Ministry of Transportation (MTO)

Highway Infrastructure Innovations Funding Program (HIIFP)

Program Guide
for Ontario Universities and Colleges

Deadline for Application Submissions:
Wednesday, January 31, 2024 at 5:00pm

Submit applications to: HIIFP@ontario.ca

Posted: December 2023

2024-25 Fiscal

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1. Introduction

The Highway Infrastructure Innovations Funding Program (HIIFP) was first introduced in 2003. The objective of this program is to encourage Ontario's academic community to research projects that contribute to generating solutions to current technical challenges encountered by the Ministry of Transportation (MTO) in the construction and maintenance of the provincial highway infrastructure network. These research projects are funded through HIIFP.

A diverse range of specific research topics have been developed by MTO that outline: 1.) the background of the research requirement, 2.) the challenge or problem to be addressed, and 3.) the anticipated outcome and/or research deliverables.

An eligible institution may choose from one of the MTO provided specific research topics or submit their own research topic (i.e., an open research topic).

Research projects awarded the HIIFP grant shall submit a written technical report to be published in the MTO Library Catalog. The research team will also present their findings to the HIIFP Steering Committee and/or an MTO Technical Committee interested in the specific subject area.

2. Purpose of the Program

The objective of this program is to supplement the technical expertise at MTO by providing HIIFP funding to eligible Ontario universities and colleges (institutions). This funding encourages the academic community to conduct research that will contribute to the generation of innovative solutions to current technical challenges experienced during the construction and maintenance of the provincial highway infrastructure network. This research aids MTO in achieving its strategic plan.

Research on innovative approaches and methodologies contribute to solutions in several areas of transportation and infrastructure engineering which are included in this program, such as:

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

A majority of the research topics involve detailed technical issues identified by MTO that will require an innovative solution to address the specified problem. MTO further supports the research methodology and solution generation by assigning an MTO Technical Specialist in the relevant subject area to liaise with the Principal Researcher for all research projects awarded HIIFP funding.

3. Scope of the Program

3.1 Eligible Institutions

All of Ontario's 23 public universities and 24 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 specific research topics have been developed by MTO that outline: 1.) the background of the research requirement, 2.) the challenge or problem to be addressed, and 3.) the anticipated outcome and/or research deliverables.

A majority of the research topics involve detailed technical issues identified by MTO that will require an innovative solution to address the specified problem. To qualify for HIIFP funding, an eligible institution's HIIFP application package must cover one (or several) of the specific research topics. An institution may also submit an HIIFP application package with their own research topic (i.e., an open research topic).

3.2.1 Specific Research Topics

Specific research topics are provided based on MTO's research needs in any given fiscal year. Some research topics will be identified as priority research needs for a particular MTO Office and/or subject area. Detailed descriptions of each specific research topic are provided in Appendix A.

The specific research topics included in Appendix A are summarized with the following information:

- **Subject Area:** Description of the general subject area.
- **Title:** Briefly describes the challenge for the subject area.
- **Background:** Discussion of the subject area and the impact to MTO, any previous work done to date, the current approach, thoughts on how to solve the challenge, any applicable reference information and/or literature that currently exists, etc.
- **Challenge:** A statement that outlines the challenge and why an improvement is necessary.

- **Anticipated Outcome(s) & Research Deliverables:** A 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 an MTO technical committee is also expected.

- **Benefits to MTO:** A description or example of the expected result(s).

3.2.2 Open Research Topics

An open research topic describes a proposed research project that is not included in Appendix A of this Program Guide, however the Principal Researcher considers it to be relevant to the provincial highway infrastructure as well as to MTO's business needs.

If the Principal Researcher chooses to submit an HIIFP application package for an open research topic, they shall complete the Open Research Topic Form, 23-B (see Appendix B) and include it with their HIIFP application package. See Section 4.1 for details regarding the application package components. The Open Research Topic Form, 23-B shall not exceed two (2) pages in length, and the research topic should clearly identify how it will enhance MTO's practices and business needs. Upon inclusion of this form (23-B), MTO may accept and evaluate HIIFP application packages on open research topics. In the case of an application package for an open research topic, where a topic number is required, please insert the word "open" in the "Topic No." field.

If a Principal Researcher proposes to include fieldwork on MTO highways and/or right-of-ways (ROWs) for their open research topic, this fieldwork must be pre-approved prior to submission of an HIIFP application package (see Section 3.6).

3.3 MTO Technical Specialist Assignment

For each approved research project, an MTO Technical Specialist, in the relevant subject area will be assigned to liaise with the Principal Researcher. Timing of periodic meetings and/or telephone conference calls will be negotiated at the commencement of the research project.

Written Project Progress Reports, Form 23-F (see Appendix C) will be required a minimum of every six (6) months. The project progress report shall be sent to the assigned MTO Technical Specialist, with a copy to the HIIFP Coordinator.

3.4 HIIFP Funding and Ineligible Expenditures

The total HIIFP funding amount for any fiscal year is subject to provincial budget approval. MTO may be required to delay the award of HIIFP funds until the provincial budget has been approved.

MTO reserves the right to restrict and/or terminate HIIFP funding at any time, at its sole discretion and without any reasons.

The salary of the Principal Researcher is **not eligible** for funding under the HIIFP, nor is the Principal Researcher eligible to charge any fees in this respect.

3.5 Multi-Year Projects

MTO will consider application packages for research project proposals that are multi-year, meaning funding may be required for the current and future fiscal year(s). In such cases, MTO will endeavour to provide funding beyond the first fiscal year, however, MTO cannot guarantee funding in future years.

For awarded multi-year research projects, institutions will be required to provide written Project Progress Reports, Form 23-F (see Appendix C) a minimum of every six (6) months to be considered for funding in subsequent years. The project progress reports shall be sent to the assigned MTO Technical Specialist, with a copy to the HIIFP Coordinator. Failure to provide such project progress reports describing the percentage completion of the tasks as set out in the original application package may result in the institution being denied funding in subsequent fiscal years. Additionally, MTO reserves the right to revoke the funding in future years, at its sole discretion, and can terminate the research project upon written notice to the institution.

3.6 Fieldwork on MTO Highways and/or ROWs

If the Principal Researcher proposes to include fieldwork on MTO highways and/or ROWs for the research project, this fieldwork must be **pre-approved** prior to submission of an HIIFP application package.

Whether the institution is submitting an application package for a specific research topic (Section 3.2.1) or an open research topic (Section 3.2.2), the Principal Researcher must clearly define and describe the proposed fieldwork and seek pre-approval. Email the HIIFP Coordinator with the Subject Line: HIIFP Fieldwork Approval to receive written consent for proposed fieldwork. Be certain to include the written consent with the application package.

3.7 Information and Data Confidentiality

The Principal Researcher and the institution agree that all information and data that MTO provides in respect of the research project shall be kept confidential. The institution shall only use the provided information and data for purposes related to the submission of a written technical report to MTO for the research project. The institution shall ensure that reasonable methods are taken to secure the confidential information and data of MTO.

Failing to comply with this provision may result in the termination of the research project, where upon the institution shall return all information and data, return all monies paid by MTO and may result in the institution being precluded from the award of future HIIFP funds.

4. Application Package

4.1 Application Package Components

The HIIFP Steering Committee will deem the information contained in the submitted application packages as confidential. Refer to Section 6 for the evaluation criteria implemented by MTO for selecting research project proposals to be awarded HIIFP funding. The application package for a research project proposal shall consist of the following components:

1. HIIFP Application Form (see Appendix D, Form 23-A)

2. Research Proposal Summary (see Appendix E, Form 23-C)

    - 300 words maximum, Arial 12-point font, 1.08 line spacing.
    - Use plain language suitable for communicating with the public.
    - Portions of this summary may be used in a media release, therefore the language should be non-technical and free of acronyms or jargon.

3. Budget Summary (see Appendix F, Form 23-D)

4. Detailed Research Project Proposal

    Ten (10) pages maximum, Arial 12-point font, minimum 1.08 line spacing, and including the following information:

    - Understanding of the need for this research and the objective.
    - Proposed methodologies, innovative approaches, and potential outcomes.
    - Details of the analysis process.
    - Schedule of the activities to be undertaken during the research project, identifying key milestones and associated dates and/or timelines.
    - Qualifications of the Principal Researcher (applicant) in the subject area.
    - Related work performed by the applicant and others on the research team.

5. Budget Details Form (see Appendix G, Form 23-E). See Section 5 for details.

6. Curriculum Vitae (CV) for:

    - The Principal Researcher.
    - The Co-Applicants (if any) listed in the HIIFP Application Form (23-A).
    - See Section 4.1.1 for recommended information to include in the CVs.

7. Additional Approvals (where required). For example:

    - Pre-approvals (use of MTO facilities, work conducted on MTO highways, etc.)
    - Open Research Topic Form 23-B (if applicable, see Section 3.2.2 for details).

