 million. Funding levels have averaged \$571,000 annually, with an average funding amount of \$33,000/project/year.

Special Projects Research

HIIFP is the ministry's formal highway research funding program that, with its current budget, typically funds about 13 projects annually. Additional research needs are supported through other arrangements, such as bi-lateral partnerships with universities, programs or researchers; pooled funding opportunities with the Transportation Association of Canada (TAC) and Federal Highways Administration (FHWA); specific in-house projects; or other internal / external partnerships. For instance, in 2009/10, MTO special projects research included: four university research projects; 12 pooled funding projects with TAC and FHWA; one in-house project; and one internal/external partnership. Over the 18 projects, MTO funding of just under \$600,000 leveraged other funding of over \$2.5 million.

Intangible Benefits

Although demonstrating the tangible value of conducting research in this manner is vital, less quantifiable merits were not overlooked. Several intangible benefits that were identified:

- Through hands-on, relevant projects, university and college students are encouraged to pursue a career in the highway transportation field
- Academic researchers develop a better understanding of MTO research needs
- MTO develops a better understanding of academic research directions, expertise and specialized equipment and is better able to pursue and implement innovation
- Multi-partner relationships among MTO, academia and industry allows MTO to sit as an active steering committee member and direct research focus

Measurable Return on Investment

In terms of research dollar leverage, the HIIFP has performed well. For every \$1.00 MTO has invested, another \$0.74 has been invested by another party.

Determining the measurable value of funding arrangements considered research dollars' return on investment: "Transportation research is considered valuable when the result is perceived to be worth an amount equal to or greater than the funds spent on it."¹ The projects themselves have yielded good return on investment to MTO, as illustrated by the following examples:

Video Logging

A Ryerson project – to increase the operational use of the ARAN vehicle and automate collecting field data – was later refined and implemented by MTO province-wide. From an initial research investment of \$34,000 (\$24,000 from MTO), MTO estimates annual savings of \$150,000 by expanding ARAN data collection through the addition of video logging equipment, rather than operating separate data collections.

Alkali-Silica Reaction

A University of Toronto project correlated short-term laboratory tests with long-term performance to predict concrete behaviour, which improved understanding of detrimental chemical processes in concrete. This new information was subsequently incorporated into ministry specifications to improve the quality and extend the life of concrete. With a research investment of \$29,000, MTO calculates implementation of the changed concrete standards >

¹ NCHRP Report 610: Communicating the Value of Transportation Research

Results of funding transportation research through partnerships, *continued*

that can add one extra year of bridge life before rehabilitation or replacement occurs – at a savings of \$40,000/structure – for an overall savings of \$72 million over the life of the ministry's 1,800 concrete bridges.

Effect of Winter Weather and Maintenance Treatments on Highway Safety

A University of Waterloo project demonstrated that Direct Liquid Application for anti-icing operations was associated with a reduction in accidents during winter storms, and that pre-treatment of granular salt with anti-icing liquid made it 18 to 40% more effective than dry granular. From a research investment of \$30,000, MTO estimates that this application will reduce ministry use of 100,000 tonnes of materials at a savings of \$7 million annually. More importantly, it is expected to reduce accidents, saving lives, injury and property damage.

Research dollar leverage in special projects partnering with universities, TAC and FHWA has been excellent. In 2009/10, for the four university projects, funding from others compared with MTO contributions was at a ratio of over three to one. In the 12 pooled TAC and FHWA projects, MTO contributed about one-tenth of the required funding. The following two examples demonstrate the kind of return on investment that these partnerships have produced:

Seasonal Load Advisory System

Currently, reduced load periods are imposed and removed based on calendar dates. A University of Waterloo project, now in the second of three years, has been using a series of sensors and models, to quantify when frost enters and leaves the roadway profile. Improving the accuracy of determining reduced load periods has potential to increase the life of surface-treated roads significantly. An American study found that a 50% weight reduction during thaw increased service life by 95%. MTO has contributed about a quarter of the \$524,000 project, and expects to realize cost savings by being able to accurately impose reduced load periods and extend the service life of roads susceptible to this type of damage.

Implementation of the Simple Performance Tester for Superpave Validation

MTO has contributed to a three-year, \$1.6 million FHWA study of performance tests used to characterize asphalt mixtures designed using Superpave technology. Performance predictors of such pavements – e.g. predicted pavement life and rutting resistance – could be used for analysis, as well as linked directly to implementation of the Mechanistic-Empirical Pavement Design Guide. An FHWA study has shown a reduction in life cycle costs of at least 5%. Based on a figure of \$250 million in hot mix asphalt placed on MTO projects in 2009, a 5% reduction would produce annual savings of \$12.5 million for the ministry.

