ORBA

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Norjohn Contracting and Paving Limited

ORBA Green Award

for **Leadership**

& **Sustainability**

2014

WINNER

April 25, 2014
News Release

The Transportation Infrastructure Industry Recognizes Norjohn Contracting and Paving Limited for its Environmental Leadership and Green Construction Practices

Toronto – The Ontario Road Builders' Association (ORBA), in partnership with the Ministry of Transportation (MTO) and the Ontario Good Roads Association (OGRA), is pleased to announce **Norjohn Contracting and Paving Limited** as the winner of the 2014 ORBA Green Leadership and Sustainability Award.

The ORBA Green Leadership and Sustainability Award was established in 2010 to recognize environmental leadership and sustainability measures in the construction of Ontario's transportation infrastructure. It recognizes contractors who go beyond the scope of requirement on a specific project or develop or adopt innovative ways and means of carrying out business activities in support of the objective of environmental protection and sustainability. The award can recognize new products, innovations in equipment, best management practices, and adoption of construction means and methods that are aligned with sustainability objectives.

"ORBA is delighted to congratulate Norjohn Contracting and Paving Limited as the winner of the 2014 ORBA Green Leadership and Sustainability Award," said ORBA Executive Director Geoff Wilkinson. "In their submission, Norjohn Contracting and Paving Limited demonstrated environmental stewardship and innovative thinking as an approach to sustainable and environmentally conscious construction and corporate practices."

"The Ontario Good Roads Association would also like to congratulate Norjohn on receiving this prestigious award," said OGRA Executive Director Joe Tiernay. "It is this kind of innovative thinking that makes Ontario's roads the safest in North America while protecting our environment," Tiernay added.

The 2014 award recognizes Norjohn Contracting and Paving Limited's work in Haldimand Country where the company used alternatives to traditional paving methods to reduce the amount of energy and resources consumed during granular conversion and road resurfacing, while achieving an equivalent strength and improved seal over the traditional method. The work

involved the conversion of 139,000 m² of gravel roads to hard surface and using cold recycled mix for over 75,000 m² of road resurfacing. Norjohn developed and placed an innovative cold-in place recycled asphalt mix, using recycled materials in place of traditional virgin aggregate for resurfacing, delivering a cleaner and more enjoyable ride for motorists and an upfront cost savings to the municipality. By placing its alternative cold recycle mix and bonded wearing course product, Norjohn achieved a 95 percent decrease in use of virgin aggregate, and a 17 percent decrease in asphalt emulsion. Energy savings amounted to the equivalent to 200,000 L of gasoline or one year of electricity consumption for 221 Ontario homes.

Honourable mention recognition for achievement in environmental leadership and sustainable best measures is also extended to ORBA members, Miller Paving Limited and Capital Paving Inc.

- **Miller Paving Limited** receives honourble mention for its ongoing commitment to sustainable practices and continuous improvement in its operations. Miller's 2014 submission involved the implementation of technological advancements at its Patterson, Carden and MRT quarries. These measures, including an air classifier at Patterson, a cyclone washing plant at Carden and elimination of the use of hydrated lime at MRT, reduced energy and water consumption, increased efficiencies in product manufacturing and improved workplace safety.

- **Capital Paving Inc.** receives honourable mention for its work to reconstitute 230,000 tonnes of stockpiled fill material that was made available to the contract by the City of Guelph. The reconstituted material was used for SSM on the Lair Road Interchange, a joint contract of the Ministry of Transportation and the City of Guelph. Through the efforts of the City of Guelph, the MTO and Capital Paving, the submission stands as an example of the 'beneficial reuse' approach to soil materials management, and how it can be achieved with the support of the local community.

"All three initiatives are examples of commitment to the objectives of the Green Leadership Award program, and also serve as examples of effective collaboration between owners and constructors working together in the spirit of environmental sustainability," added Mr. Wilkinson.

The winners of the 2014 Award will be recognized at the 2015 ORBA Convention for their commitment to green leadership and environmental sustainability.