4.1.1 Curriculum Vitae (CV) Recommended Information

To encourage consistency across all submitted CVs when evaluating the HIIFP application packages, the following information is recommended for the CV of the Principal Researcher and any other Co-Applicants listed in the HIIFP Application Form.

CV Section	Recommended Information (where applicable)
Personal Information	• Name, Address, and Contact Information
Education	• Degrees and Diplomas
Recognitions	• Prizes, Awards, Distinctions and Honors – describe the recognition received and its importance
Employment	• Academic Work Experience – include the nature of your research, teaching, training, and/or other activities • Non-Academic Work Experience
Research Funding History	• List all sources of support (e.g., grants and research funding) held as an applicant or a co-applicant
Activities	• Supervisory Activities – students (e.g., postdoctoral, undergraduate, summer projects, etc.), research associates and technicians • Mentoring Activities – list all students you have mentored • Advisory Activities – for example, as an expert witness in a legal proceeding • Knowledge and Technology Translation Activities – list activities related to a practical application such as: community engagement and outreach, activities with industry, activities with government, and innovations • International Collaboration Activities – list all collaborations outside of Canada that may be relevant to the application
Memberships	• Committees and other memberships
Contributions	• Presentations (at conferences and events), Interviews and Media Relations, Publications (as author or co-author), Intellectual Property (patents, licenses, disclosures, registered copyrights, trademarks)

4.2 Application Deadlines & Submission Location

The deadline date for the receipt of application packages is:

Wednesday, January 31, 2024 at 5:00pm.

Completed application packages (including all supporting documentation) must be received by this stipulated deadline date.

An electronic PDF copy of the complete application package shall be submitted to the HIIFP Coordinator (HIIFP@ontario.ca) with the Subject Line: HIIFP Application Package.

Subsequent to emailing the HIIFP application package to the HIIFP Coordinator, the applicant (e.g., Principal Researcher) shall receive a return email confirming receipt of the HIIFP application package.

5. Project Proposal Budget

5.1 General

The detailed budget must include a full account of purchases and activities to be financed by the HIIFP grant. The level of budget breakdown and supporting information provided should be sufficient to justify the items relative to the Detailed Research Project Proposal (Item #4, Section 4.1).

Multi-year project proposals (see Section 3.5) may be considered and evaluated on the condition that sufficient information is provided in the application package. A Budget Summary Form (23-D) should be completed for **each** fiscal year in the multi-year project proposal requiring funding.

The HIIFP Steering Committee reserves the right to disallow expenditures in the budget that are not adequately justified.

5.2 Budget Summary & Details

A Budget Summary Form (23-D) and a Budget Details Form (23-E) shall be included in the application package. It is important to consider the provisions outlined in Section 3.4 which describes available funding and ineligible expenditures.

The following types of expenditures are eligible for funding, unless specified otherwise:

5.2.1 Salaries and/or Benefits

Salaries, stipends and related federal, provincial and institutional non-discretionary benefits for research work performed by research personnel (e.g., students, research associates, and technicians) may be included in the budget.

The salary of the Principal Researcher is **not eligible** for funding under the HIIFP and should not be included in the budget.

5.2.2 Equipment and/or Facility

Equipment and/or facility costs directly attributed to the research project may be funded. The Principal Researcher may propose to use MTO equipment and/or laboratory facilities as part of their application, where similar equipment and/or facilities are not available at their institution.

MTO will not normally fund the purchase of major equipment, or the rental of existing equipment. However, in exceptional cases that satisfy MTO, major equipment purchases, rental of large, shared equipment or the purchase of computer time will be considered on a case-by-case basis.

5.2.3 Materials and/or Supplies

Materials may include the purchase of engineering materials directly attributable to the research project proposal. Supplies may include expendable materials, printing, photocopying, and other similar office supplies.

Materials that are to be supplied by MTO will be indicated in the “Background” section of the Specific Research Topic included in Appendix A of this Program Guide.

5.2.4 Travel

A presentation of the research findings to the HIIFP Steering Committee and/or an MTO Technical Committee may be a key deliverable for the research project proposal. Travel and accommodation, if required, shall be in accordance with the institution’s internal travel policy and all associated costs shall be included in the budget summary.

5.2.5 Dissemination Costs

Dissemination costs include costs associated with the preparation of the written technical report. All written technical reports shall be in conformance with the Ontario Government accessibility requirements in order to be accepted by MTO. See Section 10 for details related to the requirements for written technical reports.

5.2.6 Overhead

Overhead may be included in the budget for the research project proposal. The Budget Summary Form (23-D) requires that the applicant identify the rate (as a percentage) of overhead for the institution. Please note that HIIFP funding is considered a research grant, therefore overhead rates should be calculated and presented accordingly. Overhead rates shall not exceed 25%.

6. Evaluation Criteria

MTO will **only** accept, review and evaluate application packages (see Section 4.1 for the required components of an application package) that are received by the deadline date specified in Section 4.2.

To assist institutions and applicants in completing their application package, the evaluation criteria implemented by MTO for awarding research project proposals HIIFP funding is summarized in the following subsections.

6.1 Application Package Content

Each of the following four items are awarded a numerical score, a maximum of 20 points for each item:

- Demonstrates an understanding of the research need and the desired objective(s)/outcome(s).
- Exhibits a degree of innovativeness to address the problem described in the research need.
- Feasibility of accomplishing the required deliverables within the proposed timelines and budget.
- Experience and qualifications of the Principal Researcher (and Co-Applicants, where applicable) in the subject area(s).

The maximum total for this section is equal to **80 points**.

6.2 Other Considerations

Each of the following four questions are awarded a numerical score based on the reviewer's response ("yes" = 5 points, "no" = 0 points):

- Does the overall cost of the research project provide good Value-For-Money to MTO?
- Is the research project of great importance to MTO?
- Does the MTO Office have a Technical Specialist available to support the research team for the duration of the project?

- Does the research project demonstrate the use of sustainable materials and processes?

The maximum total for this section is equal to **20 points**.

6.3 Final Recommendation

Evaluators will make a final recommendation for each application package by choosing one of three potential outcomes:

- **Yes**, recommend for HIIFP funding.
- **Yes**, recommend for HIIFP funding with suggested changes and/or modifications.
- **No**, do not recommend for HIIFP funding.

7. Notification of Award & Next Steps

A letter announcing the award of HIIFP funds will be sent at the beginning of the award period from MTO to the Principal Researcher. A copy of the award letter will also be sent to the Authorized Signing Officer of the Sponsoring Institution as designated in the HIIFP Application Form (23-A).

Upon receipt of the award letter, the institution accepts and agrees to: 1.) the provisions in the award letter, 2.) the contents of the submitted application package for the research project proposal, and 3.) the requirements set out in this Program Guide. The award letter also provides authority for the institution to incur project expenses for items and amounts specified in the approved Budget Summary Form (23-D). Note, expenses incurred in excess of the approved budget are not the responsibility of MTO.

Following receipt of the award letter and prior to beginning the research project, the Principal Researcher shall connect with the MTO Contact (MTO Technical Specialist) listed in the award letter. This communication between the institution and MTO is critically important to re-confirm all research project proposal items such as:

- The required resources.
- The project schedule.
- Any assistance requested of MTO.
- The specific project deliverables.

Recipients of HIIFP funding and their research team and/or associates are not considered employees of the Ministry of Transportation (MTO) or the Ontario Government. MTO reserves the right to terminate HIIFP funding without cause, at any time, by providing written notice of termination to the institution.

Any public announcements about the award of funding for the Highway Infrastructure Innovations Funding Program shall be made by MTO, unless the institution obtains the prior written approval by MTO.

8. Financial Arrangements & Reporting Requirements

HIIFP funds shall be paid to the institution in one instalment. As outlined in the award letter, the institution will be required to send an invoice to the HIIFP Coordinator for the specified funding amount.

Recipients of HIIFP funding are required to maintain periodic contact with the HIIFP Coordinator and/or the MTO Contact assigned to their research project.

A financial report must be submitted to MTO by the Authorized Signing Officer of the Sponsoring Institution upon completion of the research project. This financial report shall include a full account of purchases and activities financed by the HIIFP grant. The financial report shall also include an itemized list of equipment that was purchased in whole or part with the HIIFP funds.

The following items shall be included in the financial report:

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

MTO reserves the right to audit any research project. The institution is required to keep any records that may be required for a financial audit for a minimum of five (5) years.

For approved multi-year research projects, in order to be considered for funding in subsequent years, institutions will be required to provide written Project Progress Reports, Form 23-F (see Appendix C) a minimum of every six (6) months. The project progress report shall be sent to the MTO Contact, with a copy to the HIIFP Coordinator. Failure to provide such Project Progress Reports describing the percentage completion of the tasks set out in the original application package may result in the institution being denied funding in subsequent fiscal years. Additionally, MTO reserves the right to revoke the funding in future years and can terminate the research project upon written notice to the institution.