A typical vehicle travelling on highways in northern Ontario, carrying a heavy load



Direct Liquid Application

Proven Value

Based on the FHWA definition, many of the projects that MTO has funded through partnership arrangements have proven demonstrably worthwhile by several measures. There is ample evidence that research benefits include cost savings and improvements to asset quality and longevity. The ministry plans to continue its partnership approach into the foreseeable future, supporting appropriate research projects with potential for such benefits. As well, MTO plans to seek additional and new research partnerships and models, so it may continue to implement innovations and provide good value in using its resources. ●

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A Top Infrastructure Priority *Progress on the Windsor-Essex Parkway*

The Windsor-Essex Parkway is one of Ontario's highest profile projects and with good cause. Once built, this state of the art 11 kilometre below grade freeway will feature eleven tunnelled sections, a four-lane service road, 20 km of recreational trails and more than 300 acres of green space. It will be the most significant single highway investment in Ontario history.

The Windsor-Essex Parkway is being delivered as Ontario's first Alternative Financing and Procurement (AFP) highway project in partnership with Infrastructure Ontario. On August 6, 2010, the request for proposals closed with three short listed bidders submitting proposals to deliver the Parkway. The Ontario Ministry of Transportation (MTO) and Infrastructure Ontario plan to identify a preferred proponent in fall of 2010. The Windsor-Essex Parkway will remain publicly owned, publicly controlled and publicly accountable.

Since receiving environmental assessment approval in 2009, the Windsor Border Initiatives Implementation Group (Windsor BIIG) of MTO, has been moving quickly prior to full construction scheduled to start in 2011. Activities have included property acquisition, demolition, initial construction and habitat restoration.

Property acquisition is well underway. Less than 100 of the approximately 900 property agreements required for construction of The Windsor-Essex Parkway remain to be finalized. As the ministry has purchased a number of properties with materials that could be used by the community, Windsor BIIG has partnered with local volunteers for a first of its kind pilot project, called WE Pay It Forward. To date, volunteers have salvaged over 150 tonnes of materials including windows, doors, electrical fixtures, cabinets and bathtubs from over 130 buildings. Habitat for Humanity, one of the local community groups receiving the materials, has had unprecedented sales this summer, tripling its typical monthly sales figures. In addition to benefiting the community, building materials are kept out of landfill. This pilot project is being examined by the ministry for future demolition projects elsewhere in Ontario.

Windsor BIIG has awarded four demolition contracts totalling more than \$360,000 to local Windsor-Essex companies for removal of buildings on properties purchased for the Parkway. Approximately 50 properties have been demolished to date with more slated for demolition by the end of 2010.

Efforts underway also include the protection and enhancement of Ojibway's tallgrass prairie habitat and eight identified species at risk. MTO is working closely with the Ontario Ministry of Natural Resources on detailed management, monitoring and habitat restoration plans. Through these plans MTO is



The left side of this photo shows noise barrier poles being "planted" by the highway at Tecumseh on Highway 401, in preparation for noise barrier installation.

protecting, creating and restoring hundreds of acres of habitat, enhancing links between natural areas and the long-term survival of species at risk. This past summer, Windsor BIIG Environmental Planners worked with a team of experts to build a hibernaculum that will be a future home for Butler's garter snakes and Eastern Fox snakes.

Initial construction activities currently underway are nearing completion. A \$15.5 million contract was awarded to Facca Construction to build two bridges and a two kilometre noise barrier where Highway 401 meets Highway 3. Crews are currently installing [innovative transparent panels](#) in the noise barrier to improve the visibility of the landscape for both residents and drivers. Heavy construction of the bridge structures and noise barrier began earlier this year and will be completed this fall.

The Windsor-Essex Parkway is considered Ontario's number one economic infrastructure priority. Delivery of this innovative project will support Ontario's economic growth and ensure Ontario's transportation system remains a key driver for economic competitiveness. ●

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Let it Rain!

New Design Support Tool Developed to Identify Rainfall Intensity, Duration, and Frequency across Ontario

When designing highway drainage infrastructure such as culverts, bridges, sewer systems and roadside ditches, good estimates of peak rainfall intensity are essential. Quality rainfall data enables designers to make calculations that meet drainage capacity design standards and avoid the over or under design of drainage elements. Both can be expensive: over design may waste resources and under design can result in additional maintenance or repair costs.

In collaboration with the University of Waterloo, MTO has recently developed a web-based tool for Rainfall Intensity Duration Frequency (IDF) curves. The first of its kind in Canada, this tool uses the latest Environment Canada data available at 125 Meteorological Services of Canada (MSC) stations across Ontario to determine rainfall intensities for any location in the province.

