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Integration of Sustainability Rating Tools in Contemporary Pavement Management Systems

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Outline

- Introduction – Sustainability Rating Systems
- Overview of GreenPave and GoldSET
- Case Study
- Conclusions

Sustainability Rating Systems

- What are they?

  Typically, points based rating system designed to assess the sustainability of pavements/infrastructure.

- Goal:

  To provide an assessment of the sustainability of pavement/infrastructure designs and construction for the purpose of promoting environmental “Best Practices”.

How to Identify Sustainable Benefits ?

Need:

- Growing demand for designers to implement sustainable initiatives into public infrastructure projects.

Challenge:

- To develop a System that can identify the benefits and project impacts, compare options in a balanced, transparent manner and quantify the benefits.

Methodology:

- Implement a sustainability rating system, SRS

Existing Rating Systems

- LEED® for Buildings
- University of Washington Greenroads
- NYSDOT GreenLITES
  Project Design Certification Program
- INVEST, FHWA Self Evaluation Tool
- MTO GreenPave
- Golder GoldSET

GreenPave Overview

Background:

GreenPave is primarily based on the Greenroads and GreenLITES rating systems, *customized for Ontario*. The LEED certification program were also referenced.

> *Note: The main difference between GreenPave and many of the other systems is that GreenPave focuses specifically on the pavement component rather than the entire road.*

Applicability:

Applicable to all designs of flexible and rigid pavement structures.

GreenPave Categories

Category	Goal	Points
Pavement Design Technologies	To optimize sustainable designs. These include long life pavements, permeable pavements, noise mitigating pavements, and pavements that minimize the heat island effect	9
Materials & Resources	To optimize the usage/reusage of recycled materials and to minimize material transportation distances	11
Energy & Atmosphere	To minimize energy consumption and GHG emissions	8
Innovation & Design Process	To recognize innovation and exemplary efforts made to foster sustainable pavement designs	4
	Maximum Total:	**32**

GreenPave Overview

Category

Sub-Category

- **Pavement Technologies** — *9 Points*
  - Long-Life Pavements — *3 Points*
  - Permeable Pavements — *2 Points*
  - Noise Mitigation — *2 Points*
  - Cool Pavements — *2 Points*
- **Materials & Resources** — *11 Points*
  - Recycled Content — *5 Points*
  - Undisturbed Pavement Structure — *2 Points*
  - Local Materials — *2 Points*
  - Construction Quality — *2 Points*
- **Energy & Atmosphere** — *8 Points*
  - Reduce Energy Consumption — *3 Points*
  - GHG Emissions Reduction — *3 Points*
  - Pavement Smoothness — *1 Point*
  - Pollution Reduction — *1 Point*
- **Innovation & Design Process** — *4 Points*
  - Innovation in Design — *2 Points*
  - Exemplary Process — *2 Points*

Blue font designates sections applicable only to constructed pavements

Pavement Design Technologies

Description		Points
PT-1:	Long-life Pavements	3
PT-2:	Permeable Pavements	2
PT-3:	Noise Mitigation	2
PT-4:	Cool Pavements	2
Maximum Points Available		**9**

Materials & Resources (MR)

Description	Points
MR-1: Recycled Content	5
MR-2: Undisturbed Pavement Structure	2
MR-3: Local Materials	2
MR-4: Construction Quality	2
Maximum Points Available	**11**

Energy & Atmosphere (EA)

Description	Points
EA-1: Reduce Energy Consumption	3
EA-2: GHG Emissions Reduction	3
EA-3: Pavement Smoothness	1
EA-4: Pollution Reduction	1
Maximum Points Available	**8**

Innovation & Design Process (I)

Description	Points
I-1: Innovation in Design	2
I-2: Exemplary Process	2
Maximum Points Available	**4**