Any surplus or unspent funds must be returned to MTO by the institution. If the research project is not started or is terminated part way through the proposed timeframe, any unused portion(s) of the HIIFP funding must be returned to the HIIFP Coordinator within thirty (30) calendar days.

9. Amendments to a Research Project

The Principal Researcher shall notify the HIIFP Coordinator, in writing, in advance of any intention to:

- Alter the direction or intent of the research project.
- Terminate the research project.
- Reassign research responsibilities to other researchers, other than those named in the original HIIFP application package.
- Modify the research project work schedule.
- Reallocate funding described in the Budget Summary Form (23-D) and/or Budget Details Form (23-E) included in the original HIIFP application package.
- Alter the research project deliverables and/or timelines.

Written approval from the HIIFP Coordinator must be obtained before any alterations or amendments to the research project are implemented. Extensions for research projects may be granted if a valid reason for the research extension is provided in advance and an interim Project Progress Report (23-F) is submitted.

If the Principal Researcher is uncertain as to what constitutes an alteration or amendment to the research project, the Principal Researcher shall contact the HIIFP Coordinator and/or the assigned MTO Contact to discuss further.

10. Deliverables

For projects awarded HIIFP funding, the Principal Researcher, and their research team shall:

- Submit a written technical report, published in the MTO Library Catalog, demonstrating how the research need was addressed and/or met and recommendations where improvements may be made.
- Present their findings to the HIIFP Steering Committee and/or an MTO Technical Committee interested in the specific subject area.

10.1 Written Technical Report

The Principal Researcher shall submit a written technical report, no later than three (3) months after the research completion date (as specified in the submitted HIIFP Application Form, 23-A) or after termination of the funding by MTO.

The Principal Researcher shall use the HIIFP Report Template, an MS Word™ template (see Appendix H) as a baseline when preparing the written technical report to maintain consistency of all submitted HIIFP reports. The Technical Report Style Guide for the Engineering Materials Office (EMO), EMO-208 may also be used as a resource to aid the Principal Researcher in producing a written technical report that is well organized, functional, and professional.

To be accepted by MTO, all HIIFP written technical reports require inclusion of a Technical Report Documentation Page (see page ii of the HIIFP Report Template) and shall be submitted in a PDF format. Prior to converting the MS Word™ document to PDF, an accessibility check should be performed using the MS Word™ Accessibility Checker to ensure the written technical report is in conformance with the Ontario Government accessibility requirements. Some best practices for ensuring accessibility requirements are met when preparing written technical reports include:

- Placing a focus on accessibility early in the process of preparing the written technical report.
- Using the HIIFP Report Template, an MS Word™ template with accessibility choices, e.g., font type and size, paragraph spacing, line spacing, etc. pre-defined for the written technical report.
- Choosing font types that are sans serif, e.g., Arial, Calibri, Raleway, etc. and 12-point font size or larger.

- Avoiding large sections of text set in all caps, bold and/or italic.
- Limiting the use of underlined text, except for hyperlinks.
- Using meaningful and descriptive hyperlink text. Avoiding words like “click here” or “go here” for the hyperlink text.
- Avoiding the use of visual cues alone to convey important information, e.g., text effects, highlighting text, low contrast colours, serif fonts, etc.
- Avoiding over use of the **Enter** key, **space bar** or **Tab** key to create white space in the document. An individual who uses a screen reader will hear “blank” repeated several times and this can be distracting or lead the person to believe they have reached the end of the document.
- Performing an accessibility check using the MS Word™ Accessibility Checker prior to converting the source document (e.g., HIIFP written technical report) to PDF to ensure the written technical report meets digital accessibility requirements.
- Converting the source document in a way that ensures the accessibility considerations and information, e.g. cues, tags, styles, etc., are not lost during the conversion process.

MTO will retain the written technical report, generate an ISBN (International Standard Book Number) and publish the final report in the MTO Library Catalog. It is important to note that a copy of a student thesis or dissertation is **not** a substitute for an HIIFP written technical report.

Members of the HIIFP Steering Committee that recommended support of the research project may also review the written technical report.

The institution or Principal Researcher shall also provide MTO with a copy of any follow-up publications which the Principal Researcher prepares following the research project and which incorporates any portion of the research outcomes.

10.2 Presentation of Findings

Upon submission of the written technical report, the Principal Researcher and their research team shall prepare and present the findings of their research project to the MTO Contact assigned to the research project and/or any other interested MTO staff members. In coordination with Principal Researcher, the presentation will be scheduled by the HIIFP Coordinator within two (2) months of the submission of the written technical report.

The presentation shall be prepared using MS PowerPoint™, with consideration made for the following best practices:

- Ensure each slide title is meaningful and unique.
- Choose font types that are sans serif, e.g., Arial, Calibri, Raleway, etc. and 18-point or larger for slide content.
- Avoid large amounts of text set in all capitals, bold, italics, and/or underlined.
- For colour, ensure text and background colours have a contrast ratio of at least 4.5:1, or 3:1 (for large text, 14-point bold and larger).
- Do no use colour alone to convey important information
- Ensure sufficient white space is provided between text and graphics.
- Abbreviations and acronyms shall be fully explained and/or spelled out in their first instance in the presentation.
- Use the notes pane to provide supplementary information or longer descriptions, if required.

11. Research Outcomes

When MTO elects to use the findings from research projects funded by HIIFP, as a condition of the HIIFP funding, MTO shall be granted a non-exclusive, royalty-free license, without charge to use the research outcomes, data, tools, and/or conclusions for MTO's own non-commercial internal purposes. This includes use on MTO highway contracts and work conducted on behalf of MTO.

In the event the institution is able to obtain patent protection for any of the outcomes and/or conclusions in the research project, MTO 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 provide such licenses to MTO.

Should the research outcomes be further interpreted and/or refuted by MTO, then MTO's findings and/or conclusions shall become the responsibility of MTO.

Should MTO's findings and/or conclusions differ from the findings and/or conclusions in the research outcomes, the names of the Principal Researcher, original authors, and institution shall not be associated with MTO's findings and/or conclusions.

12. External Communication of Research Outcomes

For the purpose of this section, 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. This does not include a student thesis or other communications submitted for the purpose of evaluating the student's performance. The institution retains the right to have a student's thesis reviewed and defended for the sole purpose of academic evaluation in accordance with the institution's established procedures.

12.1 External Communications

The Principal Researcher and/or institution shall notify MTO of any external disclosure, publication and/or presentation of the research project findings, outcomes and/or conclusions by adhering to the information in the following sections, where applicable to the particular situation.

12.1.1 Disclosure

Both MTO and the Principal Researcher/institution shall be sensitive to the need for timely approval of a student's thesis and/or essay.

12.1.2 Publications or Presentations

The Principal Researcher/institution, using their best efforts, shall notify MTO at least sixty (60) calendar days in advance of any proposed external publication or presentation. The associated outline or abstract shall be submitted to the HIIFP Coordinator with the Subject Line: External Communication.

12.1.3 Publication Disclaimer

Any publication resulting from a research project funded through HIIFP shall acknowledge the source of the funds and include a disclaimer indicating that the views of the authors may not necessarily reflect the views and policies of MTO. Sample wording of a disclaimer to be used is as follows:

"This research project was supported [whole or in part] by a grant from the Ontario Ministry of Transportation (MTO). Opinions expressed in this report are those of the authors and may not necessarily reflect the views and policies of MTO."

12.1.4 Reference Permission

Should the Principal Researcher/institution wish to make specific reference to MTO and/or name an MTO staff member in the publication, permission by MTO shall be obtained prior to publication. Permission requests shall be sent to the HIIFP Coordinator with the Subject Line: Reference Permission.

12.1.5 Media Inquiries

The Principal Researcher/institution should not speak directly to the media regarding the research project or any findings, outcomes and/or conclusions. Any Principal Researchers/institutions contacted by the media shall communicate the following:

“The Highway Infrastructure Innovations Funding Program policy is to refer all media inquiries to MTO’s Communications Branch”.

All media inquiries regarding awarded HIIFP research projects should be sent to the HIIFP Coordinator with the Subject Line: Media Inquiry. Once the request is received by the HIIFP Coordinator, they will refer the inquiry to the MTO Communications Branch where an Issues Advisor will draft an appropriate response. The reporter/media outlet that made the original inquiry will be sent an official response by an MTO Issues Advisor from the Communications Branch.

13. Occupational Health and Safety

The institution and Principal Researcher shall be responsible for understanding and complying with all legal obligations under the Occupational Health and Safety Act (OHSA). Any procedures undertaken as a result of the awarded HIIFP research project shall be carried out in accordance with the OHSA and all applicable regulations.

Principal Researchers intending to carry out fieldwork on MTO highways and right-of-ways and/or proposing to make use of MTO laboratory facilities shall contact MTO for additional information on operational constraints and occupational health and safety requirements.