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The Ontario Road Builders' Association (ORBA) is the voice of the road building sector in Ontario. Our members build the majority of provincial and municipal roads, bridges and transportation infrastructure across the province, and employ in excess of 30,000 workers at peak season. To learn more about ORBA go to www.orba.org

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Norjohn Contracting & Paving
ORBA Green Award Submission

Project Submitted for Consideration: Haldimand County Road Upgrades

Norjohn used alternatives to traditional paving methods to reduce the amount of energy and resources consumed during granular conversion of 139,000 m² and road resurfacing of 75,000 m²

Submission Date: April 1, 2014

Award Year: 2013

Project Location: Haldimand County, Ontario

Project Owner: The Corporation of Haldimand County

Contact Person: Derek Nunn
Division Manager – Asphalt Emulsions
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Norjohn Contracting & Paving
ORBA Green Award Submission

Project Submitted for Consideration: **Haldimand County Road Upgrades**
Project Dates: **May 22 – August 12, 2013**

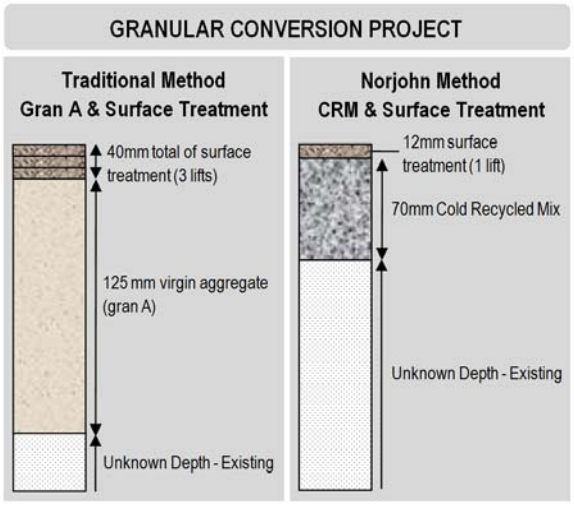
Goal:

To provide more with less; building roads with reclaimed asphalt pavement and thin wearing surfaces. Using less energy, producing fewer emissions and reducing the need for virgin material Norjohn Contracting and Paving Limited provides a sustainable alternative for building rural roads.

Section 1: Overview

Haldimand County converts some of its gravel roads every year, in an effort to improve the level of service to local rate payers and extend the life of the road network. The conversion process includes the addition of granular materials for strength, as well as the application of a new wearing surface that consists of hot mix asphalt or an asphalt emulsion based surface treatment. This new surface adds strength, delays moisture from entering the base, provides a smoother riding surface for traffic and eliminates the need for annual spending on additional granular material and dust control.

Norjohn Contracting and Paving Limited has introduced alternative techniques that provide equivalent strength, and an improved seal. These methods utilize a significant amount of recycled material, produce fewer emissions and therefore reduce environmental impact.



Granular Conversion

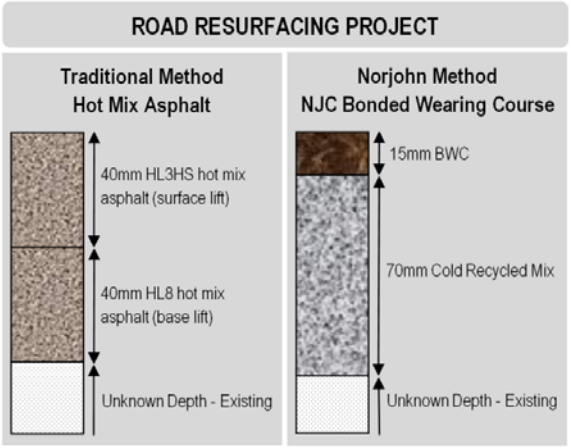
In 2013, 139,000 m^2 of gravel roads were converted to hard surface in Haldimand County. Traditionally, 125 mm of virgin granular "A" would be placed and compacted, followed by 2 lifts of surface treatment (ST). A third lift of ST lift is then placed 1 year later. ST consists of emulsified asphalt cement sprayed onto the base followed by a thin layer of aggregate spread and seated into the liquid.