Design flow rates for a particular area are typically estimated using Rainfall Intensity Duration Frequency (IDF) curves. The curves summarize extreme rainfall patterns for a particular location, by representing the statistical relationship of rainfall intensity corresponding to storm duration and frequency, by graph or table.

Historically, MTO provided these curves for each MTO District in a hard copy document which was developed based on Environment Canada data up to 1989. An update of these curves was necessary to reflect more up-to-date Environment Canada data and to provide a more robust, easy to use and more comprehensive coverage of these curves across Ontario. Furthermore, climate change implications are beginning to be reflected by the recent precipitation records. It is essential to periodically update these IDF curves when additional data and new

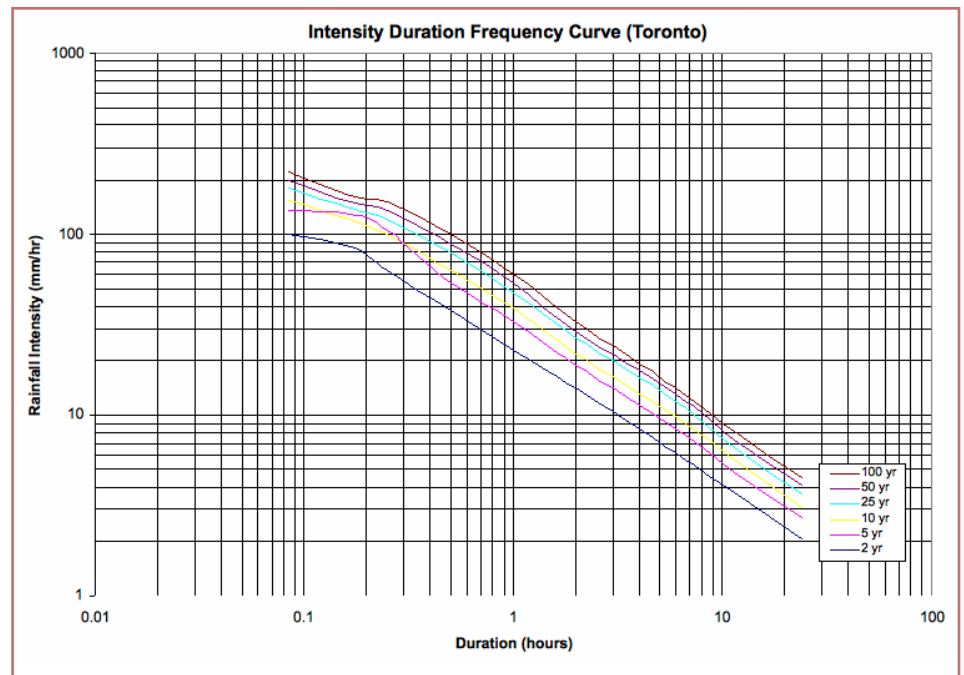


Figure 1: A sample Intensity Duration Frequency (IDF) curve.

techniques become available so that the climate change implications (if any) are reflected in a timely fashion.

The new web-based tool can provide the IDF curves electronically at any location across the Province and uses up-to-date data from Environment Canada.

The three main objectives of the MTO/ University of Waterloo project were to:

- Review the advanced statistical methods for rain gauges interpolation,
- Develop an independent statistical method to derive regional IDF curves for Ontario;
- Design a user-friendly, updatable interface to provide graphic and tabular presentation of the IDF curves; and
- Provide error estimates at gauging station locations to indicate the statistical fit of the model results to actual measured values.

The project study team selected interpolated annual maximum rainfall depth statistics for nine storm durations and six return periods to develop the updated IDF curves. This data, acquired from the WATMAPPR (Waterloo Multiple Physiographic Parameter Regression) model, were converted into a more useable format and the tool's user interface was developed using JavaScript, XHTML, PHP, and Google APIs (e.g., 'Maps' and 'Charts').

The new IDF curves are project location based. The limits of a highway project are identified on the user interface by two representative locations. These locations are defined either by entering their latitude and longitude coordinates or by selecting the locations from the Google Maps interface.

With coordinates, the system identifies the IDF curve representative of these areas. The display shows the % error at the two >

New Design Support Tool Developed to Identify Rainfall Intensity, Duration, and Frequency across Ontario, *continued*

identified points by assigning a representative colour to the icons. If the % error is greater than the acceptable value the highway section can be divided into two sections by adding a third intermediate point. This will result in dividing the highway project into two areas each with a different IDF curve.

