MINISTRY OF TRANSPORTATION ONTARIO (MTO)

Highway Infrastructure Innovation Funding Program

Guidelines & Application Forms for Ontario Universities and Colleges

2016

ONTARIO MINISTRY OF TRANSPORTATION
HIGHWAY INFRASTRUCTURE INNOVATION
FUNDING PROGRAM
for Ontario Universities and Colleges
Guidelines 2016

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ONTARIO MINISTRY OF TRANSPORTATION

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM *for Ontario Universities and Colleges* Guidelines 2016

Deadline for Applications is
Friday, April 15, 2016 at 2:30PM

1.0 INTRODUCTION

The Ontario Government seeks to invest in the future of Ontario's Transportation Infrastructure through its Highway Infrastructure Innovation Funding Program.

HIIFP provides a challenge to Ontario's academic community to contribute to solutions in a number of areas including engineering materials, traffic operations, intelligent transportation systems, highway design, investment planning, environmental, bridges, geomatics, construction and maintenance. Some of these challenges involve detailed technical issues and others are open invitations for new ideas in a focus area. Your Institution is invited to submit one or more applications on how you can help us meet these challenges.

A glossary of terminology and acronyms used in these Guidelines are provided for your ease of reference:

- Institutions: Ontario universities (and their affiliated colleges, research centres, and institutes) and Ontario colleges of applied arts and technology
- Ministry: Ministry of Transportation Ontario (MTO)
- HIIFP: Highway Infrastructure Innovation Funding Program

2.0 PURPOSE OF THE PROGRAM

The purpose of this program is to fund research at Ontario colleges and universities to encourage applied research in transportation infrastructure in Ontario. This program is intended to solicit innovative solutions to assist the Ministry in meeting its strategic plan and to encourage undergraduate and graduate research in transportation and infrastructure engineering by providing funding to aid in such research. The present funding program is designed to supplement the research expertise at the Ministry with that available from Ontario's academic community. The following areas of transportation and infrastructure engineering are included in this program:

- Traffic Operations
- Intelligent Transportation Systems
- Engineering Materials
- Highway Design
- Investment Planning
- Environmental
- Geomatics
- Bridges
- Construction
- Maintenance

Research needs statements have been developed that outline the background of the research need, the challenge or problem to be addressed and anticipated research deliverables. Most of the challenge statements involve specific problems that will require innovation to solve. Typically, the anticipated research deliverable includes a technical report (that follows the Technical Style Manual – attached) and a presentation to a Ministry technical committee.

HIIFP is intended to support and encourage research into highway infrastructure. The Ministry has identified a number of specific topics that offer an opportunity for learning, innovation, and results. The Ministry will further support researchers with the opportunity for direct contact with Ministry specialists.

3.0 SCOPE OF THE HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM

3.1 Eligible Institutions

All Ontario's 23 public universities and 25 colleges are eligible for funding under the HIIFP. The principal researcher must be a member of the faculty (full or part-time) at the sponsoring Institution.

3.2 Eligible Research Topics

A diverse range of research topics in the area of transportation and infrastructure engineering are included in this program.

To be eligible for funding, HIIFP applications must cover one (or several) of the topics from the following categories:

- **Specific Research Topics**
- **Open Research Topics**

3.2.1 Specific Research Topics

Each Specific Research Topic is defined as follows:

Subject Area:	General Subject Area
Title:	Title that identifies subject area
Background:	Discussion of the subject area, work done to date, thoughts on how to solve the challenge, reference information.
Challenge:	A statement or question that outlines the challenge.
Anticipated Deliverables:	Typical deliverable is a technical report that demonstrates how the challenge was addressed and/or met and shows how improvements may be made. A presentation to a technical committee is also expected. Sometimes the anticipated deliverable provides more information on how to meet the challenge.

The following topics have been identified as priority research areas for this year and detailed descriptions of each topic are provided in Attachment A.

	Title
1	Development of a New Asphalt Mixture Aging/Conditioning Procedure To be Used for Performance Testing of Asphalt Mixtures
2	Estimating Pavement Damage associated with Heavy Vehicle Loading using In-road Sensor Technology
3	Performance Requirements for Geogrid Reinforcement in Pavement Base-Layer Applications
4	Prediction of the Resilient Modulus for Ontario Granular Base/Subbase and Subgrade Materials Using Simple Approaches for Implementing MEPDG in the Design of Pavements
5	Calibration and Verification of Pavement Surface Images.
6	Swamp treatment for highway/road crossings
7	Climate Change Effects on Stability of Embankments
8	Gray Ratsnake Road Mortality Research Study
9	Effective Management Techniques for Invasive Phragmites
10	Increasing Biodiversity In MTO's Roadside Seed Mixes Through The Use Of Native Seed
11	Eastern Whip-poor-will Habitat Research
12	Barn Swallow GPS tracking on MTO infrastructure sites containing high nesting colonies
13	Model for Lateral Resistance of Piles
14	Geosynthetic Reinforced Soil Integrated Bridge System (GRS IBS)
15	Geophysical Methods for Subsurface Characterization and Determination of Shear wave Velocity Profiles
16	Design of reinforced concrete flexural and compression elements using stainless steel reinforcement
17	Life Cycle Assessment for Sustainability of Geotechnical Projects
18	Assessing the Impact of Winter Maintenance Standards
19	Comparative Evaluation of Road Condition Reporting and Measuring Technology
20	Review and Validation of Winter Materials Application Rates
21	RWIS Network Planning Tool

3.2.2 Open Research Topic(s)

MTO will also accept and evaluate HIIFP proposals on topics not specified in the Guidelines that the principal researcher considers relevant to highway infrastructure innovation and the Ministry's business needs.

If you choose to submit an HIIFP application on another research topic, please carefully outline to the Ministry a clear need for the research topic(s) including how its application will enhance MTO practices and business needs.

For more information and to determine suitability of the proposed topic, contact:

Jessica Grimes
Provincial Highways Management Division
Ministry of Transportation
Jessica.Grimes@ontario.ca

3.3 Ministry Assistance in Conducting Funded Research

For each application that is approved, a Ministry technical specialist in the relevant subject area will be assigned to liaise with the principal researcher.

Timing of periodic meetings or telephone conference calls and brief progress reports will be negotiated at commencement of the project. Brief written progress reports will be required a minimum of every 6 months; see Attachment E for sample template.

For most funded applications, a technical presentation of the study results will be required. The presentation will typically be held at a location agreed to and acceptable to both parties.

3.4 Available Funds and Eligible Expenditures

Please be advised that the award value is subject to budget approval and the Ministry may have to delay any awards until the budget has been approved.

The total value of the awards is expected to be about $1,000,000 beginning April 2016. It is expected that approximately twenty-eight projects will be funded. The Ministry reserves the right not to provide any funds in its sole discretion and without any reasons.

The Ministry will consider applications that are multi-year, where funding is required in each year. In such cases the Ministry will endeavour to provide funding beyond next fiscal year (ending March 31, 2017), however, cannot guarantee funding in future years and reserves the right to not provide the funding and terminate the research on written notice to the Institution.

For approved multi-year applications, Institutions will be required to provide brief progress reports to the Ministry indicating progress made on the project by the Institution; see Attachment E for sample template. Failure to provide such progress report(s) that describes substantial completion of tasks set out may result in the Institution being denied funding in subsequent fiscal years.