Appendix A. Specific Research Topics

Topic 1: Investigating Impacts of the Existing Pavement Deterioration Models and Condition Rating Methods on Road Asset Management

Subject Area	Pavements Section - Engineering Materials Office
Title	Investigating Impacts of the Existing Pavement Deterioration Models and Condition Rating Methods on Road Asset Management
Background	The existing MTO Pavement Management System (PMS-2) has been used over the past two decades to perform annual production of multi-year projects investment programming, particularly the major tasks include: 1) database management that involves dividing and updating pavement management sections that are based on road location, climate zone, traffic and environmental conditions, road classification, pavement type and construction history, 2) data analysis and reporting that is based on raw data collected in the field or received from special inspections, 3) pavement deterioration models that are used to forecast pavement conditions in the next future years, evaluation and rating pavement conditions that are used in the process of determining investment needs to maintain and improve serviceability of the road network comprising of approximate 42000 km two-lane highways. While quality of the raw data is essential, it is extremely important and necessary to establish an adequate quality assurance system for reliable and consistent measurements of pavement condition rating of all individual pavement management sections across time and space. As MTO has adapted high-speed and fully automatic collection of pavement condition measurements of quantity, it is imperative that units of distress measures expressed in measurements of quantities for specific criteria of the indices. This research aims to generate solutions for unifying and amalgamating performance measure indices and their metrological relationships, and output from the study will be used to reinforce the ongoing MTO infrastructure asset management.
Challenge	In view of uncertainty and complicated influential factors for Ontario situation, the technical challenges include but not limited to: • Proper pavement evaluation methods and deterioration prediction models that are the most important to identify accurate pavement projects and investment decisions.

	• The needs for high-quality data, accurate performance evaluation methods and/or deterioration prediction models are all parallel important in pavement asset management. • Review of the MTO PMS and assessment of pavement conditions affected by using different methods and performance indicators. • Formulating measure of pavement distress, units of measure reliable deterioration models and condition rating systems. • Use of metrological theory to provide traceability, accuracy, and consistent measurement of pavement distress, including unit, scaling and standardizing performance measures.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	Anticipated outcomes: • Major findings from investigating the existing MTO methods used in pavement performance evaluation and pavement serviceability condition rating scales based on systematic analysis and review of the historic documents relevant to this study. • What and how performance evaluation and rating systems impact pavement engineering design, asset management and investment plan to keep Ontario roads network in good health. • To what extent will the existing MTO road condition rating systems and deterioration prediction models need for evolutional changes to match with the high-speed and fully automatic data collection system. Research deliverables: 1) A presentation to a Ministry Technical Committee and representatives from MTO pavements section and road asset management offices 2) A written technical report 3) A training and workshop symposium on enhanced pavement evaluation and condition rating guidelines
Benefits to MTO	• Provide technical assistance to the ongoing development of MTO Infrastructure Asset Management in pavement aspects. • Provide theoretical and technical inputs to improving current pavement evaluation and performance prediction with digitization, and units and scales of measurement. • Ensure more accurate prediction of pavement deterioration under various traffic and environmental conditions, and secure cost savings with life-cycle cost analysis of maintenance treatments.
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Topic 2: Enhancing Aggregate Screening Tests for Alkali-aggregate Reactivity (ASR) to Identify Reactive Aggregates

Subject Area	Soils and Aggregates Section, Transportation Infrastructure Management Division
Title	Enhancing Aggregate Screening Tests for ASR to Identify Reactive Aggregates
Background	As Ontario continues to prioritize sustainable and high-quality construction materials, the Ministry of Transportation (MTO) places significant reliance on screening tests to identify reactive aggregates for use in its concrete infrastructure. These tests are stand as a linchpin in safeguarding the durability and performance of Ontario's infrastructure. Currently, MTO employs the LS-620 accelerated mortar bar test and the LS-635 concrete prism test as screening methods to determine the reactivity of aggregates. However, the need to re-evaluate and enhance these screening methods has emerged, especially in cases where slowly reactive aggregates may exhibit inconsistencies between the two tests. Some slowly reactive aggregates have a substantial history of well-documented, unacceptably poor field performance, underscoring the significance of accurately identifying them with absolute certainty for exclusion from Concrete Aggregate Source List (CASL). The inconsistent indications from the LS-620 and LS-635 results for these aggregates, compounded by the inherent test variability, raises legitimate concerns regarding their correct classification of these aggregates.
Challenge	The challenge at hand involves ensuring the effectiveness of the LS-620 and LS-635 screening tests concerning alkali-aggregate reactivity (ASR). Slowly reactive aggregates can, at times, fail the LS-620 test while only marginally failing the LS-635 test. Such a scenario has the potential to introduce ambiguity into the classification of these aggregates. The MTO heavily relies on these tests to compile the CASL, a definitive reference for aggregates permissible in Ontario's concrete infrastructure construction, in compliance with OPSS 1002 standards. Therefore, it's imperative to enhance the accuracy and reliability of these tests to avert any future complications affecting the quality of concrete aggregates. Addressing this challenge is vital to maintain the integrity of CASL and to ensure that reactive aggregates are unequivocally identified and excluded.

Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	This research project aims to achieve the following outcomes: • Review and analyze the existing LS-620 and LS-635 screening tests in-depth. • Identify factors contributing to discrepancies between the two tests, particularly for slowly reactive aggregates. • Propose improvements to the screening tests to enhance their reliability and accuracy in detecting reactive aggregates. • Propose clear criteria in the tests for distinguishing between suitable non-reactive aggregates and those that may pose a risk to concrete infrastructure. • Ensure that any modifications align with OPSS 1002 requirements and maintain the integrity of CASL. • Ensure the testing program achieves statistical significance and remains in compliance with pertinent Ontario Provincial Standard Specifications. • Establish a schedule baseline to guarantee program completion within a year. • Generate a comprehensive report that encompasses all test data, analytical results.
Benefits to MTO	• Improved LS-620 and LS-635 tests will provide more accurate identification of reactive aggregates, reducing the risk of ASR-related issues in concrete infrastructure. • The project will ensure that screening tests align with OPSS 1002 requirements, maintaining compliance and the integrity of CASL. • Accurate screening tests contribute to the selection of high-quality aggregates, ultimately improving the longevity and performance of Ontario's concrete infrastructure. These screening assessments also safeguard that non-reactive aggregates remain eligible, a fundamental aspect in our commitment to sustainability. • By correctly identifying and mitigating the risk of using reactive aggregates, MTO can reduce potential maintenance and repair costs for infrastructure projects. • The project supports MTO's commitment to sustainability and responsible resource management, aligning with evolving industry standards and environmental responsibilities.

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Topic 3: Advancing the Application of Reclaimed Concrete Material (RCM) in Ontario Infrastructure

Subject Area	Soils and Aggregates Section, Transportation Infrastructure Management Division
Title	Advancing the Application of Reclaimed Concrete Material (RCM) in Ontario Infrastructure
Background	In response to evolving regulations governing aggregate extraction sites in Ontario, the Soils and Aggregates Section is committed to exploring sustainable material sources as an alternative to traditional virgin aggregates. While the use of reclaimed concrete material (RCM) from infrastructure renewal for unbound granular applications is standard practice, its utilization as a concrete aggregate remains limited in Ontario. Compared to European and Asian counterparts, who utilize RCM as a concrete aggregate at replacement levels ranging from 20% to 100%, Ontario has the potential to enhance its sustainable practices regarding RCM application. As the volume of available RCM continues to grow with ongoing infrastructure renewal, the Soils and Aggregates Section is investigating the potential for increased use of RCM in non-structural concrete applications. Previous studies have primarily focused on RCM containing either reactive or non-reactive aggregates. However, within Ontario, there exist approximately 15 sources of marginally non-reactive and slowly reactive aggregates. These aggregates, crucial in assessing their reactivity with GUL cement, have been used historically and the majority will continue to be used in the construction of Ontario's concrete infrastructure. Consequently, before considering the integration of RCM into concrete infrastructure, it is imperative to gain a comprehensive understanding of the reactivity of RCM containing these critical aggregates.
Challenge	The challenge at hand is multifaceted.Firstly, it involves determining the appropriate proportion of RCM aggregate in concrete mixes while considering various aggregate types, all the while meeting other OPSS concrete specification requirements. Additionally, this research endeavors to assess the implications of the inherently elevated alkali content contributed by RCM on the reactivity of virgin CASL aggregates. Furthermore, the introduction of GUL cement, which is predominantly used in Ontario as a more environmentally friendly alternative, brings an additional dimension to the challenge. The limestone in GUL may further compound the

	issue of reactivity of RCM containing these aggregates, necessitating a thorough understanding of these complex interactions.Hence, to ensure that Ontario's concrete infrastructure remains of the highest quality and meets evolving standards, an in-depth exploration of these interrelated challenges becomes imperative.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	This research initiative will: • Formulate a comprehensive research and testing plan to assess concrete mixes incorporating RCMs, each produced using aggregates from a select source. Multiple select aggregate sources will be studied. • Investigate the impact of elevated alkali content derived from RCM on alkali aggregate reactivity. • Execute comparative tests, employing various GU and GUL cement sources in conjunction with RCM generated from aggregates obtained from select sources. • Identify and provide valuable insights into the variations in standard concrete properties and durability resulting from the utilization of different mixtures of RCM aggregates with GUL cement. • Ensure the testing program achieves statistical significance and remains in compliance with pertinent Ontario Provincial Standard Specifications. • Generate a comprehensive EMO report that encompasses all test data, analytical results, and the practicality of integrating RCM aggregates into concrete applications.
Benefits to MTO	This research project will greatly influence the potential incorporation of RCM aggregate in Ontario infrastructure. Through the research, MTO can identify the suitable proportion of RCM aggregate, facilitating field trials to evaluate the performance of concrete elements containing RCM. This aligns MTO with sustainable practices and supports effective aggregate resources management while upholding high-quality aggregates in Ontario's concrete infrastructure. This research is pivotal for MTO's green initiatives and aligns with evolving landscape of regulations and environmental responsibilities.