Proposed Rating Levels

GreenPave certified

BRONZE

9 to <12 Points

GreenPave certified

SILVER

12 to <15 Points

GreenPave certified

GOLD

>= 15 Points

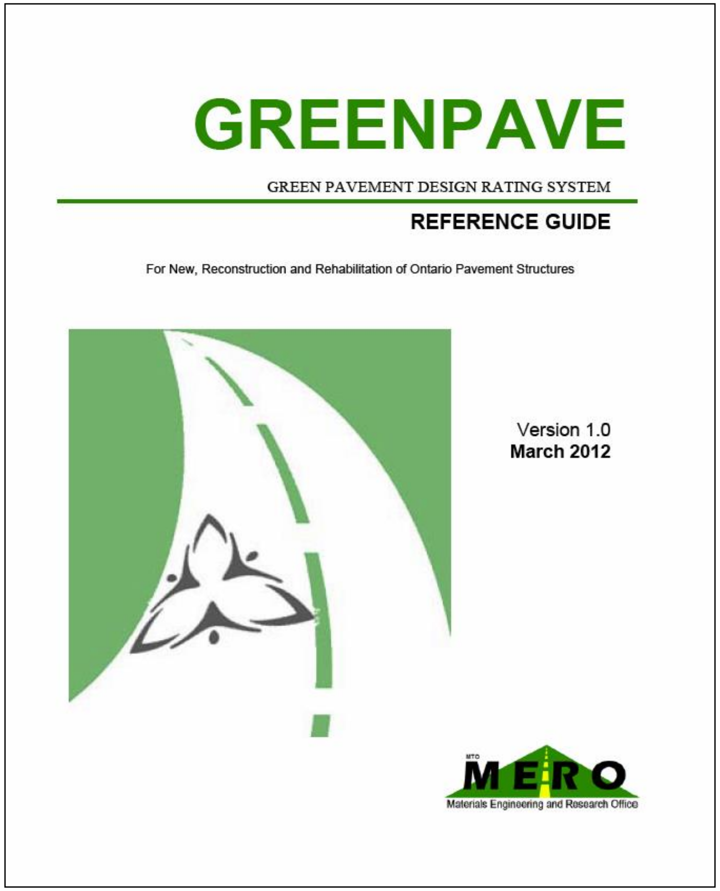
GreenPave certified

TRILLIUM

FOR FUTURE DEVELOPMENT STAGES

Additional GreenPave Resources

Reference Guide



GREENPAVE

GREEN PAVEMENT DESIGN RATING SYSTEM

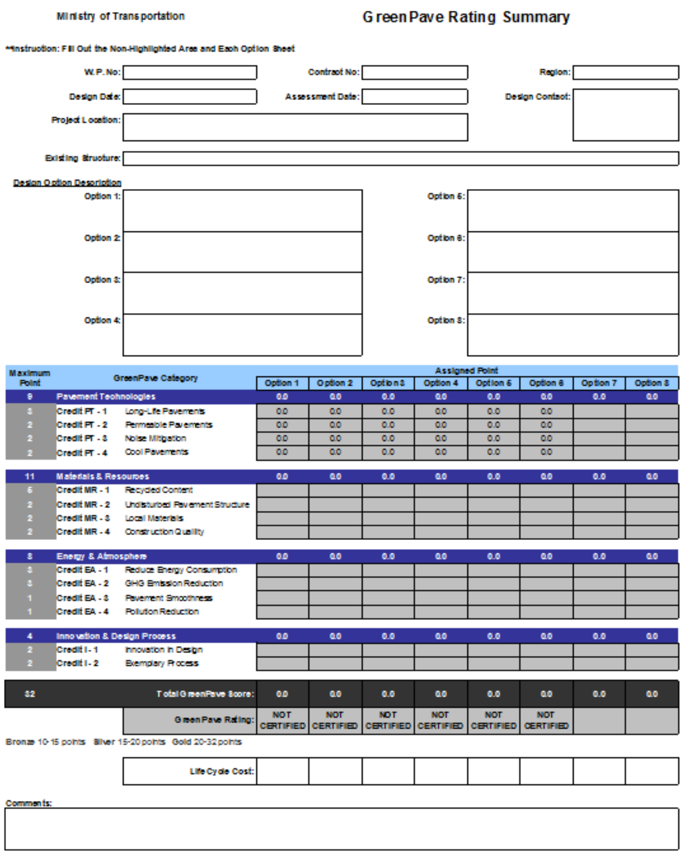
REFERENCE GUIDE

For New, Reconstruction and Rehabilitation of Ontario Pavement Structures

Version 1.0
March 2012

MTO
MERO
Materials Engineering and Research Office

Computer Spreadsheet



Ministry of Transportation

GreenPave Rating Summary

**Instruction: Fill Out the Non-Highlighted Area and Each Option Sheet

W.P. No:
Contract No:
Region:
Design Date:
Assessment Date:
Design Contact:
Project Location:
Existing Structure:

Design Option Description

Option 1:
Option 2:
Option 3:
Option 4:
Option 5:
Option 6:
Option 7:
Option 8:

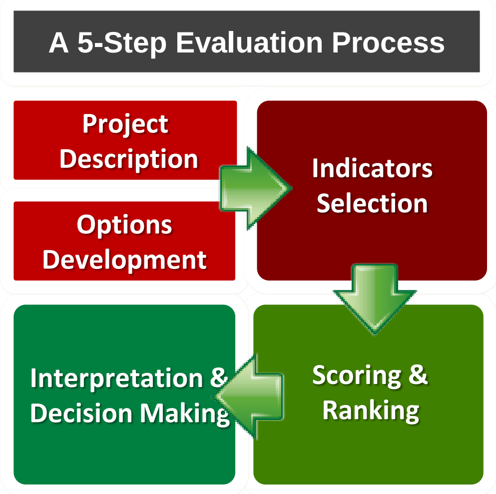
Maximum Point	GreenPave Category		Assigned Point							
			Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
9	Pavement Technologies		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Credit PT - 1	Long-Life Pavements	0.0	0.0	0.0	0.0	0.0	0.0		
2	Credit PT - 2	Permeable Pavements	0.0	0.0	0.0	0.0	0.0	0.0		
2	Credit PT - 3	Noise Mitigation	0.0	0.0	0.0	0.0	0.0	0.0		
2	Credit PT - 4	Cool Pavements	0.0	0.0	0.0	0.0	0.0	0.0		
11	Materials & Resources		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Credit MR - 1	Recycled Content								
2	Credit MR - 2	Undisturbed Pavement Structure								
2	Credit MR - 3	Local Materials								
2	Credit MR - 4	Construction Quality								
8	Energy & Atmosphere		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Credit EA - 1	Reduce Energy Consumption								
3	Credit EA - 2	GHG Emission Reduction								
1	Credit EA - 3	Pavement Smoothness								
1	Credit EA - 4	Pollution Reduction								
4	Innovation & Design Process		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Credit I - 1	Innovation in Design								
2	Credit I - 2	Exemplary Process								
32		Total GreenPave Score:	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		GreenPave Rating:	NOT CERTIFIED	NOT CERTIFIED	NOT CERTIFIED	NOT CERTIFIED	NOT CERTIFIED	NOT CERTIFIED		

Bronze 10-15 points Silver 15-20 points Gold 20-32 points

Life Cycle Cost:								

Comments:

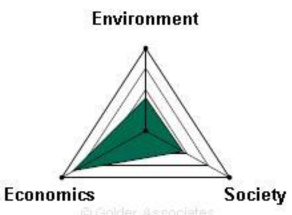
GoldSET - Overview



Environmental Aspect					
Code	**Indicator**	**Option 1**	**Option 2**	**Option 3**	**Weight**
ENV-1	Soil Quality	50	50	50	1
ENV-2	Sediment Quality	90	100	90	2
ENV-3	Soil Vapour Intrusion	90	100	90	2
ENV-4	Groundwater Quality	50	0	90	2
ENV-5	Off-Site Migration	100	50	100	3
ENV-6	Short-Term Impacts on Biodiversity and Species Status	0	100	100	1
Social Aspect					
Economic Aspect					

Conventional Deep Strength

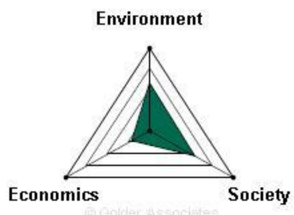
ENVIRONMENT	40%
SOCIETY	44%
ECONOMICS	85%



Greenhouse Gas Emissions :
359 Tons CO2e.
Life Cycle Cost (LCC) :
594,798 $

Perpetual Pavement

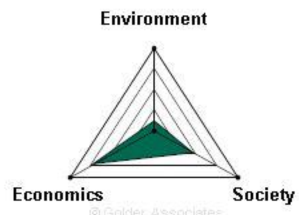
ENVIRONMENT	57%
SOCIETY	53%
ECONOMICS	22%



Greenhouse Gas Emissions :
274 Tons CO2e.
Life Cycle Cost (LCC) :
629,789 $

Conventional Deep Strength with No Subbase

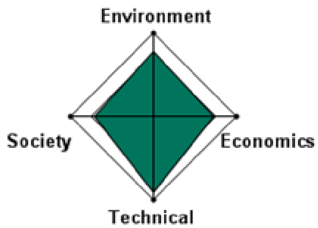
ENVIRONMENT	12%
SOCIETY	46%
ECONOMICS	70%