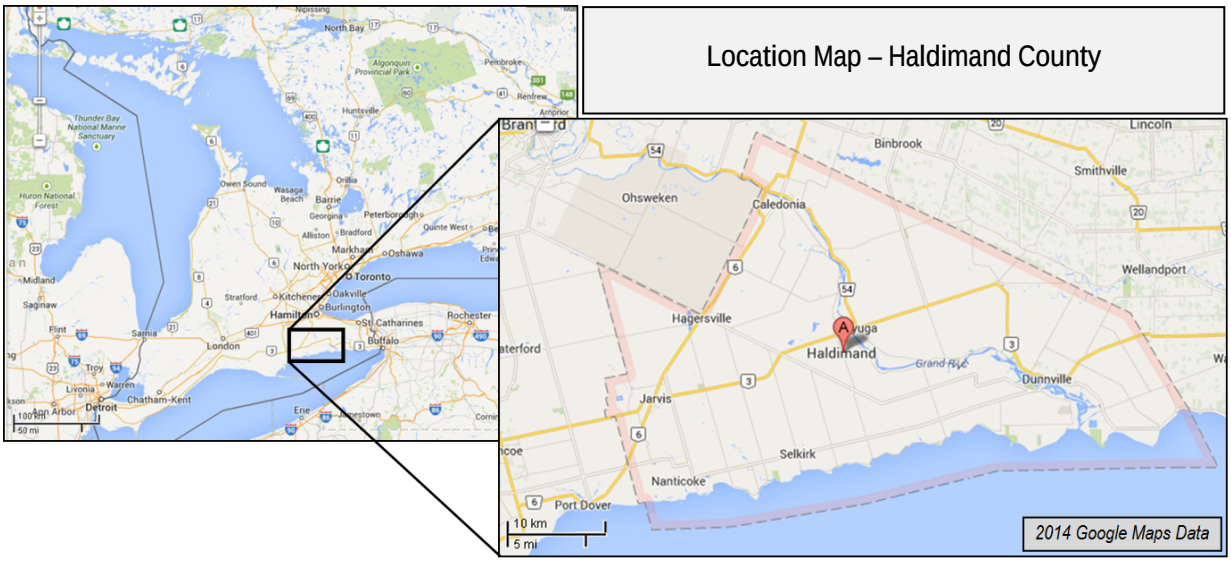
To provide comparable road surface with cost savings and environmental benefits, Norjohn Contracting and Paving proposed a lift of cold recycled mix to replace the virgin aggregate, which then only requires a single lift of ST to be complete.

Road Resurfacing

Road resurfacing was carried out on Marshagan Road and Haldimand Road 70, totaling 75,000 m^2. Typically, 40mm of hot mix asphalt would be used for both the base and the top lift.

Norjohn Contracting and Paving provided an alternate method, using a base lift of cold recycled mix (CRM) and a thin layer of bonded wearing course (BWC) that is comparable to hot mix asphalt in strength, drainage, and lifespan. This method is lower cost, conserves virgin aggregate material, and produces fewer emissions both on and off-site.





Section 2: Technical Aspects

This section will discuss the how the work was carried out for both the road resurfacing and granular conversion projects.

Table 1: Project Summary Table:

Project Start Date	May 22, 2013	Project End Date	August 12, 2013
Granular Conversion Area	139,000 m^2	Road Resurfacing Area	75,000 m^2
Project-Specific Considerations	• Distance to hot mix asphalt plants in Haldimand County (nearest in Hamilton or Simcoe) • Initial Project Cost • Life Cycle Cost • Conservation of materials		

Granular Conversion

Norjohn placed a 70± mm base lift of cold recycled mix (CRM) and a 10± mm surface treatment (single lift).

Norjohn used 100% Reclaimed Asphalt Pavement (RAP) in the CRM in Haldimand County. CRM is placed using a specialized mixing paver that blends the processed RAP with asphalt emulsion (HF 150M). The paver is equipped with an emulsion tank, twin-shafted pugmill, computerized slope and grade controls and extrudes the mix through a conventional screed that initiates the compaction process. A complement of rollers finalizes compaction and the new base is allowed to cure prior to application of the surface treatment.

CRM adds structural strength (GBE = 1.8) to the existing road, and the inclusion of additional asphalt emulsion decreases its susceptibility to moisture, allowing for a single lift of surface treatment (instead of 3 lifts using the traditional method). We will be comparing the Norjohn CRM method to the traditional method that requires virgin aggregate in order to determine environmental benefits and level of sustainability.

Road Resurfacing

Norjohn placed a 70± mm base lift of cold recycled mix (CRM), and a 15± mm surface lift of bonded wearing course (BWC). Identical to the CRM used in the Granular Conversion program, the base material is placed, compacted and cured prior to the application of the Bonded Wearing Course (BWC).

A single pass paving process, BWC consists of a heavy application of polymer modified asphalt emulsion membrane, followed by an ultra-thin hot mix asphalt surface, both placed by the same machine. A specialized “spray” paver incorporates a storage tank and distribution system, allowing the emulsion to be placed immediately in front of the hot mix. Essentially the paver applies a heavy tack coat, immediately in front of the screed.

The result, Haldimand County received a paved road with a comparable ride to hot mix asphalt. We will be comparing BWC to hot mix asphalt to determine environmental benefits and level of sustainability.