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Topic 4: Effect of Slag Content on the Durability of Concrete Exposed to Freeze-Thaw and Salt Scaling

Subject Area	EMO-Concrete Section
Title	Effect of slag content on the durability of concrete exposed to freeze-thaw and salt scaling.
Background	Replacing cement with supplementary cementing materials such as ground-granulated blast furnace slag is a common practice in the Province of Ontario to reduce the greenhouse gas emissions of concrete while improving concrete durability. However, the increase in the slag content increases the carbonation of the concrete and reduces the freeze-thaw and salt scaling resistance according to many scientific studies. To minimize the negative impact on concrete durability, the Ministry of Transportation of Ontario (MTO) currently imposes a limit on the slag content (maximum 25%) due to the concern with increased carbonation and reduced freeze-thaw and salt scaling resistance. Buried concrete exposed to a sulfate environment is excluded from this limitation. In 2021, the Federal government of Canada introduced the new Canadian Net-Zero Emissions Accountability Act, which contains a plan to reduce emissions by 40-45% by 2023. This increased the demand to reduce the carbon footprint of concrete. Currently, the MTO does not have any supporting data showing that slag content above 25% could be used in highway infrastructure applications without impacting the long-term performance of the concrete and its durability.
Challenge	It is critical to understand the interplay between slag content and the durability of concrete. Before MTO can consider adjusting its limitation on slag content, it is critical to obtain sufficient independent scientific data.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	• Evaluate the effect of ground-granulated blast furnace slag content on the durability of concrete exposed to freeze-thaw and salt-scaling • Evaluate the suitability of the existing limits on the ground-granulated blast furnace slag content to ensure the durability of concrete exposed to freeze-thaw and salt-scaling.

	• Identify the minimum curing duration required for concrete containing slag before exposure to freeze-thaw and salt-scaling • Evaluating the effect of slag when GUL cement is used instead of GU • Evaluate the effect of physical and chemical characteristics of slag on the durability of concrete exposed to freeze-thaw and salt-scaling. • Must include a written Technical Report and a Presentation to a Ministry Technical Committee.
Benefits to MTO	The outcomes of this research would benefit MTO by: • Provide the MTO with the scientific knowledge needed to decide on the limitations to concrete specifications pertaining to slag content to ensure a sustainable and durable infrastructure in Ontario. • Confirm or update curing requirements for slag concrete exposed to freeze-thaw and salt scaling
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Topic 5: Effect of Concrete Drying Period Conditions and Moisture Content of Concrete Surface on the Effectiveness of Hot-Applied Rubberized Asphalt Waterproofing (HRA)

Subject Area	EMO-Concrete Section
Title	Effect of concrete drying period conditions and moisture content of concrete surface on the effectiveness of hot-applied rubberized asphalt waterproofing (HRA)
Background	In Ontario, salt is used on roads and highways to minimize water freezing during the winter season. The salt can have a significant impact on the durability of reinforced concrete due to corrosion. MTO waterproofs all bridge decks using HRA. The waterproofing system consists of a primer, hot-applied waterproofing, protection boards and polyester reinforcement. Hot-applied waterproofing is applied at a temperature between 185°C to 210°C, which requires the concrete to be dry to avoid impacting the bond strength between the concrete surface and the waterproofing. Most waterproofing suppliers recommend the concrete surface be dried for a period that can reach up to 28 days. However, in MTO contracts it is typically not possible to dry the concrete for that period due to construction scheduling. Instead, the MTO specification specifies a minimum of 72 hours of air curing. The concrete surface should not be exposed to precipitation or water during the 72-hour period. In the past, MTO had a good experience with hot-applied waterproofing, however, in recent years there have been more issues with waterproofing related to bubbling, blow and pin holes, which are defects that impact the effectiveness of the waterproofing system.
Challenge	With the recent increase in issues with waterproofing applications, MTO would like to evaluate the current requirements for waterproofing to assist in avoiding further issues. In addition, MTO would like to identify a field test that could be used as quality assurance to ensure that the concrete surface conditions are suitable for applying waterproofing.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	• Evaluate the effect of the drying period on the bond strength of waterproofing at different environmental conditions (temperature and relative humidity) • Identify the optimum minimum drying time at different ambient conditions (temperature and relative humidity)

	• Identify the best field-testing (non-destructive testing) procedure/equipment that could be used to measure the moisture content of the concrete surface • Identify the minimum required moisture content of concrete to ensure proper bond with waterproofing • Identify the optimal conditions required to possibly eliminate the risk of bubbling, blow and pin holes • Must include a written technical report and a presentation to a ministry technical committee.
Benefits to MTO	The outcomes of this research would • Help MTO verify and potentially strengthen the requirements for the concrete drying period required before applying waterproofing. • Identify field testing that could potentially be added to the specifications as a QA test to confirm the suitability of the concrete surface to receive waterproofing
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Topic 6: Enhancing the safety of workers and motoring public at construction zones in Northeast rural highways

Subject Area	Safety at Construction Zones
Title	Enhancing the safety of workers and motoring public at construction zones in Northeast rural highways.
Background	MTO Engineering Project Delivery in Northeast is interested in research findings to improve the safety at construction zones for workers and motoring public based on best practices from North America. There were incidents at construction zones on Northeast rural highways where inattentive drivers that have not encountered a set of traffic signals for a very long time entered construction zones and collided into the rear of lined-up vehicles stopping at construction zones which resulted in fatalities.
Challenge	Northeast Traffic follow the guidelines in the Ontario Traffic Manual Book 7 “temporary Conditions”. However, some collisions at the construction zones are attributed to drivers’ fatigue. MTO Northeast current approach - To alert inattentive drivers, Northeast Traffic practice is to implement a temporary transverse rumble strips (TTRS) at qualified locations to alert drivers approaching construction zones. The challenge with using TTRS is that the self-adhesive strips get loose quickly where the pavement surface is in poor condition. Also, TTRS produce audible sound that may be undesirable for adjacent property owners.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	MTO Northeast is interested in exploring additional devices and measures to alert drivers approaching construction zones in rural areas. inattentive drivers approaching construction zones result in sever fatal collisions. The anticipated outcome is a written report recommending current best practices used by road authorities similar to MTO in North America to alert inattentive drivers in rural construction zones.
Benefits to MTO	MTO Engineering Project Delivery in Northeast is always looking for opportunities to improve safety at construction zones in rural areas.

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Topic 7: Investigating the Reduction of the Movement of Salt into MTO Right-of-Way Soils through the Use of Biofilters, Tubes, Filter Socks, etc. using on site testing

Subject Area	Design Standards Section
Title	Investigating the Reduction of the Movement of Salt into MTO Right-of-Way Soils through the Use of Biofilters, Tubes, Filter Socks, etc. using on site testing.
Background	MTO is interested in information and methods that will assist in the reduction of roadside salt movement into adjacent soils/waterbodies. In 2022, MTO completed an HIIFP project that provided the results of a literature review (Salt-impacted Soil and Water Remediation Strategies MTO Agreement 09002-R-009). However, from the literature review, there was no evidence of how this would work for MTO applications. The study did indicate that biofilters were effective and this needs to be further investigated. MTO is seeking solutions that are feasible and cost effective.
Challenge	Although there have been alternative treatments used for de-icing including a reduction in the amount of de-icers used, the level of salt in the adjacent soils and migrating into sensitive waterbodies is still problematic. Many remedies are extremely costly and not possible to use. A more sustainable, cost effective solution(s) is needed. The highway green infrastructure plays a critical role in the function, protection and aesthetics of the highway. Salt impacted soils and the movement of salt into sensitive water bodies are negative outcomes winter highway maintenance that negatively affect plant growth, soil structure and water quality. Reducing salt movement can help to reduce the negative effects of road salt and reduce the impact on soils, plants and water systems and habitats.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	Must include a written Technical Report that includes a draft sent to the MTO contact for review and a final report. Two presentations are expected including one at the mid-term of the project and one final presentation to the Ministry Technical Committee. Other deliverables may include software, technology transfer materials, design guidelines, etc. Regular contact via online meetings or emails with the contact person are expected. Work is to include field testing on MTO property (chosen in conjunction with MTO and the HIIFP submitter), field visit with