Greenhouse Gas Emissions :
393 Tons CO2e.
Life Cycle Cost (LCC) :
603,386 $

Thickened Tail

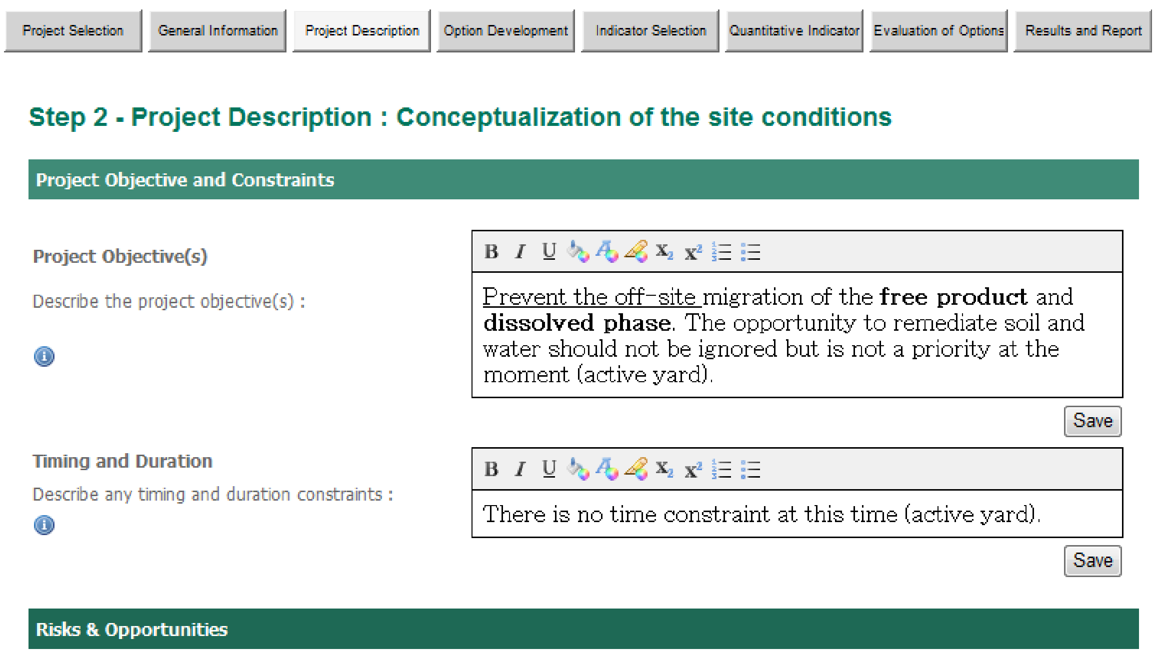
ENVIRONMENT	78%
SOCIETY	70%
ECONOMICS	72%
TECHNICAL	91%



GoldSET Step 1: Project Description

Input project management information

Document the important project parameters



GoldSET Step 2: Option Development

Develops the Options for each project and perform a **Fatal Flaw Analysis**

Step 2 - Option Development

Option	Name	Status	Actions
1	Conventional Deep Strength	Selected	

Option Description

General description of the approach versus objective(s)

Provide a general description of the approach and explain how the approach will meet the project objective(s):

```
Conventional deep strength
asphalt pavement designs
incorporate at least 200 mm of
hot mix asphalt, underlain by
OPSS approved granular base and
```

Is the proposed approach expected to meet the objectives ? Yes

Description of technology

Technology

Provide a summary of the technology and explain how the technology will meet physical site constraints if any :

```
To construct the new new pavement
structure in the median, no new
tecnology will be utilized.  The
pavement structure will be
constructed using typical
```

Additional Testing Required

Detail additional testing required if any :

N/A

Machinery and System Components

Describe the machinery and physical components required (succinct description of main components only) :

```
The larger construction machinery
equipment on site will include:
dozeres, excavators, granular
material/soil/asphalt hauling
vehicles, material transfer
```

Fatal Flaw Analysis

Objective(s) met ?	Yes ☑
Technically feasible ?	Yes ☑
Timing & Duration Constraints met ?	Yes ☑
Financially Feasible ?	Yes ☑
Risks are manageable ?	Yes ☑
Option is Qualified ?	Yes ☑

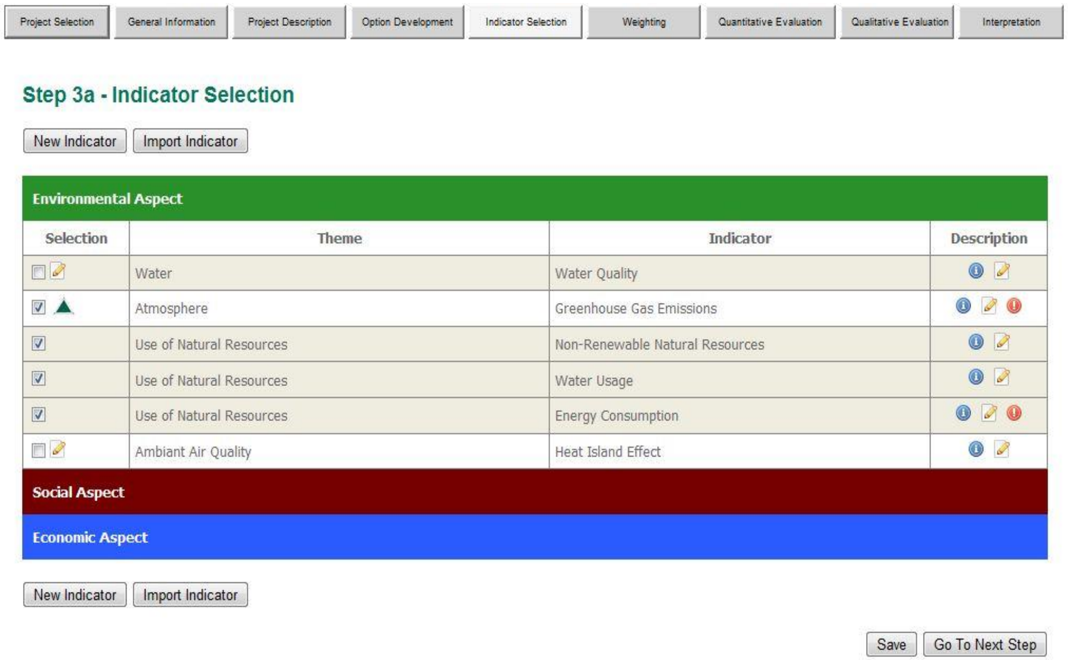
Provide justification(s) for rejecting the approach for further investigation, if applicable :