The salary of the principal researcher is not eligible for funding under the HIIFP, and nor is the principal researcher to charge any fee in this respect.

3.5 Fieldwork on Ministry Highways

The Ministry must approve proposed fieldwork on Ministry highways, and any proposed fieldwork on Ministry highways must be communicated by the principal researcher to the Ministry prior to submitting an HIIFP application. Approval to proceed will be given by:

Jessica Grimes
Provincial Highways Management Division
Ministry of Transportation
Jessica.Grimes@ontario.ca

3.6 Information and Data Confidentiality

The principal researcher and the Institution agree that all information and data that the Ministry may provide in respect of the research project shall be kept confidential and that the Institution shall only use the information and data for the purposes related to the submission of a final report to the Ministry for the research project. The Institution shall ensure that reasonable methods are taken to secure the confidential information and data of the Ministry. Failing to comply with this provision may result in the termination of the project, where upon the Institution shall return all information and data, return all monies paid by the Ministry and may result in the Institution being precluded from the award of future HIIFP awards.

4.0 APPLICATION PROCEDURE, DEADLINES

4.1 Application Components

The application shall consist of the following components:

1. **MTO HIIFP Application Form (Attachment B)**
2. **Summary** of Research Proposal (300 words maximum, in plain language suitable for communicating with the public **(Attachment C).** Portions of this summary may be used in a media release, so the language should be non-technical and free of acronyms or jargon.
3. **Budget Summary (Attachment D)**
4. Detailed **Research Proposal** (maximum 12 pages in 12-point font). Note, requirements are described in Section 4.2
5. **Budget** Details (see section 5.0 BUDGET).
6. ***Curriculum vitae*** of Principal Researcher and other principal research staff named in the Application Form (component 1, above).
   Only ONE COPY of the *curriculum vitae* for each principal staff member need accompany the application. Submission of an NSERC Form 100 personal data form is acceptable.
7. Appendices. Only **ONE SET** of the complete appendices containing papers, reports, and other relevant information need accompany each application.
8. **For Principal Researchers who received funding for research projects as part of the 2015 HIIFP, a brief Progress Report is required** for each respective research project that the Principal Researcher received HIIFP funding for in 2015. The principal researcher can provide a progress report as per

sample template in Attachment E or copy(s) of written progress reports complete to date if within the previous 3 months.

9. If applicable, description of and reason for request for use of MTO Facilities and or work on MTO highways.

Section 6.0 SELECTION CRITERIA outlines the criteria used to assess the applications for HIIFP funding.

The Ministry reviewers will treat information contained in the submitted applications as confidential.

4.2 Detailed Research Proposal Requirements

The detailed research proposal must include a description of:

- Understanding of the need for this research and the objective
- Methodology and details of the proposed analysis
- Proposed innovation in approaches, methodologies and potential outcomes
- Schedule of the activities to be undertaken during the project, identifying key milestone and associated dates
- Qualifications of the principal researcher in the planned area
- Related work performed by the applicant and others on the team.

4.3 Deadlines & Address for Applications

Deadline for the receipt of applications is **Friday, April 15, 2016 2:30PM EST.** Completed applications and all supporting documentation must be received by this deadline. They must be submitted to:

Jessica Grimes
Executive Office, Highway Standards Branch
Ministry of Transportation
301 St. Paul Street, 2nd Floor
St. Catharines, ON L2R 7R4

Please submit:

- 1 electronic digital copy on CD or USB.
- 1 hard copy of the innovation funding application form with original signatures (application components as describe in 4.1 Application Components). Only one copy of the appendices need be supplied.

5.0 BUDGET

5.1 General

The detailed budget must include a full account of purchases and activities to be financed by the HIIFP funding. The level of budget breakdown and supporting information provided should be sufficient to justify the items relative to the Research Proposal description.

As stated in Section 3.4, multi-year funding applications will be considered and provided on condition that sufficient information is provided.

The Ministry selection committee reserves the right to disallow expenditures in the budget that are not adequately justified. The committee may recommend partial support of a Proposal.

5.2 Budget Summary

Institutions must submit a budget summary as stated in 4.0 Applications Procedures, Guidelines, and having regard to the provision of Available Funds and Eligible Expenditures.

Furthermore, the following types of expenditures are eligible for funding:

5.2.1 Estimated Salaries and Benefits

Salaries, stipends, and related federal, provincial and institutional non-discretionary benefits for research work performed by research personnel (i.e., students, research associates, and technicians). The Ministry will not fund the salary of the principal researcher.

5.2.2 Estimated Equipment or Facility

Equipment or facility costs directly attributed to the research proposal may be funded. The researcher may propose to use Ministry materials and structural laboratory facilities as part of their application, where facilities are not available in their Institution. The Ministry will not normally fund the purchase of major equipment, or the rental of existing equipment. However, in exceptional cases that satisfy the Ministry, major equipment purchases, rental of large shared equipment or purchase of computer time will be considered on a case-by-case basis.

5.2.3 Materials and Supplies

Materials and Supplies include materials directly attributable to the research proposal such as the purchase of engineering materials. Where the Ministry is supplying materials, this has been indicated in Section 3.2.1 Defined Research Topics and Attachment A.

Supplies include expendable materials, printing, photocopying, and other similar office supplies.

5.2.4 Travel

A presentation to a Ministry technical committee will normally be required and the location will typically be agreed to by both institutions. Travel and accommodation costs should be in accordance with the Institution's internal guidelines.

5.2.5 Dissemination Costs

Dissemination costs include costs associated with the preparation of the final report. The Ministry will require the technical report to be submitted in accordance with the ***Style Manual for Technical Publications*** as shown in Attachment F Word document template. This Style Manual will enable researchers to submit in a consistent and cost effective format.

5.2.6 Overhead

Overhead may be included in the cost of your application. The Budget Summary form provided in Attachment D requires that you identify the rate of overhead for your Institution. **Please note that funds provided under this Program are considered a Research Grant and overhead rates should be calculated and presented accordingly, but must not exceed 25%.**

6.0 SELECTION CRITERIA

Staff of the Ministry of Transportation will review applications for funds from the HIIFP. To assist Institutions/applicants in completing the forms, the selection criteria for applications are as follows:

- Experience and qualifications of the researcher(s) in the subject area(s) – maximum of 20 points
- Demonstrated understanding of the need for the research and the objective – maximum 20 points
- Innovativeness of proposed research approach, methodologies and potential outcomes – maximum 20 points
- Adequacy and appropriateness of proposed research methodology and analysis – maximum 20 points
- Feasibility of accomplishing the research within estimated timelines and budgets using proposed methodology – maximum 20 points
- Other Considerations Not Awarded a Numerical Score:
    - Value-for-money (overall costs to the Ministry including Overhead Rate)
    - Importance of research proposal to MTO strategic plan
    - Demonstrates the utilization of sustainable materials and processes
    - If requested by principal researcher, availability of Ministry facilities for research and/or approval of proposed fieldwork on Ministry highways
    - For principal researchers who received funding for project(s) from the 2013 HIIFP, satisfactory work in progress of their respective 2013 HIIFP research project(s). The evaluation of this criterion will be based on the brief progress reports requirement as described in Section 4.0 Application Procedures, Deadlines
    - Level of funding secured or provided in-kind from other sources.