Section 3: Why is it Green & Sustainable?

Norjohn Contracting and Paving has initiated changes in methods and materials for road resurfacing and granular conversion that further the objective of environmental protection and sustainability. Additionally, Norjohn and parent company Walker Industries embrace continual improvement and environmental stewardship through the EARTH 1st Environmental Management System, which includes comprehensive environmental policies and procedures, as well as training and outreach.

For calculations of energy requirements, MJ/tonne values were obtained from Table 8 of the Road Rehabilitation Energy Reduction Guide for Canadian Road Builders, published by Natural Resources Canada in 2005[1]. The exception is cold recycled mix, for which Norjohn has provided energy consumption values since there was no appropriate category in Table 8. In addition, the "Binder" energy value for bonded wearing course (BWC) was increased to reflect a more energy-intensive emulsion. All energy values and justifications for added/modified values are located in Appendix A-2. All calculations are located in Tables 4, Table 5, and Appendix A-3.

Granular Conversion

By changing the road resurfacing method from hot mix asphalt to CRM and BWC, significant savings in both materials and energy were achieved. The following are estimates of savings achieved, based on values and calculations in Table 4 and Appendix A-3.

- 28% decrease in energy = savings of 1,986,102 MJ
- 95% decrease in virgin aggregate = savings of 42,951 tonnes
- 17% decrease in asphalt emulsion = savings of 122 tonnes

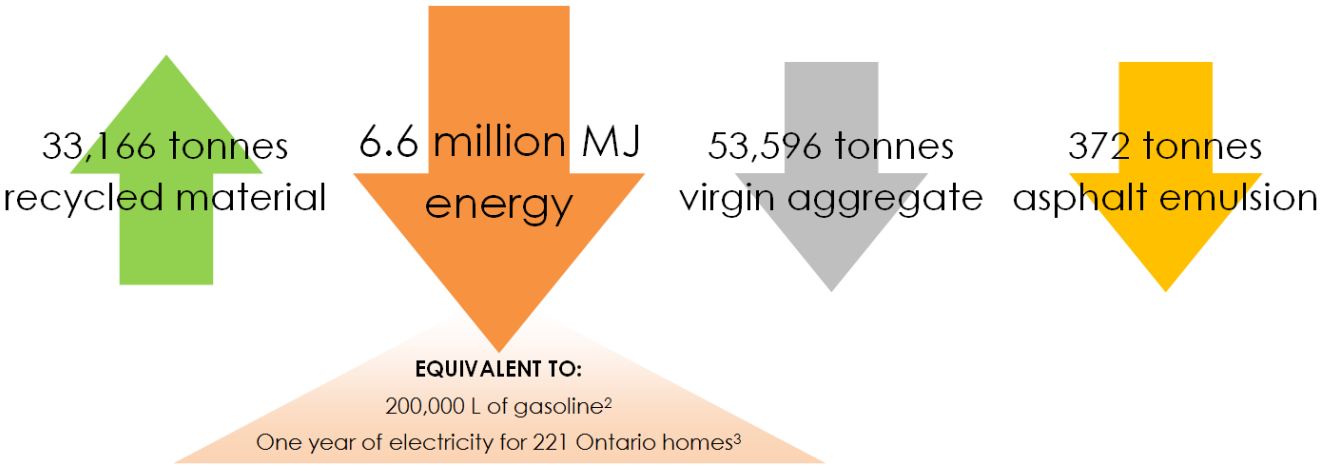
In addition, 21,152 tonnes of Reclaimed Asphalt Pavement (RAP) was used in the CRM.

Road Resurfacing

The switch from hot mix asphalt to CRM and BWC produced significant savings in energy and materials. The following are estimates of savings achieved, based on values and calculations in Table 5 and Appendix A-3.

- 50% decrease in energy = savings of 4,648,838 MJ
- 77% decrease in virgin aggregate = savings of 10,645 tonnes
- 77% decrease in asphalt cement = savings of 561 tonnes

11,624 tonnes of Reclaimed Asphalt Pavement (RAP) was used in the CRM process, as well as 250 tonnes of asphalt emulsion in BWC.



Sustainability Outcomes

These savings in energy and resources have tangible, positive economic, social, and environmental benefits that make the Norjohn granular conversion method preferable to traditional methods.