GoldSET Step 3a: Indicator Selection

Each module contains a list of indicators pertinent to the module application

Additional indicators can be created or imported from the indicator bank

And scoring schemes modified


Project Selection | General Information | Project Description | Option Development | Indicator Selection | Weighting | Quantitative Evaluation | Qualitative Evaluation | Interpretation

Step 3a - Indicator Selection

New Indicator | Import Indicator

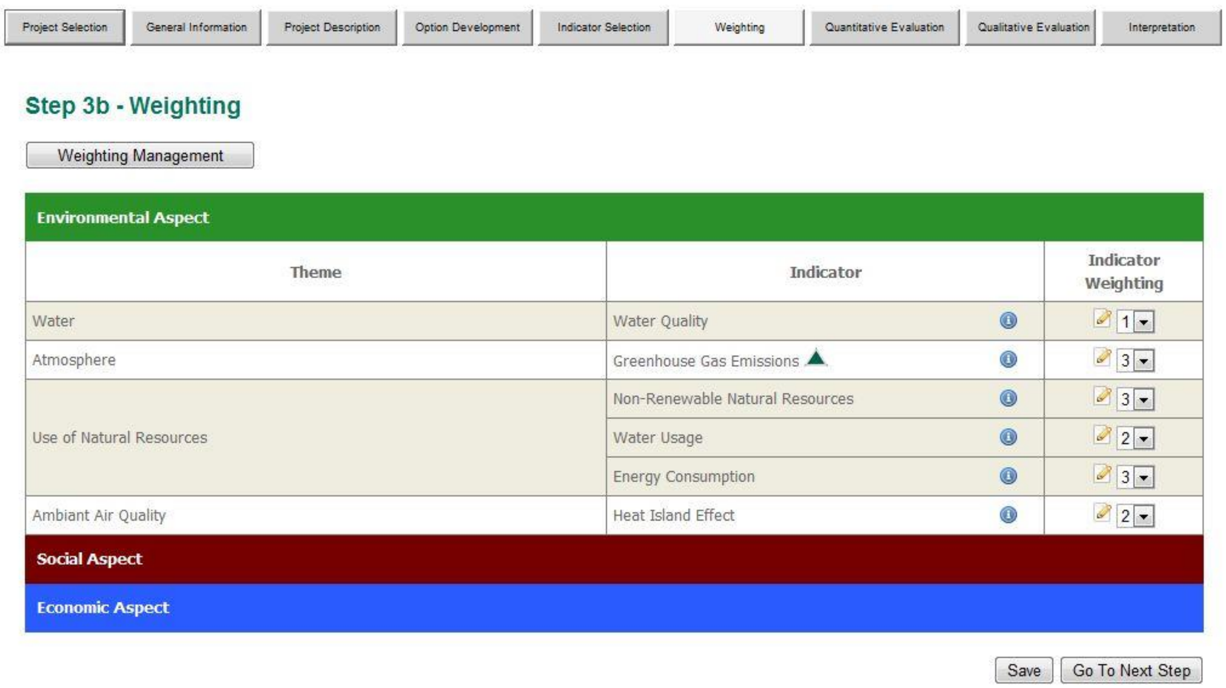
Environmental Aspect			
Selection	Theme	Indicator	Description
☐	Water	Water Quality	
☑	Atmosphere	Greenhouse Gas Emissions	
☑	Use of Natural Resources	Non-Renewable Natural Resources	
☑	Use of Natural Resources	Water Usage	
☑	Use of Natural Resources	Energy Consumption	
☐	Ambiant Air Quality	Heat Island Effect	
Social Aspect			
Economic Aspect			

New Indicator | Import Indicator

Save | Go To Next Step

GoldSET Step 3b: Weighting

Weighting of Indicators



Project Selection | General Information | Project Description | Option Development | Indicator Selection | Weighting | Quantitative Evaluation | Qualitative Evaluation | Interpretation