The Ministry selection committee may request clarification of points contained in the proposal of any applicant, by letter or personal interview.

7.0 NOTIFICATION OF AWARD

A letter announcing an award will be sent from the Ministry to the principal researcher at the beginning of the award period, and a copy is sent to the financial official of the Institution designated in the application. The letter provides authority to incur project expenses for items and amounts specified in the **approved**, detailed budget. Expenses incurred in excess of the approved budget are not the responsibility of the Ministry.

The holders of research awards and their associates are not considered employees of the Ministry of Transportation Ontario or the Government of Ontario. The Ministry reserves the right to terminate an award without cause at any time by providing written notice of termination.

Any public announcements about the award of funding for the HIIFP shall be made by the Ministry, unless the Institution obtains the prior written approval of the Ministry.

8.0 FINANCIAL ARRANGEMENTS & REPORTING REQUIREMENTS

Awards will be paid to the Institution in one instalment of each year of the award in **May**.

Recipients of funds under this program are requested to maintain periodic contact with MTO staff assigned to monitor the progress on the research. A **financial report** must be submitted to the Ministry by the designated official of the Institution upon completion of the research project. This report will include a full account of purchases and activities financed by the HIIFP. It will also include an itemized list of equipment that was purchased in whole or part with the funds. The following headings will be included in the financial report:

- Salaries and Benefits;
- Equipment or Facility;
- Materials and Supplies;
- Travel;
- Dissemination Costs;
- Other Costs

The Ministry reserves the right to audit any project. The Institution is required to keep for five years any records that may be required for a financial audit.

For approved multi-year applications, in order for an institution to be funded in subsequent years on a multi-year basis, Institutions will be required to provide brief progress reports to the Ministry indicating progress made on the project by the Institution; see Attachment E for sample template. Failure to provide such progress report(s) that describes substantial completion of tasks set out may result in the Institution being denied funding in subsequent fiscal years.

Any surplus or funds not spent must be returned to the Ministry by the Institution. If the research is not started or terminated part way through a project, any unused portion of the research funding must be returned to the Ministry within 30 calendar days.

9.0 AMENDMENTS TO A RESEARCH PROPOSAL

The Ministry must be notified either in writing or verbally in advance of any intention to:

- Alter the direction or intent of the research;
- Terminate the research;

- Reassign research responsibilities to other researchers, than those named in the original HIIFP application;
- Alter the work schedule.

The principal researcher must consult with the Ministry and obtain approval from:

Jessica Grimes
Provincial Highways Management Division
Ministry of Transportation
Jessica.Grimes@ontario.ca

Written approval from the Ministry must be obtained before any alterations in the project are implemented. If the Institution is uncertain as to what constitutes a major alteration in the project, he/she should contact the above noted contact to discuss this matter. If the principal researcher is unable to provide a significant level of participation as originally set out in the application, then alternative arrangements for responsible supervision of the project must be submitted for Ministry approval prior to the start of the absence.

10.0 ANTICIPATED OUTCOME / DELIVERABLES

The Institution shall submit a final report (typically about ten to fifteen pages in length) in both hard copy and electronic format no later than **three months after** the end of the funding period or after termination of funding by the Ministry. Some or all of the members of the Ministry application review committee that recommended support of the research will review the final report.

The final report shall be submitted in Adobe Acrobat format and should include:

- Conclusions and discussion of applications of the new findings to the challenge statement
- Plans for publication and for dissemination of results

The Ministry will retain the final report and usually make it widely available to others through the **MTO Online Research Library**.

Note: A copy of a student thesis or dissertation is **NOT** a substitute for a final report according to the above format

Reprints of publications or manuscripts submitted to journals and copies of papers presented at scientific meetings should be included with the final report. (Manuscripts and articles *in press* will remain confidential.)

The Institution or the principal researcher shall also provide the Ministry a copy of any follow-up publications which the researcher prepares following the project and which incorporates any portion of the research outcomes.

10.1 Disclaimer

Any publication resulting from research funded under this program shall acknowledge the source of funds and include a disclaimer, indicating that the views of the authors may not necessarily reflect the views and policies of the Ministry.

> *Sample of Disclaimer to be used:*
> "This research was supported [or in part] by a grant from the Ministry. Opinions expressed in this report are those of the authors and may not necessarily reflect the views and policies of the Ministry."

Should the Institution want to make specific reference to the Ministry and/or name Ministry staff in the publication, permission of the Ministry must be obtained prior to publication. Permission requests should be sent to the contact mentioned in Section 9.0.

11.0 RESEARCH OUTCOMES

The Ministry may use the research outcomes from the HIIFP applications that are funded by the Ministry. In this regard, and as a condition of funding the research project, the Ministry shall be granted a non-exclusive, royalty-free license without charge to use the outcomes and/or conclusions in the research outcomes for the Ministry's own non-commercial internal purposes including use on Ministry highway contracts and work conducted on behalf of the Ministry.

In the event the Institution is able to obtain patent protection for any of the outcomes and/or conclusions in the research outcomes, the Ministry shall be granted a royalty-free non-exclusive license without charge to use the outcomes and/or conclusions in the research outcomes with no right to sub-license to third parties. The Institution shall arrange for the execution of the appropriate documents to give such licenses to the Ministry.

Should the research outcomes be further interpreted and/or refuted by the Ministry, then the Ministry's findings and/or conclusions shall become the responsibility of the Ministry. Should the Ministry's findings and/or conclusions differ from the findings and/or conclusions in the research outcomes, the names of the principal researchers, original authors, and Institution shall not be associated with the Ministry's findings and/or conclusions.

12.0 EXTERNAL PUBLISHING OF RESEARCH OUTCOMES

Researchers are encouraged to publish and present their research findings independently, but must notify the Ministry of the research findings and/or conclusions, and/or research outcomes being published or communicated must follow the procedure set out below, and must ensure the disclaimer described in Section 10.1 is attached there to:

12.1 In determining when the research findings and/or conclusions in the research outcomes, or the research outcomes should be disclosed, both the Ministry and Institution shall be sensitive to the need for timely approval of graduate student theses and essays.

12.2 The Institution, using best efforts, shall provide to the Ministry, at least

sixty (60) calendar days in advance of any proposed publication or presentation, an outline and associated abstract of any research findings and/or outcomes, and/or research outcomes (or any other matter related to these Guidelines) which it intends to publish or present.

12.3 For the purpose of section 12.2 the terms "disclosure", "publication" and "presentation" include articles, seminars and any other oral or written presentations as deemed appropriate by the Institution to the public, but does not include student theses or other communications submitted for the purpose of evaluating student performance.

12.4 The Institution retains the right to have graduate student theses reviewed and defended for the sole purpose of academic evaluation in accordance with the Institution's established procedures.

13.0 OCCUPATIONAL HEALTH AND SAFETY

The Institution will be responsible for meeting all of the obligations under the Occupational Health and Safety Act (OHSA) and shall ensure that the research is carried out in accordance with the OHSA and all applicable regulations. This includes but is not limited to, the duties to: provide a safe workplace; provide information and educate the workers on workplace hazards; appoint a competent supervisor; prepare and provide a health and safety policy; implement a comprehensive health and safety program to support the policy; and take every reasonable precaution to protect the health and safety of workers.