In most highway projects, one IDF curve will be representative of the rainfall statistics for the entire project. In rare cases, two IDF curves may be necessary. For bridge and culvert design, multiple points can be selected to define the boundary of the catchment area contributing water to the crossing location.

The new IDF curves, MTO's latest design support tool, ensures that future highway drainage infrastructure designs are based on a more precise representation of recent weather patterns and can be reflective of any climate change trends in the historic data. It will be easily updated as new rainfall data becomes available.

The new MTO IDF curves web interface tool is in the final stages of completion. The release of this tool is expected in October 2010. A Highway Design Bulletin will announce the effective date when the new IDF Curve tool can be used for the design of MTO highway projects.

The interface tool is being made available through the MTO Internet website at: <http://www.mto.gov.on.ca/english/engineering/drainage/index.shtml> as well as on the Provincial Highway Management, Drainage and Hydrology Intranet Page. ●

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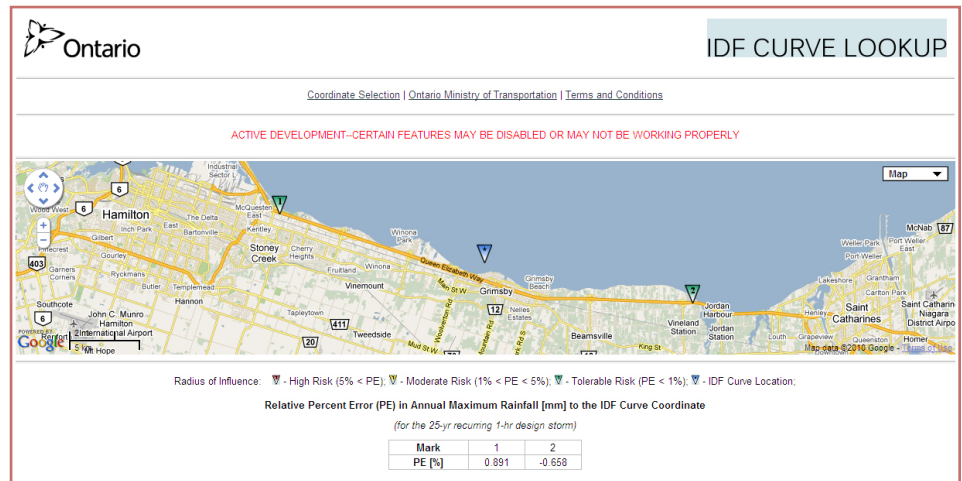


Figure 2: Example site location: QEW near Hamilton.

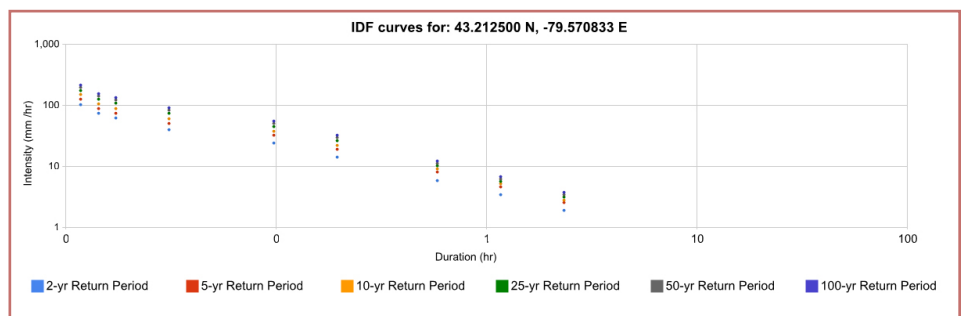


Figure 3: Graphical presentation of the IDF curve by the interface tool.

Return Period [yr]	Annual Maximum Rainfall Intensity [mm hr ⁻¹]								
	Storm Duration [hr]								
	0.083333 (5-min)	0.166667 (10-min)	0.25 (15-min)	0.5 (30-min)	1	2	6	12	24
2	104.0	75.0	61.6	39.8	24.3	14.2	6.0	3.4	1.9
5	124.8	88.8	74.4	51.0	32.2	19.2	8.3	4.6	2.5
10	152.4	107.4	90.0	60.0	37.8	22.1	9.3	5.2	2.8
25	177.6	127.8	109.2	75.2	45.3	26.5	10.3	5.7	3.1
50	196.8	142.2	121.6	84.0	50.5	29.6	11.3	6.3	3.4
100	217.2	157.8	134.0	92.6	55.7	32.6	12.4	6.9	3.7

Figure 4: Tabular presentation of the IDF curve by the interface tool.



Figure 5: Highways during a rainfall event.