Step 3b - Weighting

Weighting Management

Environmental Aspect		
Theme	Indicator	Indicator Weighting
Water	Water Quality	1
Atmosphere	Greenhouse Gas Emissions	3
Use of Natural Resources	Non-Renewable Natural Resources	3
	Water Usage	2
	Energy Consumption	3
Ambiant Air Quality	Heat Island Effect	2
Social Aspect		
Economic Aspect		

Save | Go To Next Step

GoldSET Step 4a: Scoring and Ranking

Quantitative Indicators

Project Selection | General Information | Project Description | Option Development | Indicator Selection | Weighting | Quantitative Evaluation | Qualitative Evaluation | Interpretation

Step 4a - Quantitative Evaluation

Environmental Aspect

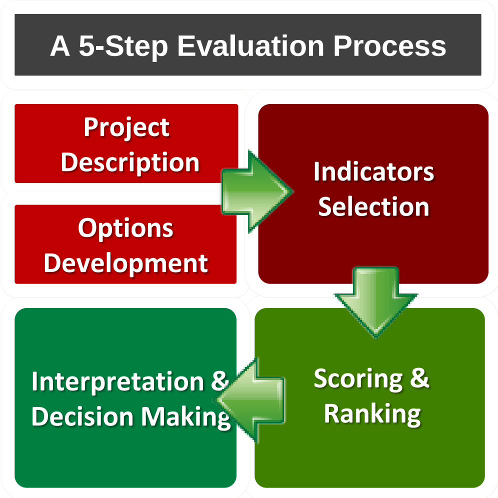
Code	Indicator	Units	Conventional Deep Strength	Perpetual Pavement	Conventional Deep Strength with No Subbase
ENV-1	Non-Renewable Natural Resources	Tons	8239	7624	8647
ENV-2	Water Usage	Liters	3588528	2762180	3833901
ENV-3	Energy Consumption	GJ PFE	5453	4196	5262
ENV-4	Greenhouse Gas Emissions	Tons CO2e.	370	285	353

Social Aspect

Code	Indicator	Units	Conventional Deep Strength	Perpetual Pavement	Conventional Deep Strength with No Subbase
SOC-1	Motor Vehicle Disruption & Accident Potential	Days	7	8	6
SOC-2	Vehicule Movements	Haul Units	1344	1307	1379
SOC-3	Emissions	kg	22249	15704	20719

Economic Aspect

Code	Indicator	Units	Conventional Deep Strength	Perpetual Pavement	Conventional Deep Strength with No Subbase
ECONO-1	Life Cycle Cost (LCC)	$	588610	629789	603386



GoldSET Step 4b: Scoring and Ranking

Qualitative Indicators

Project Selection | General Information | Project Description | Option Development | Indicator Selection | Weighting | Quantitative Evaluation | Qualitative Evaluation | Interpretation

Step 4b - Qualitative Evaluation

Environmental Aspect			
	Conventional Deep Strength	Perpetual Pavement	Conventional Deep Strength with No Subbase
ENV-1 Water Quality	0	0	0
ENV-2 Greenhouse Gas Emissions	25	100	0
ENV-3 Non-Renewable Natural Resources	100	0	24
ENV-4 Water Usage	20	100	0
ENV-5 Energy Consumption	24	100	0
ENV-6 Heat Island Effect	50	50	50
Social Aspect			
Economic Aspect			

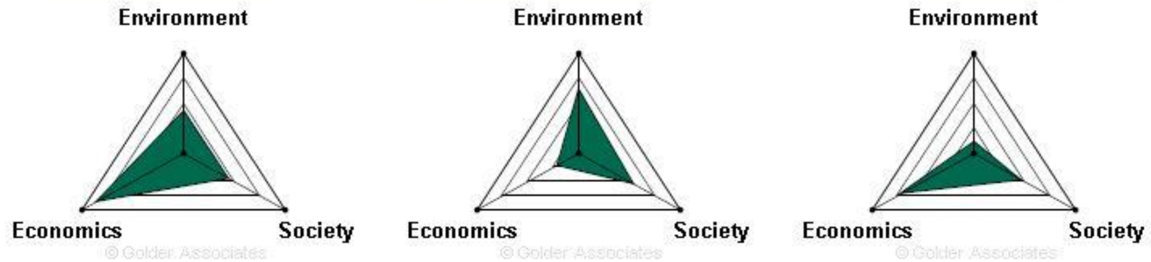
Step 5: Interpretation and Decision Making

The evaluation of Options are computed from the pre-determined indicator scoring and weighting

