Outline

• Ontario road system overview
• Past - What have we learned
• Present - Current practices and improvements
• Sustainable Future - Challenges
Ontario Road System

- Provincial System
  - Funded through provincial taxes
  - 16,520 centre-line km
  - 3000 bridges
  - $ 2.4 B Capital Constr.

- Municipal System:
  - 152,000 centre-line km
  - 132,000 bridges

Ministry of Transportation
MTO Pavement Network Composition

- Provincial Road Network
  - freeway  8,900 lane-km
  - arterial  13,000 lane-km
  - collector  9,800 lane-km
  - local  7,500 lane-km
- 95% ==> Bituminous pavements
- 5%  ==> Concrete and other types of pavements
- 70% of Canada’s exports and $1.2 trillion in goods are carried on Ontario’s provincial highways
Hwy 17, Northern Ontario
Green Pavement Initiatives

Environmentally friendly pavement design, preservation and rehabilitation strategies include:

- Reuse and recycling of materials
  - Pavement recycling
  - Roof shingles, rubber tires, glass and ceramics
  - Blast furnace slag, fly ash and silica fume
- Warm mix asphalt concrete
- Drainable/permeable pavements
- Reduced noise and perpetual pavements
Implementation of Pavement Recycling in Ontario

- Central plant recycling - late 70’s
- Milling, partial depth - early 80’s
- Full depth reclamation - mid 80’s
- Cold in-place recycling - 1989
- Hot in-place recycling - 1990
- FDR with EA (FA) - 2000
- CIR with EA (FA) - 2003
MTO In-situ Asphalt Recycling Quantities

Years

Quantity (m²)
0 1,000,000 2,000,000 3,000,000 4,000,000 5,000,000 6,000,000 7,000,000
Full Depth Reclamation - FDR
Hot In-Place Recycling - HIR

Ministry of Transportation
Cold In-Place Recycling -CIR
FDR with Expanded Asphalt Stabilization
CIR with Expanded Asphalt
10 Years Summary of Quantities

- Full Depth Reclamation (FDR): 20,184,245 m²
- Hot In-place Recycling (HIR): 324,124 m²
- Cold In-place Recycling (CIR): 3,448,496 m²
- FDR with Expanded Asphalt: 2,005,061 m²
- CIR with Expanded Asphalt: 1,248,812 m²

Total Since 2000: 27,210,738 m²
Past Performance

- In-situ recycled pavements have performed well, often carrying significantly more traffic over their service life than anticipated.
- Designs built in the past have evolved from theory, road tests, and trial and error.
- Lessons have been learned from design problems/flaws, materials, and construction practices that have caused problems.
Recent improvements in design, materials and construction processes have significantly increased the benefits of in-situ recycling techniques.

Improvements in technology have provided cost effective designs and optimization of rehabilitation strategies.
Design Improvements

Comprehensive Construction and Material Specifications

- OPSS 330, Full depth reclamation
- OPSS 334, Cold recycled mix
- OPSS 333, Cold in-place recycling
- OPSS 332, Hot in-place recycling
- OPSS 331, FDR with Expanded Asphalt Stabilization
- OPSS 335, CIR with Expanded Asphalt

Available online:

http://www.mto.gov.on.ca/english/transrd
Towards a Sustainable Future

What is Sustainable Development?

"... Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
Towards a Sustainable Future

To achieve sustainability, every corporate decision should consider the impact of the triple-bottom-line.

“What are the Social, Economic, and Environmental (SEE) Impacts of the decision”
GHG Emissions and Global Warming

Variation in Mean Surface Temp and CO$_2$ Concentration

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Ministry of Transportation
Sustainable Pavement Criteria

“....safe, efficient, environmentally friendly pavements meeting the needs of present-day users without compromising those of future generations”

- In-situ recycling technologies address the main criteria for a sustainable pavement:
  - Optimizing the use of natural resources
  - Reducing energy consumption
  - Reducing greenhouse gas emissions
  - Limiting pollution
  - Improving health, safety and risk prevention
  - Ensuring a high level of user comfort and safety
Energy Use Per Tonne Of Material Laid Down

Source: The Environmental Road of the Future, Life Cycle Analysis by Chappat, M. and Julian Bilal. Colas Group, 2003, p.34
Sustainable Pavements

• The report concludes that recycling technologies are the most promising tool to assist in the selection of environmentally friendly flexible pavements.