Researchers intending to carryout fieldwork on Ministry right of way and researchers proposing to make use of Ministry laboratories must contact the Ministry for additional information on operational constraints and occupational health and safety requirements.

ATTACHMENT A – DETAILED DESCRIPTIONS OF SPECIFIC TOPICS

Subject Area:	Engineering Materials
Title:	1. Development of a New Asphalt Mixture Aging/Conditioning Procedure to be used for Performance Testing of Asphalt Mixtures
Background:	Aging is one of the principal contributing factors causing deterioration of asphalt pavements. It has been shown by various researchers that chemical ageing occurs due to oxidation and loss of volatile components. Ageing occurs during plant production, placement and continues during the service life of the pavement. Aging at each step varies. Other factors affecting asphalt mix aging may include silo storage, haul distance, characteristics of the asphalt cement and its content in the mix, additives, film thickness, aggregate type and gradation, air void content, permeability and climate (including ultraviolet and moisture). However, it appears that asphalt mixture performance tests used to evaluate fatigue and fracture resistance (e.g., Dynamic Modulus, Disk-Shaped Compact Tension (DC(t)) and Semicircular Bending (SCB) tests etc.) don't consider aging factors and mix design parameters mentioned above. The objective of this research study is to develop a comprehensive asphalt mixture aging/conditioning procedure that will mimic ageing that occurs from the above mentioned factors so that asphalt mixture performance testing can better predict pavement performance using lab or plant produced mixtures. Work to include validation of the new asphalt mixture aging/conditioning procedure to simulate asphalt mixture aging on a selection of un-aged and aged typical asphalt mixes used in Ontario.
Challenge:	Conduct an experimental study on un-aged and aged asphalt mixes and develop and propose recommendations on a new asphalt mixture aging/conditioning procedure for performance testing based on the experimental results. Sound knowledge and experience in the characterisation of the behaviour of asphalt mixtures are vital to the success of this project.
Anticipated Outcome:	Technical report that includes recommendations on changes to current asphalt mixture aging procedures and presentation to a functional MTO Committee.

Subject Area:	Engineering Materials
Title:	2. Estimating Pavement Damage associated with Heavy Vehicle Loading using In-road Sensor Technology
Background:	MTO pavements are designed to carry commercial vehicle loads based on traffic data and axle configurations and loading limits as defined in the Highway Traffic Act. Pavement serviceability is impacted by increasingly heavier vehicle loading. Pavement damage costs associated with heavier axle loading are generally determined based on an estimated loss in service life. The objective of this assignment is to obtain real time data to determine actual stresses and strains occurring in different pavement types under heavy loading. The assignment includes: • Identification of representative pavement structure sites in the vicinity of truck inspection stations, • Installation of pressure-in-motion sensor technology together with stress/strain instrumentation within the pavement layers, and • Monitoring long term stresses/strains within the pavement structure. • Determine/predict pavement damage associated with heavy traffic loading.
Challenge:	Identification of sites for pressure/weigh in motion instrumentation will require coordination with several MTO offices.
Anticipated Outcome:	Technical report Presentation to technical committee

Subject Area:	Engineering Materials
Title:	3. Performance Requirements for Geogrid Reinforcement in Pavement Base-Layer Applications
Background:	The types and configurations of geosynthetics that are marketed for pavement base-layer applications are many and variable. A material specification that identifies minimum physical property requirements for geogrid is not always appropriate for the intended application nor does it ensure that that the product selected will provide long term performance. The objective of this assignment is to begin the process of moving from a material to a performance specification for geosynthetics in pavement applications. The activities associated with this assignment include: • A jurisdictional scan of construction specifications for geogrid reinforcement in pavement applications • Review of the standard physical property requirements and assessing their relevance when comparing geogrid reinforcement products, i.e. what physical properties are consistent and appropriate for most/all geogrid materials and configurations • Developing a framework for a performance specification that proposes minimum performance requirements for reinforced base-layer applications.
Challenge:	Although the physical properties of geosynthetics are determined by standardized test methods, finding common properties that can be used as a basis of comparison and as a measure of equivalency is not standard.
Anticipated Outcome:	Technical report Presentation to technical committee

Subject Area:	Engineering Materials (Pavements)
Title:	4. Prediction of the Resilient Modulus for Ontario Granular Base/Subbase and Subgrade Materials Using Simple Approaches for Implementing MEPDG in the Design of Pavements
Background:	Ontario is among several government agencies in the U.S. and Canada at the forefront in adopting the Mechanistic-Empirical Pavement Design Guide (MEPDG) which provides rational pavement designs with improved design reliability resulting in most cost-effective pavement design and lower life-cycle costs. Fundamental to MEPDG is the analytical reporting that predicts pavement distresses quantitatively and that can be adopted by performance based contracting models to establish the performance measures. Material characterisation is an essential step in establishing local input parameters for MEPDG. A few HIIFP studies were completed that developed the resilient moduli for granular base/subbase and subgrade materials following the testing protocol recommended by the Manual of Practice for MEPDG. However, experimental determination of the resilient modulus requires elaborate testing facilities as well as trained personnel, and is difficult to perform for use in the routine design of pavements. For this reason, simple approaches are required for the reliable prediction of the resilient modulus such as unconfined compression tests, falling weight deflectometer tests, pocket penetrometer tests, CBR tests, etc. that can be easily accessible by most of the design consultants. Another objective of this study is to investigate the influence of freeze-thaw cycles on the resilient modulus of subgrade with high silt content, which is sensitive to the temperature changes and is typical in Southern Ontario. The temperature fluctuations associated with freeze-thaw cycles during the early spring usually result in serious damages to the highway roadbed with a considerable amount of silt. The previous HIIFP study was undertaken only at the room temperature and the influence of freeze-thaw cycles was not considered. Fulfilling the above two objectives of this research study should facilitate MTO to implement MEPDG for the design of pavements in Ontario more effectively.
Challenge:	(i) Propose simple approaches to reasonably predict the resilient moduli of granular base/subbase and subgrade materials using the results of conventional and easy-to-conduct tests;

	(ii) Develop and conduct a comprehensive testing program to reasonably simulate the freeze-thaw cycles and investigate their influence on the resilient modulus of typical Ontario subgrade materials.
Anticipated Outcome:	Technical report that includes: • Propose simple approaches for quick and reliable estimation or prediction for the resilient moduli of typical granular base/subbase and subgrade materials in Ontario; • Summary of resilient modulus test results for typical Ontario subgrade soils taking account of environmental factors. Presentation to the technical committee.

Subject Area:	Engineering Materials
Title:	5. Calibration and Verification of Pavement Surface Images.
Background:	With the potential use of imaging systems for conducting pavement condition surveys and evaluations, the Ministry continues to struggle with how to calibrate the imaging systems and verify that they are properly functioning as intended. While MTO ARAN-9000 and ARAN-7000 models of high-speed fully automated data collection equipment are used in collecting pavement condition data for King's highway network and Secondary highway network respectively, there is still no widely accepted method or procedure for measuring the accuracy of such imagery. The objective of this research is to determine traceable, objective, practical, repeatable, and transparent approaches to assess the accuracy of the system and the subsystem components.
Challenge:	• Identify and develop a method to calibrate the image data collection systems and subsystems. • Develop approaches to assess the appropriateness and relevancy of such a calibration methodology. • Review and apply an appropriate approach to determine the accuracy of the image data collection system. • Develop a system level accuracy statement
Anticipated Outcome:	Provide a special report that describes all necessary activities to implement the data quality verification and calibration procedures developed from this research. 1. The research will evolve the survey and review the current MTO practices regarding standards for calibration and verification procedures. 2. Review other jurisdictions' standards and identify the gaps or needs for improving the practices for pavement condition image data calibration and verification. 3. Determine methods to assess the accuracy of image data collection systems.