The Results are presented graphically using a “Spider-Web” Diagram

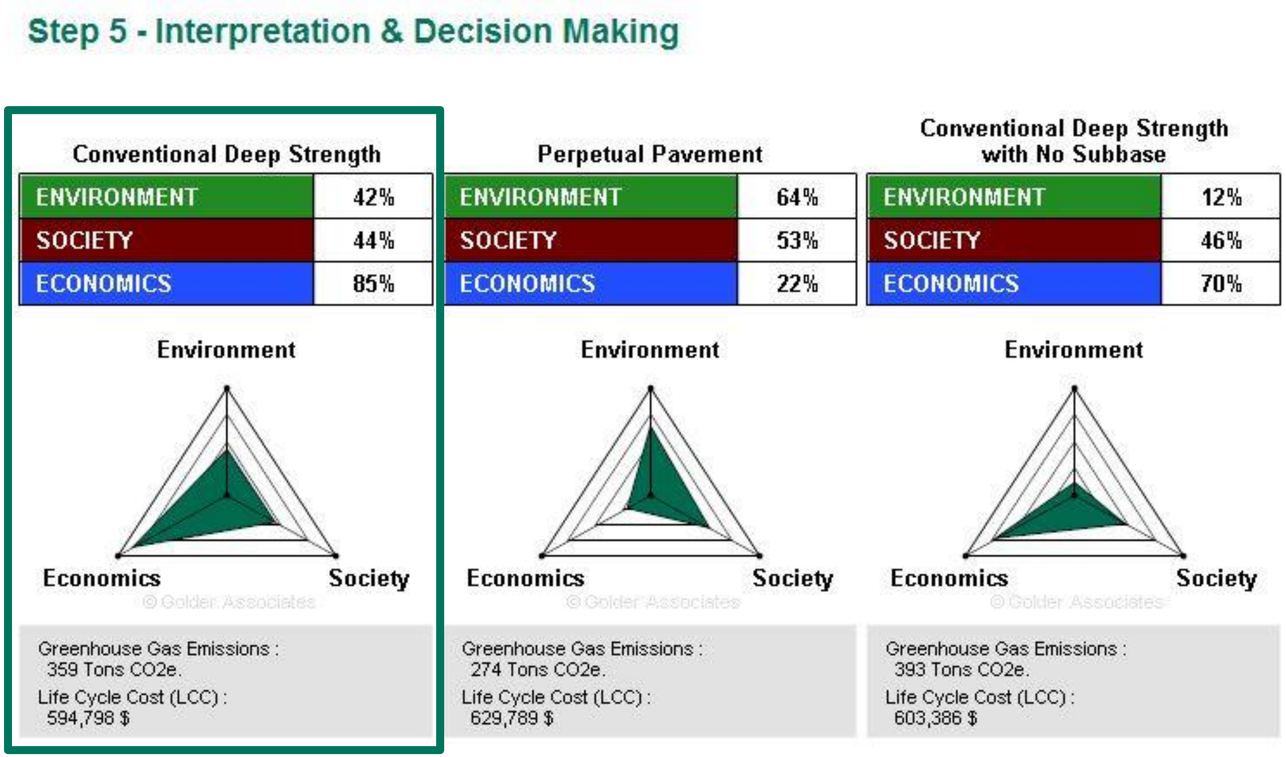
Step 5 - Interpretation & Decision Making

	Conventional Deep Strength	Perpetual Pavement	Conventional Deep Strength with No Subbase
ENVIRONMENT	42%	64%	12%
SOCIETY	44%	53%	46%
ECONOMICS	85%	22%	70%



Conventional Deep Strength	Perpetual Pavement	Conventional Deep Strength with No Subbase
Greenhouse Gas Emissions : 359 Tons CO2e.	Greenhouse Gas Emissions : 274 Tons CO2e.	Greenhouse Gas Emissions : 393 Tons CO2e.
Life Cycle Cost (LCC) : 594,798 $	Life Cycle Cost (LCC) : 629,789 $	Life Cycle Cost (LCC) : 603,386 $

Step 5: Interpretation and Decision Making



The largest, most balanced triangle generally represents the most sustainable Option.

SRS Case Study

QEW Resurfacing
from Casablanca Blvd to Victoria Avenue

Regional Municipality of Niagara

Major rural freeway in the Niagara Falls area

Freeway Section Details

- The existing pavement structure:
  - 40 mm dense friction surface course, DFC
  - 220 mm of heavy duty binder course, HDBC
  - 100 mm of open graded drainage layer, OGDL
  - 300 mm of crushed granular base, Granular A
- The pavement was in fair condition and identified as a 2012 need for rehabilitation.