• MTO’s primary pavement design/rehabilitation goal is to provide safe durable roads that maximize the use of recycled materials.
Ontario Case Study

Environmental Benefits of In-place Recycling (CIR + CIREAM) vs. Mill and Overlay
Impact Evaluation

- **PaLATE software** - Pavement Life-cycle Assessment for Environmental and Economic Effect
- Created by Dr. Horvath of the University of California at Berkley with funding from the Recycled Materials Resource Centre/FHWA
- Assists decision-makers in evaluating the use of recycled materials in highway construction (both LCC and Environmental Impacts).
Study Assumptions

<table>
<thead>
<tr>
<th></th>
<th>CIR</th>
<th>CIREAM</th>
<th>M&amp;O</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Existing HMA Depth</strong></td>
<td>150mm</td>
<td>150mm</td>
<td>150mm</td>
</tr>
<tr>
<td><strong>New HMA</strong></td>
<td>50mm</td>
<td>50mm</td>
<td>130mm</td>
</tr>
<tr>
<td><strong>% AC</strong></td>
<td>5%</td>
<td>1.0% &amp; 5%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>% Emulsion</strong></td>
<td>1.2%</td>
<td>0%</td>
<td>0%</td>
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</table>

Using PaLATE model, the following emissions were calculated and compared:
CO₂ Emissions

![Bar graph showing CO₂ emissions comparison between Mill & HMA, CIR, and CIREAM treatments. The graph indicates that Mill & HMA has a significantly higher emission compared to CIR and CIREAM.](image-url)
$\text{NO}_x$ Emissions

![Bar chart showing NO\textsubscript{x} emissions for different treatments: Mill & HMA, CIR, CIREAM. The emission levels are in kg.}
SO\textsubscript{2} Emissions

![Graph showing SO\textsubscript{2} emissions for different treatments]
Environmental Benefits

- Per 2-lane km, CIR/CIREAM emits approximately 50% less GHG, consumes 62% less aggregates, and costs 40-50% less when compared to a conventional mill and overlay treatments.
- Since the implementation of CIR/CIREAM contracts, MTO has reduced GHG emissions by:
  - 127,000 tonnes of CO$_2$
  - 1,000 tonnes of NO$_x$
  - 22,100 tonnes of SO$_2$

And saved 1.7 million tonnes of aggregates.
Technology Transfer

- CIR/CIREAM are two of the most environmental friendly flexible pavement rehabilitation techniques available; they reduce Life Cycle Costs, reuse existing non-renewable material, minimize new materials and reduce on site transportation.

- MTO actively promotes CIR/CIREAM through technical papers, presentations and by example
What's next?

- Current Life Cycle Costing (LCC) includes:
  - Initial, and discounted main/rehab costs and remaining life costs
  - User costs
- We now have the tools to calculate GHG emissions and energy savings – PaLATE software
- MTO has developed a rating system to quantify and encourage pavement sustainability
- We are moving towards including an environmental component into LCC (Environmental benefits/credits).
- Insures that the best treatment is selected to benefit economic, social and environmental needs
  - a Sustainable Approach.
Existing Green Rating Systems

- LEED® for Buildings
- University of Washington Green Roads
- NYSDOT GreenLITES Project Design Certification Program
- Alberta/Stantec Green Guide for Roads
- TAC Green Guide for Roads
# MTO Green Rating System Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Goal</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>Pavement Design Technologies</td>
<td>To optimize sustainable designs. These include long life pavements, permeable pavements, noise mitigating pavements, and pavements that minimize the heat island effect.</td>
<td>8</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>To optimize the usage/reusage of recycled materials and to minimize material transportation distances.</td>
<td>13</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>To minimize energy consumption and GHG emissions.</td>
<td>10</td>
</tr>
<tr>
<td>Innovation &amp; Design Process</td>
<td>To recognize innovation and exemplary efforts made to foster sustainable pavement designs.</td>
<td>4</td>
</tr>
</tbody>
</table>

Maximum Total: 35
Green Adjustment

- Green Discounted Life Cycle Cost (GDLCC)

- \[ \text{GDLCC} = \text{LCC} - \text{Green Adjustment} \]

- For example:
  - Using a 20% Adjustment
  - $1,000,000 LCC
  - Green Rating = 12 points; maximum 35 points

  \[ \text{GDLCC} = \$1,000,000 - (20\% \times (12/35) \times \$1,000,000)) \]
  \[ \text{GDLCC} = \$931,429 \]
Summary

We will better achieve our sustainable pavement goals through:

- Building on current industry/ministry partnerships in the development of improved in-situ recycling specifications and design/construction procedures
- Encouraging continued innovation by the province's in-situ recycling contractors
- Supporting dedicated research programs to advance the technology
- Increasing technology transfer to accelerate adoption of in-situ recycling concepts
Conclusions

- There is an increased focus on sustainable asset preservation in Ontario, both at the provincial and municipal levels.
- Pavement preservation and rehabilitation incorporating timely insitu recycling treatments can significantly extend pavement life and result in improved network performance over time.
- Implementation of sustainable AM principles and performance measures are critical to addressing infrastructure investment requirements and environmental stewardship over the long-term.
Thank you!

Questions?

Chris Raymond, PhD, P. Eng.
Head, Bituminous Section
Materials Engineering and Research Office
Tel: 416-235-3725
Fax: 416-235-3996
Email:
Chris.Raymond@ontario.ca