Subject Area:	Highway Design
Title:	6. Swamp treatment for highway/road crossings
Background:	MTO Northwestern/Northeastern Regions have topography unlike the remainder of the province. Specifically, these 2 Northerly Regions have swampy areas throughout. Some existing highways have been built over deep swamps and minor settlement and pavement distortion is ongoing. Upgrading of the existing highways, (which sometimes includes additional lanes) or the construction of new remote all season roads to northern First Nation communities or roads to MTO remote Airports require construction over swampy topography. Furthermore, roadway access to the much talked about "Ring of Fire" area requires traversing over many large swamp areas, some many km's in length. Therefore not only MTO but the public would have interest in new swamp crossing research technology. Traditional (old) methods to cross swamps make use of corduroying with trees or filling them with rock and these are not always long-term / effective solutions. Complete dig-out of the swamp in some cases is not feasible due to the depth.
Challenge:	Research latest developments for crossing swamps. Develop new cost effective techniques using new innovative products to help minimize excavation of swamp material and provide a long-term stable road or highway.
Anticipated Outcome:	A technical report Presentation to technical committee

Subject Area:	Environmental
Title:	7. Climate Change Effects on Stability of Embankments
Background:	The effect of climate is slowly becoming apparent with more frequent natural disasters like hurricanes, floods, intense drought, etc. Such extreme events with changing characteristics over time have a detrimental effect on the transportation infrastructure. For example, intense heat and drought followed by sudden heavy rainfall and even flooding make natural and man-made slopes vulnerable. Several Ontario highways pass adjacent to slopes or are on embankments with sloping grounds. Failure of these slopes can be dangerous, disruptive and expensive. Traditional designs of slopes and embankments cannot take into account the climate change effects. However, it is necessary to incorporate these effects to ensure safety and serviceability of highway infrastructure.
Challenge:	Analysis of the effects of climate change on slopes and embankments involves climate modeling, processing of climate modeling data for use in geotechnical analysis, geotechnical analysis, and design or redesign of slopes based on climate inputs. This requires a multidisciplinary approach incorporating the effects of migration of subsurface and surface water (from sudden events) on soil stability and strength.
Anticipated Outcome:	Technical report Presentation to technical committee

Subject Area:	Environmental
Title:	8. Gray Ratsnake Road Mortality Research Study
Background:	One of the environmental impacts of adding passing lanes on Highway 15 near Crosby was the removal of Gray Ratsnake habitat. The project area is within regulated habitat of the Frontenac Axis population of Gray Ratsnakes. MTO is required to establish 30 habitat creation and enhancement sites as well as conduct a Gray Ratsnake research study. MTO is required under Endangered Species Act Permit KV-C-004-13 to complete a Gray Ratsnake research study in consultation with MNRF as follows: • Study is to be completed by a Master's level student at a university or a person with expertise in reptile biology that has been approved by MNRF; • Study is to be conducted with a study design completed to the satisfaction of the MNRF and include the following element: o Complete a feasibility study that examines non-intrusive and affordable road exclusion methods or other means to reduce road mortality of Gray Ratsnakes.
Challenge:	What are possible methods to effectively and economically exclude or deter Gray Ratsnakes and other similar climbing snakes from highways to reduce road mortality?
Anticipated Outcome:	Peer reviewed technical or scientific report with the study results. The final report is to be submitted for publication to a peer-reviewed scientific journal or otherwise made available to the public in a manner that is approved by MNRF.

Subject Area:	Environmental
Title:	9. Effective Management Techniques for Invasive Phragmites
Background:	*Why is controlling phragmites of concern to MTO?* Several studies have shown that transportation corridors are a major vector for the spread of Phragmites. Without careful management, roadway maintenance activities can also contribute to the spread of Phragmites. Phragmites can impact transportation corridors and MTO-mandated activities in a number of ways: 1) Phragmites can impede drainage in highway ditches which can lead to improper drainage of roadbed material and ultimately damage to road surfaces. 2) Phragmites can impede sight lines, in highway corridors including at entrances and in medians. 3) Phragmites poses a fire hazard, particularly during the dormant season. While the risk of ignition along the highway corridor is low, the potential impact could have significant health and safety concerns. 4) The spread of Phragmites can negatively impact environmental assets including ecological restoration areas, created wetlands and fish habitat compensation areas required by Environmental Legislation, including the Federal Fisheries Act and the *Endangered Species Act (ESA), 2007* permits. A research project is currently underway in partnership with McMaster University to map the distribution of Phragmites on MTO roadsides in southern Ontario. This project will also analyze the spread of Phragmites through change detection analyses to determine how this invasive species colonizes segments of roadsides over time. Having this information will put the Ministry in a good position to understand the extent of issue and the rate of growth; however, at this time, MTO does not have a suite of Best Management Practices to apply to our roadsides. MTO is listed as a supporting Ministry for a number of the activities in the State of Ontario's Biodiversity report, 2015, and the Ontario Biodiversity Strategy, 2011 including: Activity 12 - Reduce the threat posed to biodiversity by invasive species by working to implement the Ontario Invasive Species Strategic Plan, 2012. This research needs statement responds directly to the *Ontario Invasive Species Strategic Plan, 2012*: • Action 19 - Improve research on methods to eradicate and inhibit the spread of invasive species. • Action 20 - Conduct research to better understand and predict the

	impacts of invasive species on Ontario's society, economy and biodiversity. • Action 23 - Manage key pathways to prevent the introduction and spread of invasive species. With Ontario's Invasive Species Act recently receiving Royal Assent, Phragmites continues to receive increasing public attention on its negative economic, social and environmental impacts. Although regulations are not in effect yet, there is growing pressure on MTO to manage Phragmites as local municipalities and First Nations begin to tackle this invasive plant. There is an urgent need for MTO to develop Best Management Practices that can assist the ministry in managing their corridors to prevent the spread of invasive Phragmites.
Challenge:	The challenge will be to conduct an inventory of historic and current Phragmites management practices on MTO roadsides, and elsewhere in Ontario and other jurisdictions where Phragmites is being managed. The challenge will also be to conduct road surveys, visual confirmation and mapping of the effectiveness of Phragmites management.
Anticipated Outcome:	Technical report – which will include recommended BMPs for Phragmites management in MTO corridors. Presentation to technical committee.