	MTO contact and recommendations and best practices for the use of the successful methods.
Benefits to MTO	Finding low impact and cost-effective methods to deal with salt impacting the soil and adjacent sensitive waterbodies will give MTO a valuable tool(s) to use in a variety of different locations. Reducing the impacts of salt can improve the negative impacts to sensitive waterbodies and improve the growing environment for roadside plants. This in turn creates stronger and more diverse plants that will reduce the impact of rainwater, absorb water and reduce the impact on the highway drainage systems. Stronger plant communities provide habitat and also provide aesthetic benefits for drivers. Protecting waterbodies will help to maintain the quality of water and habitat for aquatic flora and fauna.
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Topic 8: Economic Evaluation of Phragmites Remediation Treatments

Subject Area	Maintenance - Vegetation
Title	Economic Evaluation of Phragmites Remediation Treatments
Background	*Phragmites australis,* hereafter Phragmites, is an invasive weed with major impacts to infrastructure, drainage, and biodiversity. In Ontario, the Invasive Species Center (ISC) states that municipalities and conservation authorities spent 2.8 million CAD in 2019 on this invasive species alone - and it should be noted that the MTO's invasive spending is not included in this value and in 2021 the West Region spent 1.2 million CAD on this species. Once an invasive species has arrived in an area the expenditures increase exponentially as more area is colonized, the ISC cites a 100x return on investment to prevent the colonization of an invasive species than it is to control. Presently the MTO uses chemical control as the primary method for the treatment of Phragmites, however, even with the robust program for this species, it continues to spread to new regions and is re-colonizing treated patches. There is novel research being performed analyzing the effects of plant and fungal species composition and the resilience of an area to colonization of non-native species, but there is a gap in the research regarding the effect of species composition and resilience to Phragmites colonization along roadways. In the spring of 2024, the MTO will be installing 2 test areas to analyse various treatment regimes and their efficacy in the containment and prevention of recolonization of Phragmites in our ROW's. Treatments will include: 1) Conventional: Cut and Spray, 2) Reseed: Cut, Spray and Seed with MTO standard roadside mix (non-native species composition), 3) Naturalize: Cut, Spray and Seeded with MTO West Region Native Seed Mix and 4) Restore: Cut, Spray, Seeded with MTO West Region Native Seed Mix and drill-seed application of a Native Arbuscular Mycorrhizae product.
Challenge	MTO is responsible for maintaining sight lines, drainage pathways and to prevent the spread of invasive species between sites during operations and construction projects. This is an increasing expense to the tax paying public as invasive species colonize new areas and increase land coverage over time. The MTO is interested in exploring research opportunities into alternative methods to prevent the colonization and improve the effects of invasive weed control in our rights-of-way. Standardizing the abatement and

	seeding procedures after Phragmites spray will allow for greater success in the prevention and control of this species and reduce the cost to the public. Specifically, the researchers should: 1) Evaluate the effectiveness of Phragmites treatments, and, 2) Evaluate the cost of various treatments as compared to the level of control achieved The research initiative can focus on two (2) locations each with four (4) treatments in the West Region where Phragmites has colonized, and populations are expanding and are difficult to control.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	Progress reports on measures and analysis every 6 months for review and for the MTO to provide input. Additionally, a technical report or publication of the results and efficacy of each treatment. -An economic analysis of control level achieved by treatment -A report on the proportion of Phragmites that has recolonized after treatment -A review of the impacts on highway operations – drainage, maintenance needs and invasive weed control -Recommendations for the adoption of a treatment as a standard specification for the control and abatement of Phragmites
Benefits to MTO	Currently, there is insufficient research on the effectiveness of treatments, the cost benefits of treatments, and monitoring of spread. This knowledge gap has resulted in an inconsistent approach to compensation across MTO projects, and potentially not using the most resource effective methods to control and abate invasive species colonization. The information received from this report will support a more effective and economically viable treatment plan for Phragmites treatment. MTO will use this information to improve the cost efficiency of our Phragmites treatment program and restore the function of our vegetation rights-of-way.
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Topic 9: Practical Field Chloride Content Testing in Concrete Structures

Subject Area	Concrete Structures
Title	Practical Field Chloride Content Testing in Concrete Structures
Background	Infrastructure owners face an ongoing challenge combatting damage caused by chloride induced corrosion in reinforced concrete structures, however test methods can range from onerous to unreliable. MTO has adopted a standard test method for determination of chloride ions in concrete, which requires extraction of 100mm diameter cores from the concrete component. While this can be accommodated on many concrete components, areas with high rebar congestion are precluded. Various alternative methods for determination of chloride content in concrete exist, however experimental reliability in comparison to the Ministry's standard method for chloride determination has not been well studied. Less invasive field tests that provide reasonably accurate results are needed to assess the chloride contamination of reinforced concrete.
Challenge	Infrastructure owners require a toolbox of practical non-destructive test methods that can reliably produce chloride content results at the rebar level. Extracting 100mm diameter cores on structures condition surveys can be operationally difficult, relatively time consuming and impractical for elements with irregular geometry. An alternate method of drilling a small diameter hole (~13mm) with a percussion drill bit and extracting concrete dust samples at different depths has been applied in other jurisdictions and is purported to provide a reasonable level of accuracy in determining chloride content in concrete via the acid-soluble titration method. However, concerns regarding the accuracy of the chloride test results arise from the potential impact of a blended sample that includes the coarse aggregates. A study is needed to compare the relative efficacy of this test method by carrying out a statistically significant number of tests on chloride contaminated specimens. Alternative non-destructive test methods that produce a reasonably high reliability of results may also be considered. Development of an experimental study to compare the non-destructive test results calibrated against the MTO standard acid soluble test as a benchmark method is needed.

Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	Phase 1) - Perform a literature review of the various non-destructive test methods for in situ determination of chloride content (% by wt of cement) on reinforced concrete elements in the field. - Select 2-3 non-destructive test methods for application in experimental program that could practically be applied to a systemic field testing regime. Phase 2) -Construct chloride contaminated specimens to reasonably replicate a varying chloride profile that is a maximum at the surface and reduces toward the centre of the slab. (Co-ordination with the Ministry may be possible to obtain field samples in lieu of preparing lab specimens, pending availability of field samples.) - Complete experimental program on chloride contaminated slabs to compare the results of the selected NDT methods. -Compare results of 3 different core sizes: 50mm, 75mm, and 100mm when completing the acid-soluble titration method. -Present findings on statistical reliability and accuracy of the alternate NDT methods in comparison with current acid-soluble chlorides benchmark method. - Develop recommendations for combined field extraction and laboratory procedures for alternate NDT methods studied. - Final Report and Presentation.
Benefits to MTO	- Access to key information to be used in bridge rehabilitation treatment decision making. - Expanded toolbox for non-destructive test methods on reinforced concrete bridge components. - Establish practical ability to define exposure zones of structure components for service life design of new and existing structures - Cost savings through selection of the right repair strategy based on a scientific approach to reinforced concrete repair that has previously relied on guesswork or assumptions.
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Topic 10: Discrete Anode Performance Criteria in Concrete Patches

Subject Area	Bridges
Title	Discrete Anode Performance Criteria in Concrete Patches
Background	MTO Engineers and Designers have shown an increasing interest in the use of sacrificial galvanic anodes for cathodic protection in the repair of reinforced concrete elements on bridges. Various research studies suggest that sacrificial anodes can extend the service life of concrete patches reducing traffic disruption and costly rehabilitation. Sacrificial galvanic anodes can be used in a variety of bridge components, including bridge deck overlays, substructure refacings, cantilever reconstruction and in concrete patch repairs. While larger anodes in refacings and overlays have been better studied, the criteria for successful performance of discrete anodes in partial depth concrete patches is uncertain. In part, this is due to the difficulty of monitoring many different small areas in the field. While the technology has been around for many decades, the products available have evolved at the same time and a reliable performance metric to qualify products and assess ongoing performance is needed.
Challenge	Bridge and Corrosion engineers require an established target criteria to specify peformance requirements for discrete anodes. The long established 100 mV depolarisation criteria has been used successfully for impressed current systems, however there is a need to consider a criteria specific to the anode ring effect of typical concrete patching and its dependence of other parameters such as concrete resistivity, relative humidity, and chloride content in concrete. An experimental program is needed to simulate the performance of different anode types and configurations (ie. spacing) to determine a conservative benchmark criteria for corrosion damage prevention/ propogation of the ring anode effect.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	Phase 1) - An exhaustive literature review on the depolarisation criteria for galvanic anodes, including a jurisdictional scan of any metrics used by sophisticated infrastructure owners. Phase 2)

	i. An experimental program designed to test the performance of at least 2-3 different anode types in reinforced concrete samples with varing degrees of chloride contamination, relative humidity and resistivity. The program shall be designed to measure/monitor performance via current density and depolarisation at a minimum in a climate controlled environment that simulates field conditions. If available, employ the use of electrochemical impedance spectroscopy to study the corrosion protection system through the analysis of Bode and Nyquist plots. ii. The performance of the different anodes shall be compared against the proposed benchmark for corrosion damage prevention in the different environments simulated. - Provide recommendations for suitable environments for the anode types and environments studied - Provide recommendations for field monitoring methods of discrete anodes in partial depth concrete patch repairs. - Final Report and Presentation.
Benefits to MTO	- Improved understanding of the methods available to assess satisfactory performance of sacrificial galvanic anodes - Definition of anode performance metrics independent of product supplier - Increased reliability of use of sacrificial galvanic anodes - Life cycle cost savings and reduce traffic disruption through reduced service life via the application of modern technology to concrete patches in bridge rehabilitations.
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Topic 11: Mechanically Stabilized Earth (MSE) Wall Stability in Flood Plains