Environmental

- Fewer non-renewable resources consumed, increasing the lifespan of natural resources (aggregates, petroleum products, water)
- Utilization of recycled material (Reclaimed Asphalt Pavement)
- Decreased energy consumption due to decreased materials (acquiring raw materials, processing, transportation, laydown)
- Fewer emissions (greenhouse gases and other) due to less energy consumption and less hot asphalt paving
- Norjohn's success in using sustainable methods provides incentive for other companies to consider sustainable options.
- Smoother riding surface improves fuel efficiency of vehicle.

Economic

- $333,180 in estimated up-front cost savings for Haldimand County
    - Granular Conversion Savings = $329,430
    - Road Resurfacing Savings = $3750

Note: Cost models are still being developed, as this method is relatively new

Table 2: Granular Conversion Lifecycle Analysis (130,000 m^2)

	Cost per m^2	Life (Years)	$/$m^2$/year
Traditional Method	$11.40	7	$1.63
Norjohn Method			
	$9.03	7	$1.29
		Initial Savings per m^2	$2.37

Table 3: Road Resurfacing Lifecycle Analysis (75,000 m^2)

	Cost per m^2	Life (Years)	$/$m^2$/year
Traditional Method	$19.60	15	$1.31
Norjohn Method			
	$12.60	10	$1.26
		Expected Savings per m^2	$0.05

Social

- More roads can receive treatment for the same cost, improving the network for more residents
- Reduced emissions and perceived disturbance from odours
- Smoother, quieter riding surface
- Reduced user delays during construction period

Table 4: Granular Conversion Data & Calculations

Data Table

					Energy (MJ)					
Method	Layer	Thickness	Material	Tonnage	Binder	Aggregate	Manufacture	Transport	Laydown	Total Energy
Traditional Method	Surface Treatment	3 lifts	Virgin Aggregate	7089	1,770,123	288,522	109,171	631,630	46,787	2,846,234
			Asphalt Emulsion	709						
	Gran A	125 mm	Virgin Aggregate	38,225	0	1,529,000	0	2,599,300	229,350	4,357,650
				Traditional Method Total Energy:	*1,770,123*	*1,817,522*	*109,171*	*3,230,930*	*276,137*	*7,203,844*
Norjohn Method	Surface Treatment	1 lift	Virgin Aggregate	2363	590,041	96,174	36,390	210,543	15,596	948,745
			Asphalt Emulsion	236						
	Cold Recycled Mix	70 mm	Virgin Aggregate	21,542	2,298,713	0	131,355	885,938	197,033	4,269,038
			Asphalt Emulsion	350						
				Norjohn Method Total Energy:	*2,288,754*	*96,174*	*167,745*	*1,096,481*	*212,628*	*5,217,782*
% INCREASE OR DECREASE IN ENERGY FROM TRADITIONAL METHOD TO NORJOHN METHOD					*63% INCREASE*	*95% DECREASE*	*54% INCREASE*	*43% DECREASE*	*23% DECREASE*	*28% DECREASE*

Summary Table

	Material	Tonnage	Energy (MJ)
Traditional Method	Virgin Aggregate	45,314	8,075,414
	Asphalt Emulsion	709	
Norjohn Method	Virgin Aggregate	2363	5,217,782
	Asphalt Emulsion	587	
	Reclaimed Asphalt Pavement	21,542	

Comparison Table

Trend	Aspect	Amount Change	% Change
Decrease	Energy	1,986,102 MJ	28% decrease
Decrease	Virgin Aggregate	42,951 tonnes	95% decrease
Decrease	Asphalt Emulsion	122 tonnes	17% decrease
Increase Recycled Content	Reclaimed Asphalt Pavement	21,542 tonnes	Norjohn Method Only

Table 5: Road Resurfacing Data & Calculations

Data Table

					Energy (MJ)					
Method	Layer	Thickness	Material	Tonnage	Binder	Aggregate	Manufacture	Transport	Laydown	Total Energy
Traditional Method	Hot Mix Asphalt HL8 (Base)	40 mm	Virgin Aggregate	6,897	1,422,960	261,360	1,996,500	544,500	65,340	4,290,660
			Asphalt Cement	363						
	Hot Mix Asphalt HL3HS (Surface)	40 mm	Virgin Aggregate	6,897	2,061,840	275,880	2,098,140	573,540	65,340	5,074,740
			Asphalt Cement	363						
				Traditional Method Total Energy:	*3,484,800*	*537,240*	*4,094,640*	*1,118,040*	*130,680*	*9,365,400*
Norjohn Method	Cold Recycled Mix	70 mm	Reclaimed Asphalt Pavement	11,624	1,240,313	0	70,875	885,938	106,313	2,303,438
			Asphalt Emulsion	189						
	Bonded Wearing Course	15 mm	Virgin Aggregate	3149	1,012,500	128,250	975,375	266,625	30,375	2,413,125
			Asphalt Cement	165						
			Asphalt Emulsion	61						
				Norjohn Method Total Energy:	*2,252,813*	*128,250*	*1,046,250*	*1,152,563*	*136,688*	*4,716,563*
% INCREASE OR DECREASE IN ENERGY FROM TRADITIONAL METHOD TO NORJOHN METHOD					*35% DECREASE*	*76% DECREASE*	*74% DECREASE*	*3% INCREASE*	*5% INCREASE*	*50% DECREASE*