Subject Area:	Environmental
Title:	10. Increasing Biodiversity in MTO's Roadside Seed Mixes Through The use Of Native Seed
Background:	Numerous studies have shown that roadsides dominated by native species support more pollinators including butterflies and bees than those dominated by non-native species. Currently, MTO's standard roadside mixes have low species diversity, and a very low compliment of native species. As a consequence, MTO's current roadsides have limited biodiversity and pollinator potential. Both the Ontario Biodiversity Strategy, 2011 (including the 2015 State of Ontario's Biodiversity) and OMAFRA Pollinator Health Strategy, 2015 call on the government of Ontario to increase native habitat areas and decrease fragmentation of habitat for numerous species including pollinators. With over 16,000 kilometers of road with vegetated roadsides, MTO has the potential to be a contributor to Provincial Biodiversity and Pollinator objectives. To date, MTO has completed a limited number of projects in Southern Ontario which have used native non-standard roadside seed mixes, including the Rt. Hon. Herb Gray Parkway, Highway 40, and Highway 407. However, no research (e.g. test plots) has been done to assess whether native mixes have a broader application on MTO projects. MTO lacks quantitative data on the benefits, costs, and changes in management practices that might be required if native seed mixes were to be used more broadly in the Ministry. A number of other jurisdictions in Canada (including Saskatchewan and Alberta) and the United States (including Minnesota, Iowa, Nebraska and Indiana) have already successfully integrated native seed mixes into their roadside vegetation focussing on increasing pollinator habitat and creating linear movement corridors. The results and experiences from these and other jurisdictions can provide MTO with valuable information on how to successfully integrate native plant material into our landscape.
Challenge:	• To conduct a jurisdictional review and analysis of others' experience with native roadside mixes. • To conduct test plots of native seed mixes that can

	meet MTO's performance measurement for cover in a cost-efficient manner. • To analyze life cycle costs for native seed mixes versus the standard roadside mixes
Anticipated Outcome:	Technical report including specifications for MTO use Presentation to technical committee

Subject Area:	Environmental
Title:	11. Eastern Whip-poor-will Habitat Research
Background:	One of the environmental impacts of the MTO four-laning of Highway 69 is the removal of Eastern Whip-poor-will habitat. MTO is required to replace that habitat. In order to determine how to best create Whip-poor-will habitat, it is necessary to understand their habitat needs. MTO is required under Endangered Species Act Permit PS-C-001-12 to conduct scientific research into Whip-poor-will habitat use and needs, including: - Basic habitat study, using territories and nests that are found in the Highway 69 corridor; - Determination of basic habitat requirements, territory size, indirect impacts of development, and distribution and abundance in the Georgian Bay Area. This research is to be specific to the Georgian Bay population, and directly related to Highway impacts. The study should complement, but not repeat, the work done by Gregory J. Rand from Trent University: Home Range Use, Habitat Selection, and Stress Physiology of Eastern Whip-Poor-Wills (*Antrostomus vociferous*) at the Northern Edge of Their Range, May 2014.
Challenge:	What are the habitat requirements of Eastern Whip-poor-will?
Anticipated Outcome:	Peer-reviewed Technical or Scientific report, to be submitted for publication to a peer-reviewed scientific journal, and/or made available for public review.

Subject Area:	Environmental
Title:	12. Barn Swallow GPS tracking on MTO infrastructure sites containing high nesting colonies
Background:	*Current Legislative Requirements:* Since the uplisting of the Barn Swallow to 'threatened' under the *Endangered Species Act* in January, 2012, the MTO is required under the Act to create habitat for the Barn Swallow (a medium-sized songbird that is about 15-18 cm long) by replacing a nest that was removed, damaged or destroyed on MTO infrastructure with artificial wooden nest cups (at a 1:1 ratio). These artificial nest cups must be placed within 1 km of the removal site, and within 200 m of foraging habitat. On MTO infrastructure projects across the province, the current practice is to erect "kiosks", which is a type of nesting structure used to create replacement habitat where the nest cups are located. *Work Completed to Date:* Since the species was uplisted under the Act, MTO has been compensating for Barn Swallow nest removals ranging from a variety of projects including bridge rehabs/replacements, culvert replacements, salt dome replacements, as well as new highway corridors (Highway 407). Nearly 100 kiosks have been placed containing over 1500 nest cups across the province. Although the nest cups (and kiosks) built as part of the compensation strategy exhibit some success, the success rate is significantly less than the compensate rate. For example, a bridge replacement site with a kiosk containing 70 nest cups monitored over a three (3) year period has resulted in eight (8) occupied nest cups. In other words, 62 nest cups remain unoccupied. The data across the province suggests similar results, whereby the rate of occupied nest cups is significantly less than the rate of compensation. Research to date undertaken by the MTO has focused on monitoring the success of the kiosks as well as researching new kiosk designs to attract barn swallows. In addition, the MTO Central Region has been exploring new designs in consultation with other agencies including Bird Studies Canada (BSC) and Bird Ecology and Conservation Ontario (BECO) including placing actual nests in the nest cups, cross beams, privacy walls, dowels, artificial swallows made of

	wood and perched on the kiosks, as well as playback calls. However, none of the features listed above have been proven to attract more breeding pairs to the kiosks. *Research Purpose:* The purpose of this research is to study where the swallows relocate to under conditions where the existing colonized area is under construction and inaccessible for nesting (e.g., a bridge site). For example, in 2014, MTO Central Region boarded up the underside of the South Canal Bridge along Highway 400, which contained 89 Barn Swallow nests, 68 of which were active during the 2014 breeding bird season. Two (2) large 45 foot long kiosks were constructed within 200 m of foraging habitat, and within 1 km of the site. During the 2015 breeding bird season, approximately 15 new nests were constructed under the existing bridge; in new areas (e.g., concrete pier vertical faces) not previously nested on. No Barn Swallows used the two (2) large kiosks that were constructed for compensation. Where did the other 53 breeding pairs nest? There are notable colonized sites within 5 km of the South Canal Bridge; were additional breeding pairs found on these sites? Did they not migrate back to the province? The research will involve placing GPS trackers (i.e., geolocators, satellite transmitters, or similar) on the swallows specific to high colonized areas. The activities shall include at least three (3) project sites with over 20 breeding pairs (e.g., the North Canal Bridge/Highway 400). The birds are to be captured and equipped with tracking devices in year 1 of nesting (before any exclusion measures are placed on the site) preferably in April. Prior to the second year of nesting, exclude the test site (boarding/tarping) and provide a kiosk at a 1:1 ratio, and track where the birds are relocating to. Bird banding is a feasible alternative but will involve recapturing. In addition, bird banding will only provide us with information on whether the bird returns to the same site, it will not reveal where else the bird is going unless recapturing is done at other sites. MTO has established good working relationships with various agencies across the province from the Barn Swallow recovery strategy meetings. As part of this proposal, the researchers shall consult and obtain input from MNRF Policy, Environment Canada CWS, BSC, and BECO. Contact personnel information will be provided.