Proposed Rehabilitation Strategy

- Mill 50 mm and resurface 90 mm using warm mix asphalt:
  - Surface course:
    - 40 mm SP 12.5 FC 2
    - 15% RAP
    - 15% of local material
  - Binder course:
    - 50 mm SP 19.0
    - 20% RAP
    - 100% of local material

GreenPave Evaluation: Innovation and Exemplary Components

- RAP generated from milling was reused within the project
- Maximize echelon paving
- Thermal imaging was done to verify the temperature for warm mix asphalt technology

Maximum Point	GreenPave Category		Option 1
9	Pavement Technologies		5.0
3	Credit PT - 1	Long-Life Pavement	2.0
2	Credit PT - 2	Permeable Pavements	0.0
2	Credit PT - 3	Noise Mitigation	1.0
2	Credit PT - 4	Cool Pavements	2.0
11	Materials & Resources		6.6
5	Credit MR - 1	Recycled Content	1.6
2	Credit MR - 2	Undisturbed Pavement Structure	2.0
2	Credit MR - 3	Local Materials	1.0
2	Credit MR - 4	Construction Quaility	2.0
8	Energy & Atmosphere		6.1
3	Credit EA - 1	Reduce Energy Consumption	2.6
3	Credit EA - 2	GHG Emission Reduction	2.6
1	Credit EA - 3	Pavement Smoothness	1.0
1	Credit EA - 4	Pollution Reduction	
4	Innovation & Design Process		3.0
2	Credit I - 1	Innovation in Design	2.0
2	Credit I - 2	Exemplary Process	1.0
32		Total GreenPave Score:	20.7
		Green Pave Rating:	GOLD

GoldSET Analysis – QEW HWY

Rehab Strategy:
Mill 50mm and Pave 90mm WMA with RAP

Indicators selected to carry out the GoldSET Evaluation:

Environmental	Social	Economic
▪ Greenhouse Gas Emissions[1] ▪ Non-Renewable Natural Resources [1] ▪ Water Usage[1] ▪ Energy Consumption[1]	▪ Direct Local Employment ▪ Motor Vehicle Disruption and Accident Potential[1] ▪ Vehicle Movements[1] ▪ Friction and Permeability ▪ Emissions[1] ▪ Ride Quality	▪ Life Cycle Cost (LCC) [1] ▪ Reliability (Maintenance and Repair) ▪ Technological Uncertainty

Note: [1.] Quantitative estimation during the evaluation process.

GoldSET Analysis – QEW HWY

Some Key Benefits Realized Via the Mill and Pave WMA with In-Situ RAP

Environmental Dimension

- Reduced GHG Emissions; and
- Reduced Energy Consumption.

Social Dimension

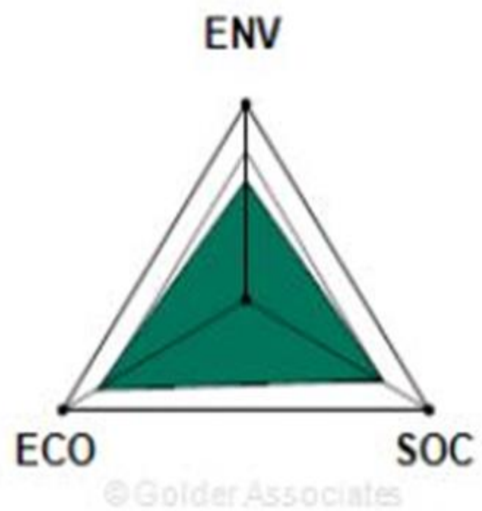
- Less disruption to the travelling public and businesses;
- Improved pavement frictional properties;
- Reduced GHG Emissions; and .

Economic Dimension

- Reasonable initial construction and LCC;
- A recognized reliable strategy in terms of maintenance and effectiveness.

Mill 50 and Pave 90 WMA SP with In-Situ RAP

Environmental	60%
Social	74%
Economic	80%



Integration of SRS into PMS

- Sustainability principles need to be integrated into all engineering decision making processes and management systems
- SRS can be readily incorporated using Excel-based decision support tools
- Tools will ensure all viable sustainability opportunities are considered
- Sustainability profiles in graphical form can be provided beside LCC data

Summary

We will better achieve our sustainable pavement goals through:

- Building on current industry/agency partnerships in the development of improved specifications and design/construction procedures
- Encouraging continued innovation by our pavement preservation and rehabilitation contractors
- Supporting dedicated research programs to advance sustainable technologies
- Increasing technology transfer to accelerate adoption of sustainable pavement concepts

Conclusions

- The GreenPave and GoldSET Rating Systems have been well received and are endorsed as viable sustainability assessment tools for pavements.

- Ultimately, the goal of GreenPave and GoldSET is to enhance the sustainability of transportation infrastructure through designing, promoting and selecting the most economical and environmental-friendly pavement treatment alternatives.

Conclusions

- There is an increased focus on sustainable asset preservation and rehabilitation, both at the state/provincial and municipal levels
- “Sustainable” pavement preservation and rehabilitation treatments applied at the right time 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?

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