Summary Table

	Material	Tonnage	Energy (MJ)
Traditional Method	Virgin Aggregate	13,794	9,365,400
	Asphalt Cement	726	
Norjohn Method	Virgin Aggregate	3149	4,716,563
	Reclaimed Asphalt Pavement	11,624	
	Asphalt Cement	165	
	Asphalt Emulsion	250	

Comparison Table

Trend	Aspect	Amount Change	% Change
Decrease	Energy	4,648,838 MJ	50% decrease
Decrease	Virgin Aggregate	10,645 tonnes	77% decrease
Decease	Asphalt Cement	561 tonnes	77% decrease
Increase Recycled Content	Reclaimed Asphalt Pavement	11,624 tonnes	Norjohn Method Only
Increase	Asphalt Emulsion	250 tonnes	Norjohn Method Only

Section 4: Reference Information

[1]Natural Resources Canada. (2005). Road Rehabilitation Energy Reduction Guide for Canadian Road Builders. *Canadian Industry Program for Energy Conservation.* [ISBN 0-662-69540-2]

[2]Statistics Canada. (2011). Households and the Environment: Energy Use. *Analysis.* Retrieved from http://www.statcan.gc.ca/pub/11-526-s/2013002/part-partie1-eng.htm.

[3]Statistics Canada. (2011). Households and the Environment: Energy Use. *Table 3-2 Household energy use, by fuel type and by province, 2011 – Average Energy Use.* Retrieved from http://www.statcan.gc.ca/pub/11-526-s/2013002/t004-eng.htm.

Appended as separate files are the following:

1) Tender for granular conversion
2) Tender for road resurfacing

Appendix A – Other Information

A-1: Correspondence from a resident to Haldimand County:

"A letter of thanks…

My husband and I have lived on the east side of the Dunnville/Wainfleet Townline Road for the past 30 years. Recently the road has undergone a transformation that we thought would never happen. We just wanted to send a note of thanks to all who were involved in the decision making to have the road tarred and chipped for whatever the reason. The job was done well, and all the workers that we encountered were helpful and professional. For us it will mean a cleaner and much more pleasant environment. Sometimes it's just nice to get a note of thanks rather than complaint, so thank you.

Regards, Susan & Bob McCann"

A-2: Energy Values used in Calculations

PRODUCT		ENERGY (MG/TONNE)					
Name in this Document	**Name in Table 8 (NRCan, 2005[1])**	**Binder**	**Aggregate**	**Manufacture**	**Transport**	**Laydown**	**Total**
Bonded Wearing Course (BWC)*	Hot-Mix Asphalt Concrete	*300*	38	275	79	9	**701**
HL3HS	High Modulus Hot-Mix Asphalt Concrete	284	38	289	79	9	**699**
HL8	Binder Course Hot-Mix Asphalt	196	36	275	75	9	**591**
Surface Treatment	Gravel-Emulsion	227	37	14	81	6	**365**
Gran A	Unbound Granular Material	0	40	0	68	6	**114**
*Cold Recycled Mix (CRM)***		*105*	*0*	*6*	*75*	*9*	***195***

All Values are obtained from the Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005), with the exception of those values outlined below.