	<u>Significance to the MTO:</u> Barn Swallows have adapted to nesting in or on human structures including culverts, bridges, salt domes, barns, etc., and are present on most MTO maintenance, rehabilitation, and/or replacement projects. There has been significant staff/financial resources devoted to building these kiosks over the last few years with limited nesting success. Thus, the MTO regional offices are challenged in understanding how building these kiosk structures promote species recovery. This research will provide new information to all interested agencies in understanding species behaviour. More importantly, it will provide further insight on compensation strategies, which can facilitate in changing the requirements for building kiosks. If the species are found to use other bridge sites nearby, or if most of the swallows from that colony where MTO work is occurring does not migrate back to the same site, it defeats the purpose of building kiosks at every site at a 1:1 ratio. There are several speculations as to why the Barn Swallow population has been declining in the province of Ontario; loss of nest site habitat is only one (1) speculation. As the species was originally uplisted under the Act due to a lack of understanding of the causes of the population decline, financial resources on a project by project basis can be better spent on recovery measures that actually benefit the species.
Challenge:	For high colonized areas where exclusion measures are implemented on MTO infrastructure (e.g., tarping, boarding) and kiosks are installed, the success rate is much lower than on the bridge. Where are the birds going during construction? Challenges with the research: • The work will include harassment of the birds and may require a permit under the Act. • Capturing the birds at the sites will be challenging and mist nets will likely need to be installed • The battery life of the geolocators/transmitters may only reveal data for 1 year, which means the birds will need to be recaptured after the first year to ascertain multi-year data.
Anticipated Outcome:	Technical report and data sheets. Presentation to technical committee as well as regulatory agencies involved in the study.

Subject Area:	Bridges
Title:	13. Model for Lateral Resistance of Piles
Background:	A large number of bridges in Ontario are supported on pile foundations. These foundations are subjected to lateral loads and moments at the top from traffic, wind, and seismic activities. Design of these piles against lateral loads is crucial for serviceability of bridges. The current practice for calculation of static lateral capacity of piles for MTO projects is based on the empirical linear subgrade modulus approach, which leads to highly conservative designs. A more accurate method for calculation of lateral capacity for piles is required for economical and safe pile design against lateral loads.
Challenge:	A suitable method for lateral capacity calculation involves nonlinear soil-structure interaction analysis. The p-y method widely used in geotechnical engineering for lateral capacity calculations can be adopted but not without proper verification regarding its applicability for the piles used in Ontario. Thus, the challenge is to develop the most appropriate method for calculating lateral capacity of piles in Ontario.
Anticipated Outcome:	Technical report Design Guideline Presentation to technical committee

Subject Area:	Bridges
Title:	14. Geosynthetic Reinforced Soil Integrated Bridge System (GRS IBS)
Background:	The Geosynthetic-Reinforced Soil Integrated Bridge System (GRS IBS) was developed by the Federal Highway Administration (FHWA) almost 20 years ago to help meet the demand for the next generation of single-span bridges in the U.S. As an alternative to conventional bridge foundations, GRS IBS is an economical solution that accelerates bridge construction while resulting in a safe, efficient design with excellent performance. By using closely-spaced, alternating layers of compacted granular fill and geosynthetic reinforcement for the foundation and abutment support, along with an integrated approach, superstructures can bear directly on the GRS IBS substructure to create a seamless and smooth transition between the bridge and roadway without using joints, deep foundations, approach slabs, or cast-in-place concrete. GRS IBS can eliminate the bump that typically develops when using deep foundations
Challenge:	There is significant diversity in the range of superstructure types, bridge geometries, loading conditions, and materials in terms of backfills, geosynthetics, and facing elements. Implementation efforts shall include the development of training materials, design and construction guidelines and opportunities, Peer Exchanges and workshops will be required to bridge the gap between Foundation, Bridge and Pavement Engineering.
Anticipated Outcome:	Technical report Design Guideline Presentation to technical committee

Subject Area:	Bridges
Title:	15. Geophysical Methods for Subsurface Characterization and Determination of Shear wave Velocity Profiles
Background:	The determination of subsurface conditions and the shear wave velocity of the soil profile are essential in producing safe, reliable and cost effective foundation designs. Presently, the delineation of subsurface conditions is based on the advancement of boreholes at a given spacing. Geophysical methods in combination with conventional methods will provide a more accurate subsurface model leading to improved foundation designs and mitigating contractual claims. The shear-wave velocity profile is required for the geotechnical earthquake engineering design of bridges and highway embankments as per the Canadian Highway Bridge Design Code. The determination of shear wave velocity soil profile using geophysical methods will provide the MTO with a cost-effective tool to evaluate the dynamic properties of subsoils.
Challenge:	Geophysical methods in combination with conventional methods can result in more accurate subsurface model determination. Shear wave velocity (Vs) profiles are needed to determine the seismic site class in accordance with the new CHBDC. In addition, the measured shear wave velocities can be used to establish dynamic soil properties that may be used in seismic soil-structure interaction modelling. Without shear wave velocity determination, empirical methods may indicate lower Site Classes. .More accurate assessment based on shear wave velocity measurements may provide for a higher Site Class, resulting in lower seismic loading and corresponding cost savings for the structures. A robust experimental and analytical methodology needs to be developed, calibrated and adapted. The foundation engineering and bridge engineering practitioners need to have knowledge of the Geophysical methods most suitable for the varying project sites. .
Anticipated Outcome:	Technical report Design Guideline Presentation to technical committee

Subject Area:	Bridge Engineering
Title:	16. Design of reinforced concrete flexural and compression elements using stainless steel reinforcement
Background:	MTO started using stainless steel reinforcement in bridge decks and in components subjected to salt splashing in the early 2000's. Currently, stainless steel reinforcement is frequently used in substructures within splash zone, in PL3 barrier walls and in decks carrying high volume freeways. The yield strength of the two types of stainless steel used by MTO (316 LN and duplex 2205) can be much higher than 400 MPa. However, there might not be a definite yield plateau and it is not clear what limiting stress and strain should be used for design of flexural and compression elements such that all intents of the code would be met. MTO currently specifies the minimum yield strength of stainless steel as 500 MPa. The coefficient of thermal expansion of certain types of stainless steel, particularly the austenitic ones could be larger than carbon steel and concrete. This may result in additional thermal stress in the concrete as well as in the reinforcement if the component is subjected to wide temperature range in service, as well as during curing of concrete due to heat of hydration.
Challenge:	CHBDC Section 8 does not have provisions for stainless steel reinforcement. It is not clear whether the normal requirements for design using carbon steel could apply to stainless steel that has a much higher yield strength than 400 MPa. It is also not clear how the yield strength of stainless steel should be measured, whether by the 0.2% offset or at a certain strain value, bearing in mind that the limiting compressive strain of concrete is 0.0035. A literature survey shall be undertaken to collect information from previous researches and other codes, possibly the European code, that are related to this subject. Liaise with the suppliers of the two types of stainless steel used by MTO to obtain typical mill certificates showing the stress-strain behaviour, obtain samples for verification testing. Propose design methodology and changes to code's

	provisions for flexural and compression elements; verify by laboratory testing of scaled specimens. Review material testing standards and make recommendation on yield strength measurement. Perform finite element analysis to investigate the thermal effect of stainless steel reinforcement in the radial direction and its relationship to concrete cover.
Anticipated Outcome:	Technical report Presentation to technical committee

Subject Area:	Construction
Title:	17. Life Cycle Assessment for Sustainability of Geotechnical Projects
Background:	Sustainable development requires that a proper balance between economic, environmental, and societal needs is maintained in any form of developmental efforts. This approach is different from traditional engineering practice in which economical goals are given the highest priorities. Geotechnical engineering projects within MTO uses a significant amount of natural resources and creates environmental pollution. Therefore, it is necessary to incorporate sustainable practices in the geotechnical constructions of MTO projects. A balanced approach can be obtained by performing life cycle assessment (LCA) and integrating the results of LCA in the traditional design.
Challenge:	Life cycle assessment can be used to assess the environmental impacts of geotechnical constructions. The input and output inventory and the environmental impacts can be calculated using LCA. Challenge lies in integrating geotechnical design and LCA as a unified tool to provide an optimized solution that satisfies the sustainability requirements
Anticipated Outcome:	Technical report Presentation to technical committee