Subject Area	Bridges
Title	Mechanically Stabilized Earth (MSE) Wall Stability in Flood Plains
Background	Mechanically Stabilized Earth (MSE) Walls are the preferred retaining wall systems in MTO. MSE walls are being increasingly used in flood plains. There are no details or categories available for MSE Walls in the Designated Source of Materials (DSMs) of MTO. There are no guidelines available for selection of materials, and design and construction of MSE walls in flood plains with specific considerations for flooding conditions. The RSS committee reviews MSE Wall project applications in real time, which is a difficult task for engineers without the availability of proper guidelines.
Challenge	Bridge engineers require accurate guidelines regarding how MSE walls perform in the short term and in the long term under different flooding conditions. Guidelines are needed for review of project proposals in which MSE walls are used in flood plains. Development of such guidelines will require systematic finite element analysis of MSE walls under combined hydraulic and mechanical loadings. Choice of appropriate backfill materials and appropriate design modifications under flooding conditions should be ascertained after systematic parametric analysis of MSE walls under different flooding conditions and storm events, based on which guidelines should be prepared. Considerations for scour, piping, durability of reinforcements, as well as internal and external stabilities of MSE walls under different flooding conditions must be included in the guidelines.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	- An exhaustive literature review on design and construction of MSE walls in flood plains. - Finite element analysis of MSE Walls with different flooding conditions, and parametric studies to map the extent of damages possible. - Design modifications required for safety, serviceability, and durability under flooding. - Guidelines for safe, serviceable, and durable design of MSE walls in flood plains to aid the RSS committee. - Recommendations for construction specifications and monitoring.

	- Final Report and Presentation.
Benefits to MTO	- Development of Design Recommendations for MSE Walls on Flood Plains that will help the RSS committee in making decisions - Improved reliability and durability of MSE Walls in Flood Plains - Improved Constructibility and Choice of Backfill Materials - Cost Savings on MSE Wall Construction and Repair Projects
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Topic 12: Determination of Jacking Forces for Tunnel Liners

Subject Area	Construction - Tunnelling
Title	Determination of Jacking Forces for Tunnel Liners
Background	Trenchless Installations of highway infrastructure such as culverts, and utility installations such as pipe sewers, watermains, gas lines, communications beneath our highways has many benefits. Trenchless installations minimize or eliminate traffic disruptions, reduce restoration costs and have environmental and sustainability advantages. There are inconsistencies in predicting the magnitude of force required to jack liners in place for either what is called a one-pass method (one liner) or a two pass method (primary liner and secondary interior carrier pipe). Although the determination of the jacking force is the responsibility of the Contractor for trenchless work as the trenchless item is administered as a design build, the MTO MTO Contract Administrators lack knowledge to verify the accuracy of the predicted jacking force. This puts the MTO at a disadvantage when Contractors claim that unexpected additional jacking forces are required due to different soil conditions.
Challenge	The challenge is to investigate different methods of calculating the jacking forces that considers liner dimensions, liner material, subsurface and groundwater conditions and method of installation. A comprehensive literature review and researching local state of practice in Ontario is needed to develop a guideline for MTO trenchless projects
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	A written guideline that will provide MTO Designers, MTO Construction, Contract Administrators with a tool to verify Contractors Design and Submissions and specifically jacking forces. Upgrade specification to specify requirements for submission of predicted jacking forces and for monitoring jacking forces.
Benefits to MTO	Knowledgeable Owner Upgrade Technical Standard Reduction of Construction Claims

Contact (Name, email, phone number)	Tony Sangiuliano Email: Tony.J.Sangiuliano@ontario.ca Phone: 647-330-3743

Topic 13: Providing Analysis to Identify Wildlife-Vehicle Collision (WVC) Hotspots on Provincial Highways and Developing Criteria for When Mitigation Should be Considered and Implemented

Subject Area	Environmental – Wildlife Vehicle Collisions
Title	Providing analysis to identify wildlife-vehicle collision (WVC) hotspots on provincial highways and developing criteria for when mitigation should be considered and implemented.
Background	WVC's represent a serious threat to the motoring public as they cause serious human injuries and fatalities. An average of 4,160 wildlife collisions per year on provincial highways were reported to the OPP in Ontario from 2015 to 2017. The actual number of collisions may be higher as many of these collisions go unreported. WVCs also are a serious road mortality threat to smaller animals including species at risk, which are protected under the Ontario Endangered Species Act (ESA). Many species of wildlife in Ontario have the potential to be hazardous to drivers, with larger animals being a greater threat. To mitigate public safety hazards caused by large wildlife species and to satisfy requirements under ESA authorizations, MTO has been installing more substantial wildlife mitigation measures on highway projects. MTO has developed several resources to provide guidance for considering wildlife mitigation measures and to assist with identifying WVC hotspots including: ▪ MTO's Environmental Guide for Mitigating Road Impacts to Wildlife published in 2017 only provides guidance for considering wildlife mitigation measures as part of a highway project. No consideration for wildlife mitigation measures outside of MTO highway projects are contemplated. ▪ MTO's Large Animal Mitigation Planning Tool (LAMPT) and Small Animal Mitigation Planning Tool (SAMPT) that was created in 2017 that allows MTO staff to locate WVC hotspots for species at risk and large mammals such as deer and moose along provincial roads. In addition, MTO's CARS database can provide location-based wildlife-vehicle collision data, when captured as part of a collision report. Wildlife mitigation measures are typically installed as part of a regulatory process such as the EA process or ESA authorization process. In these circumstances there is an active process to facilitate consultation, implement actions, and address funding. EPO will match HIIFP funds to support the research.

Challenge	Work previously undertaken by MTO focused on the various types of wildlife mitigation and developing the LAMPT and SAMPT tools to identify wildlife-vehicle collision hotspots. MTO is seeking to build upon this work to help reduce the number and severity of WVC's across the province. However, the following policy and information is required to support this objective: 1) **Defining WVC hotspots:** In addition to existing data, MTO often receives requests from the public to install wildlife mitigation at specific locations. To support policy development and consistent application, criteria to define a WVC (e.g. likelihood of collision, species (e.g. large mammals, endangered/threatened), and other supporting data) is required. The criteria should allow for the ability to rank/prioritize sites across the province. 2) **Potentially outdated hotspot data:** Prior to identify priority WVC hotspots, a review of the existing methodology and data should be reviewed for data gaps, staleness, and opportunities for improvement identified. Predictive modelling methods and the ability to maintain current data should be considered. 3) **Criteria to assess if mitigation should be considered**: To help determine if mitigation should be considered and prioritized for implementation, criteria for consideration should be developed. This should include technical (e.g. mitigation can be effectively applied to the site), administrative (e.g. MTO owns the property), and financial (e.g. is it cost effective).

Anticipated Outcome(s) and/or Research Deliverable(s) (e.g. Written Technical Report and a Presentation)	The deliverables should include: 1) Prepare a report that: • Documents the opportunities to inform an evidence-based criteria for defining, identifying, ranking WVC hotspots. • Reviews existing methodology and data (SAMPT/LAMPT, CARS) and provides recommendations to update existing tools and/or new opportunities to identify WVC hotspots. • Updates and/or develops new tools, methodologies, and data to support GIS mapping and ranking of WVC hotspots. • Provides recommendations and options to keep GIS mapping data current. • Provides criteria to assess if mitigation should be considered for the WVC hotspot. 2) Updated GIS Mapping and Ranking of WVC hotspots. 3) Framework that will allow the ministry to consider the priority of WVC hotspots and potential for mitigation (technical, administrative and economic feasibility) to develop a provincial priority list.
Benefits to MTO	The information received from these reports will provide a framework for determining when to consider wildlife mitigation in response to public concerns, support rationale for funding requests, and will help identify priority locations to implement mitigation to ensure public safety.
Contact (Name, email, phone number)	Michael Glinka Email: Michael.Glinka@ontario.ca Phone: +1 (647) 631-1063

Topic 14: Identifying the Opportunities and Risks of Connected Technologies to MTO Highway Operations

Subject Area	Connected and automated vehicles/Connected infrastructure
Title	Identifying the opportunities and risks of connected technologies to MTO highway operations.
Background	Connected technologies in vehicles and as part of road infrastructure can transform the ministry's operations and impact how the ministry approaches traffic management and congestion. Opportunities (and risks) to leverage connected technologies to improve MTO highway operations in a way that optimizes mobility benefits and mitigates potential negative impacts (e.g., congestion, inequitable access). Some types of technologies that are being introduced to the market include smart cones that send messages to vehicles warning of construction activities affecting lane alignments, speeds, and other temporary changes to road operations; traffic signal messaging systems that provide signal phase information to vehicles (to supplement vehicle cameras "seeing" the light colour); and jurisdictions sharing virtual maps with embedded rules of the road. The Queen Elizabeth Way (QEW) innovation corridor, a project being led by MTO Operations Division, with support from the Ontario Vehicle Innovation Network (OVIN), will provide opportunities for Ontario companies to test their connected vehicle systems in the Ontario context. Research on connected vehicle technology innovations could support the QEW project and provide insights into applications of such data provision and collection. Future opportunities that could support road operators include vehicle reporting of road and other infrastructure conditions to road authorities. This would support improved maintenance information, needs for emergency road repairs, road friction level information that could support messaging to other motorists (e.g., Icy Roads next 10 km).
Challenge	The ministry currently has a limited understanding of the opportunities and risks of leveraging connected technologies to improve MTO highway operations in a way that optimizes mobility benefits and mitigates potential negative impacts (e.g., congestion, inequitable access). The lack of any data sharing agreements between jurisdictions and vehicle operators and Original Equipment Manufacturers (OEMs) with MTO/jurisdictions prevents a deeper

	understanding of the type and volume of information. There is a need to understand industry's data sharing expectations and direction, to develop systems to exchange information on, and to then integrate MTO data systems to provide and receive the data, and to optimize the use of the data we receive. Other challenges include liability implications and mitigation opportunities regarding road authorities sending information that could be relied upon for safety decision making by drivers or an Automated Driving Systems (ADS) as well as the projected increased costs of installation and maintenance for more advanced infrastructure assets.
Anticipated Outcome(s) and/or Research Deliverable(s) (e.g., Written Technical Report and a Presentation)	Written technical report and presentation that could support future strategy work to update MTO operations and ensure infrastructure readiness, such as: • Connected infrastructure technology use cases that could support ministry priorities (e.g., congestion management, road safety) • Impacts on existing highway standards and whether there is a need to harmonize infrastructure with neighbouring jurisdictions • Identification of data sharing standards options being considered in the marketplace • Identification of data elements that the market is considering sharing, along with concerns and considerations from the OEMs and vehicle owners, especially regarding privacy, incrimination, and other use of information • Assessment of how the rules of the road are being integrated in vehicles, and whether compliance by driving systems is on the horizon (e.g., if the speed limit is shared with a connected vehicle, will the vehicle adhere to the speed limit?) • Identifying key partners and roles in advancing infrastructure connectivity • Funding and cost impacts associated with upgrading to connected infrastructure • Data and privacy impacts of connected vehicles communicating with Ontario infrastructure

Benefits to MTO	Information identified through this research could be leveraged to support the testing and validation of connected technologies in MTO operations (such as through the QEW Innovation Corridor initiative), to support preparation of MTO systems to send/receive the data and to integrate the data to evolve processes that could benefit from the data (network planning studies, maintenance, safety assessments) and, in the future, to update MTO operations and prepare provincial transportation infrastructure for automated vehicles. This research would advance work for Actions 3.1 and 3.3 under MTO's CV/AV Action Plan.
Contact (Name, email, phone number)	Mike DeRuyter Email: Michael.DeRuyter@ontario.ca Phone: 647-631-6138

Appendix B. Open Research Topic Form (23-B)

Ontario

Open Research Topic Form

Notes: Form shall not exceed two (2) pages in length. Include a detailed description of the open research topic and clearly identify how it will enhance MTO's practices and business needs (i.e., benefits to MTO).

Subject Area	
Title	
Background	
Challenge	

Anticipated Outcome(s) **and** **Research Deliverable(s)**	
Benefits to MTO	
Principal Researcher (name, email, phone number)	

Appendix C. Project Progress Report (23-F)

Ontario

Project Progress Report

		For Ministry Use Only	
		Project Number	
Date (dd/mm/yyyy)		HIIFP Funding Year	
Principal Researcher (print name)		Email Address	
Institution Name		Institution Address	
Telephone No. (of Applicant)			

Topic No.	Title of Research Topic

Start Date		Completion Date (estimated)	

Brief Description of Progress Completed to Date.
Include information about: (1.) the status of major tasks (2.) the status of outcomes and/or the final report (3.) changes and/or issues (if applicable)

…..continue on Page 2 (if necessary)

Signatures

	Principal Researcher	Head of Department	Authorized Signing Officer of Institution
Print Name			
Signature			

Ontario

		For Ministry Use Only	
		Project Number	
Date (dd/mm/yyyy)		HIIFP Funding Year	
Principal Researcher (print name)		Email Address	
Institution Name		Institution Address	
Telephone No. (of Applicant)			

Topic No.	Title of Research Topic

Start Date		Completion Date (estimated)	

Brief Description of Progress Completed to Date. (continued)
Include information about: (1.) the status of major tasks (2.) the status of outcomes and/or the final report (3.) changes and/or issues (if applicable)

…..continued from Page 1.

Appendix D. HIIFP Application Form (23-A)

Ontario

HIIFP Application Form

	For Ministry Use Only
	Application Number

Principal Researcher (print name)	Email Address
Institution Name	Institution Address
Telephone No. (of Applicant)	

Co-Applicants (Name, Email Address, Institutional Affiliation)	
1.	
2.	
3.	

Topic No.	Title of Research Topic
open	

Brief Purpose of Research

Start Date		Completion Date (estimated)	

Financial Summary

Total Funds Requested from MTO	Total Funds Requested from Other Sources	Total Funds Requested (MTO + Other Sources)
		$ 0

Have you applied to any other funding agencies in support of this research?

YES ☐ (provide details) **NO** ☐

Signatures

It is understood that the provisions outlined in the MTO HIIFP Program Guide AND the details contained in the Research Project Proposal submitted by the Institution are hereby accepted and agreed to.

	Principal Researcher	Head of Department	Authorized Signing Officer of Institution
Print Name			
Signature			

Appendix E. Research Proposal Summary (23-C)

Ontario

Research Proposal Summary

Topic No.	Title of Research Topic
open	

Principal Researcher (print name)	Email Address

SUMMARY OF RESEARCH PROPOSAL
(Non-technical language, 300 words maximum, Arial (12-point) font, 1.08 Spacing)

Appendix F. Budget Summary Form (23-D)

The attached MS Excel™ file (Form 23D_Budget Summary.xls) may also be used to complete this form.

Ontario

Budget Summary

Note: For multi-year proposals, complete one form for each fiscal year requiring funds.

Principal Researcher (print name)	Fiscal Year Ending
	March 31, _____ (insert year)

Topic No.	Title of Research Topic

Research Items	**Direct Costs [$]**	**Overhead Costs [%]** not to exceed 25% of Direct Cost	**Funds Requested from:**	
			MTO [$]	**Other Sources [$]**
Salaries and/or Benefits				
a) Students				
b) Post-doctoral fellows				
c) Technical/Professional Assistants				
d)				
Subtotal:	0		0	0
Equipment and/or Facility				
a) Purchase or Rental				
b) Operation & Maintenance costs				
c) User fees / Other fees				
Subtotal:	0		0	0
Materials and/or Supplies				
a)				
b)				
c)				
Subtotal:	0		0	0
Travel				
a) Technical presentation				
b) Field work				
c)				
Subtotal:	0		0	0
Dissemination Costs				
a) Publication costs				
b)				
Subtotal:	0		0	0
Other Costs (specify)				
a)				
b)				
Subtotal:	0	0	0	0
Column Total:	$ 0		$ 0	$ 0
Total Budget (MTO Portion):	**$ 0**			

Appendix G. Budget Details Form (23-E)

Ontario

Budget Details

Principal Researcher (print name)	Total Funds Requested from MTO

Topic No.	Title of Research Topic
open	

Research Item	**Direct Cost [$]**
Salaries and/or Benefits	
Equipment and/or Facility	
Materials and/or Supplies	
Travel	
Dissemination Costs	
Other Costs (specify)	
Overhead Cost (_____ % overhead on all Direct Costs) =	$0

Appendix H. HIIFP Report Template

See attached MS Word™ template (HIIFP_Report Template.docx).

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