Subject Area:	Maintenance
Title:	18. Assessing the Impact of Winter Maintenance Standards
Background:	Models have been developed to assess the relationships of input, output and outcomes of winter maintenance (plowing-salting-sanding, time to regain bare pavement after a storm, reduced risk of accidents and travel delay). Certain of the maintenance inputs that can be adjusted to local conditions, such as number of plows, circuit time, salt application rate, are not included as modelling factors and therefore cannot be considered in case studies to predict the impact of potential changes.
Challenge:	The challenge is to add additional factors to the performance-based maintenance models, and to undertake case studies to assess the outcomes and impacts of selected inputs.
Anticipated Outcome:	Technical report Computer-based case study modelling tool Presentation to technical committee Technical paper at a transportation conference such as TRB Annual Meeting.

Subject Area:	Maintenance
Title:	19. Comparative Evaluation of Road Condition Reporting and Measuring Technology
Background:	Awareness of road and weather conditions is an important aspect of the winter maintenance tool kit. MTO is updating its public reporting of winter conditions to improve both contractor and public awareness of conditions. A variety of new technologies have become available with the potential to monitor and report conditions more quickly and reliably than past approaches. Guidance is needed to characterize the strengths, weaknesses and costs of implementing the various available technologies to support these possible inputs to the winter information system.
Challenge:	The challenge is to develop and apply a structured approach to comparing the available and developing technologies that will guide MTO in their future implementation.
Anticipated Outcome:	Technical report Presentation to technical committee Technical paper at a transportation conference such as TRB Annual Meeting.

Subject Area:	Maintenance
Title:	20. Review and Validation of Winter Materials Application Rates
Background:	The use of anti-icing liquids has gained wide acceptance in Ontario as a means of reducing overall road salt application rates and of activating salt rapidly to improve road conditions. Standard application rates have been established where liquids are used for pre-wetting and for anti-icing. Most users have gained confidence in the effectiveness of these techniques and consideration is being given to fine-tune the use of liquids to achieve lower application rates.
Challenge:	The challenge is to review experience and testing of winter liquid products in other jurisdictions, to identify whether opportunities exist to improve practices in Ontario, and to validate the safety and effectiveness of alternate materials or practices.
Anticipated Outcome:	Technical report Practical guideline for implementation Presentation to technical committee Technical paper at a transportation conference such as TRB Annual Meeting.

Subject Area:	Maintenance
Title:	21. RWIS Network Planning Tool
Background:	Ontario operates a Road Weather Information System of roadside environmental stations to Contractors plan local winter operations. A variety of competing priorities must be considered as the system is expanded to improve coverage. Approaches have recently been developed that help to set priorities for fixed-location weather stations with respect to weather variability at a continental scale, traffic levels and incremental costs.
Challenge:	The challenge is to further develop the model to include analysis of weather variability at a regional scale within the province, and to consider local factors that may be accounted by mobile RWIS technology.
Anticipated Outcome:	Technical report Web-based application that enables the Ministry to exercise case studies using the developed model Presentation to technical committee Technical paper at a transportation conference such as TRB.

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2016
ATTACHMENT B – APPLICATION FORM

For Ministry use only	
Application Number:	

Principal Researcher (Name & Business Address):	Location of Research (address):
Institution:	Applicant's Business Telephone No.
	Applicant's Email Address

Co-Applicants (name, institutional affiliation, city):

1	
2	
3	

Title of Research including Ministry Topic Number:	

Brief Purpose of Research

FINANCIAL SUMMARY:

Funds Requested From MTO	Funds Requested from Other Sources	Starting Date:	Estimated Completion Date:

Total Budget (MTO and other sources):	

Have you applied to any other funding agencies for support of part of this Research?

YES ☐ **NO** ☐ If YES, please provide details below:

Signatures: It is understood that the provisions of the Ontario Ministry of Transportation HIIFP as outlined in the 2016 HIIFP Guidelines are hereby accepted and agreed to.

Principal Researcher	Head of Department	Dean/Director of Research or Authorized Signing Officer of Sponsoring Institution
Name and Title:	Name and Title:	Name and Title:

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2016
ATTACHMENT C – RESEARCH PROPOSAL SUMMARY

Short Title of Research including Ministry Topic Number:	
Principal Researcher	
SUMMARY OF RESEARCH PROPOSAL (Non-technical language; 300 words maximum)	

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2016
ATTACHMENT D – BUDGET SUMMARY

Note:
For multi-year applications, complete one form for each Ministry Fiscal Year ending March 31.

FISCAL YEAR ENDING: March 31, _____(INSERT YEAR)

Principal Researcher:				
Short Title of Research including Ministry Topic Number:				
RESEARCH ITEMS	**Direct Costs of Research**	**Percent Overhead (%) (not to exceed 25%)**	**Net Funds Requested from MTO**	**Amount from other sources**
SALARIES AND BENEFITS				
a) Students				
b) Postdoctoral fellows				
c) Technical/professional assistants				
d)				
SUBTOTAL:				
EQUIPMENT OR FACILITY				
a) Purchase or rental				
b) Operation and maintenance costs				
c) User fees				
d)				
SUBTOTAL:				
MATERIALS AND SUPPLIES				
a)				
b)				
c)				
d)				
SUBTOTAL:				
TRAVEL				
a) Technical presentation				
b) Field work				
c)				
SUBTOTAL:				
DISSEMINATION COSTS				
a) Publication costs				
b)				
SUBTOTAL:				
OTHER (specify)				
a)				
b)				
c)				
SUBTOTAL:				
	Direct Costs of Research	**Net Overhead**	**Net Funds Requested from MTO**	**Amount from other sources**
COLUMN TOTAL:				
TOTAL:				

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2016
ATTACHMENT E – PROGRESS REPORT TEMPLATE

PAGE 1 OF 2

	For Ministry use only
Application Number:	

HIIFP Funding Year:	Date:
Principal Researcher (Name & Business Address):	Business Telephone No.
Institution:	Email Address:

Title of Research including Ministry Topic Number:	
Start Date of Research:	
Estimated Completion Date of Research:	

Brief Description of Progress completed to date including 1) status of major tasks, 2) status of outcomes/report, and if applicable, 3) changes and or issues:

Continue on page 2

Signatures:

Principal Researcher	Head of Department	Dean/Director of Research or Authorized Signing Officer of Sponsoring Institution
Name and Title:	Name and Title:	Name and Title:

HIGHWAY INFRASTRUCTURE INNOVATION FUNDING PROGRAM 2016
ATTACHMENT E – PROGRESS REPORT TEMPLATE

PAGE 2 OF 2

Principal Researcher (Name & Business Address):	Date:

Institution:	
Title of Research including Ministry Topic Number:	

Brief Description of Progress completed to date including 1) status of major tasks, 2) status of outcomes/report, and if applicable, 3) changes and or issues:

Continued from page 1