Exceptions:

*BWC: Binder value has been increased from 279 MJ/tonne (Hot-Mix Asphalt Concrete Value) to 300 MJ/tonne to account for a more energy-intensive emulsion

**CRM:

1) Binder – Requires the same energy for the binder as CIP (Emulsion)
2) Aggregate – No virgin aggregate is used
3) Manufacture – Energy used for crushing of RAP only
4) Transport – Transport of RAP is considered to be the same distance as virgin aggregate, with the energy value increased to 75MJ/tonne to account for transportation of asphalt emulsion.
5) Laydown – Requires the same energy as laydown of hot-mix asphalt products

A-3: Supporting Calculations

Part 1: Granular Conversion

Traditional Method: Surface Treatment

Area Paved	139,000	m^2
Number of Lifts	3	
Aggregate	0.017	tonnes/m^2 per lift
Asphalt Emulsion	1.7	L/m^2 per lift
Asphalt Emulsion Density	1000	L/tonne

*Energy Values - "Gravel-Emulsion" from Table 8 of the Guide**

Energy - Binder	227	MJ/tonne
Energy - Aggregate	37	MJ/tonne
Energy - Manufacture	14	MJ/tonne
Energy - Transport	81	MJ/tonne
Energy - Laydown	6	MJ/tonne
Total Energy	365	MJ/tonne

CALCULATED VALUES

Total Virgin Aggregate	7,089.0	tonnes
Total Asphalt Emulsion	708.9	tonnes
Total Tonnage	7,797.9	tonnes
Total Energy - Binder	1,770,123.3	MJ
Total Energy - Aggregate	288,522.3	MJ
Total Energy - Manufacture	109,170.6	MJ
Total Energy - Transport	631,629.9	MJ
Total Energy - Laydown	46,787.4	MJ
TOTAL ENERGY	2,846,233.5	MJ

**Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005)*

Traditional Method: Gran A

Area	139,000	m^2
Thickness (compacted)	125	mm
Density (compacted)*	2.2	tonnes/m^3

*Energy Values - "Unbound Granular Material" from Table 8 of the Guide**

Energy - Binder**	0	MJ/tonne
Energy - Aggregate	40	MJ/tonne
Energy - Manufacture	0	MJ/tonne
Energy - Transport	68	MJ/tonne
Energy - Laydown	6	MJ/tonne
Total Energy	114	MJ/tonne

CALCULATED VALUES

TOTAL TONNAGE	38,225.0	tonnes
Total Energy - Binder	0.0	MJ
Total Energy - Aggregate	1,529,000.0	MJ
Total Energy - Manufacture	0.0	MJ
Total Energy - Transport	2,599,300.0	MJ
Total Energy - Laydown	229,350.0	MJ
TOTAL ENERGY	4,357,650.0	MJ

**Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005)*

Norjohn Method: Surface Treatment

Area Paved	139,000	m^2
Number of Lifts	1	
Aggregate	0.017	tonnes/m^2 per lift
Asphalt Emulsion	1.7	L/m^2 per lift
Asphalt Emulsion Density	1000	L/tonne

*Energy Values - "Gravel-Emulsion" from Table 8 of the Guide**

Energy - Binder	227	MJ/tonne
Energy - Aggregate	37	MJ/tonne
Energy - Manufacture	14	MJ/tonne
Energy - Transport	81	MJ/tonne
Energy - Laydown	6	MJ/tonne
Total Energy	365	MJ/tonne

CALCULATED VALUES

Total Virgin Aggregate	2,363.0	tonnes
Total Asphalt Emulsion	236.3	tonnes
Total Tonnage	2,599.3	tonnes
Total Energy - Binder	590,041.1	MJ
Total Energy - Aggregate	96,174.1	MJ
Total Energy - Manufacture	36,390.2	MJ
Total Energy - Transport	210,543.3	MJ
Total Energy - Laydown	15,595.8	MJ
TOTAL ENERGY	948,744.5	MJ

Norjohn Method: Cold Recycled Mix

Area Paved	139,000	m^2
Thickness	70	mm
Density	2.25	tonnes/m^3
% Weight Reclaimed Asphalt Pavement	98.4	%
% Weight Asphalt Emulsion	1.6	%

Energy Values - Determined by Norjohn Contracting & Paving

Energy - Binder	105	MJ/tonne
Energy - Aggregate	0	MJ/tonne
Energy - Manufacture	6	MJ/tonne
Energy - Transport	75	MJ/tonne
Energy - Laydown	9	MJ/tonne
Total Energy	195	MJ/tonne

CALCULATED VALUES

Total Reclaimed Asphalt Pavement	21,542.2	tonnes
Total Asphalt Emulsion	350.3	tonnes
TOTAL TONNAGE	21,892.5	tonnes
Total Energy - Binder	2,298,712.5	MJ
Total Energy - Aggregate	0.0	MJ
Total Energy - Manufacture	131,355.0	MJ
Total Energy - Transport	1,641,937.5	MJ
Total Energy - Laydown	197,032.5	MJ
TOTAL ENERGY	4,269,037.5	MJ

**Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005)*

Part 2: Road Resurfacing

Traditional Method: Hot Mix Asphalt (HL8 – Base)

Area Paved	75,000	m^2
Thickness	40	mm
Density*	2.42	tonnes/m^3
% Weight Virgin Aggregate	95	%
% Weight Asphalt Cement*	5	%

*Energy Values - "High Modulus Hot-Mix Asphalt Concrete" from Table 8 of the Guide**

Energy - Binder	196	MJ/tonne
Energy - Aggregate	36	MJ/tonne
Energy - Manufacture	275	MJ/tonne
Energy - Transport	75	MJ/tonne
Energy - Laydown	9	MJ/tonne
Total Energy	591	MJ/tonne

CALCULATED VALUES

Total Virgin Aggregate	6,897.0	tonnes
Total Asphalt Cement	363.0	tonnes
TOTAL TONNAGE	7,260.0	tonnes
Total Energy - Binder	1,422,960.0	MJ
Total Energy - Aggregate	261,360.0	MJ
Total Energy - Manufacture	1,996,500.0	MJ
Total Energy - Transport	544,500.0	MJ
Total Energy - Laydown	65,340.0	MJ
TOTAL ENERGY	4,290,660.0	MJ

**Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005)*

Traditional Method: Hot Mix Asphalt (HL3HS – Surface)

Area Paved	75,000	m^2
Thickness	40	mm
Density*	2.42	tonnes/m^3
% Weight Virgin Aggregate	95	%
% Weight Asphalt Cement*	5	%

*Energy Values - "High Modulus Hot-Mix Asphalt Concrete" from Table 8 of the Guide**

Energy - Binder	284	MJ/tonne
Energy - Aggregate	38	MJ/tonne
Energy - Manufacture	289	MJ/tonne
Energy - Transport	79	MJ/tonne
Energy - Laydown	9	MJ/tonne
Total Energy	699	MJ/tonne

CALCULATED VALUES

Total Virgin Aggregate	6,897.0	tonnes
Total Asphalt Cement	363.0	tonnes
TOTAL TONNAGE	7,260.0	tonnes
Total Energy - Binder	2,061,840.0	MJ
Total Energy - Aggregate	275,880.0	MJ
Total Energy - Manufacture	2,098,140.0	MJ
Total Energy - Transport	573,540.0	MJ
Total Energy - Laydown	65,340.0	MJ
TOTAL ENERGY	5,074,740.0	MJ

**Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005)*

Norjohn Method: Bonded Wearing Course

Area Paved	75,000	m^2
Thickness	15	mm
Density	3.0	tonne/m^3
Weight % Aggregate	93.3	%
Weight % Asphalt Cement	4.9	%
Weight % Asphalt Emulsion	1.8	%

*Energy Values - "Hot Mix Asphalt Concrete" from Table 8 of the Guide**

Energy - Binder**	300	MJ/tonne
Energy - Aggregate	38	MJ/tonne
Energy - Manufacture	289	MJ/tonne
Energy - Transport	79	MJ/tonne
Energy - Laydown	9	MJ/tonne
Total Energy	715	MJ/tonne

CALCULATED VALUES

Total Virgin Aggregate	3,148.9	tonnes
Total Asphalt Cement	165.4	tonnes
Total Asphalt Emulsion	60.8	tonnes
TOTAL TONNAGE	3,375.0	tonnes
Total Energy - Binder	1,012,500.0	MJ
Total Energy - Aggregate	128,250.0	MJ
Total Energy - Manufacture	975,375.0	MJ
Total Energy - Transport	266,625.0	MJ
Total Energy - Laydown	30,375.0	MJ
TOTAL ENERGY	2,413,125.0	MJ

**Road Rehabilitation Energy Reduction Guide for Canadian Road Builders (NRCan, 2005)*

***Binder value increased from 279 to 300 MJ/tonne to account for more energy-intensive emulsion.*

Norjohn Method: Cold Recycled Mix

Area Paved	75,000	m^2
Thickness	70	mm
Density	2.25	tonnes/m^3
% Weight Reclaimed Asphalt Pavement	98.4	%
% Weight Asphalt Emulsion	1.6	%

Energy Values - Determined by Norjohn Contracting & Paving

Energy - Binder	105	MJ/tonne
Energy - Aggregate	0	MJ/tonne
Energy - Manufacture	6	MJ/tonne
Energy - Transport	75	MJ/tonne
Energy - Laydown	9	MJ/tonne
Total Energy	195	MJ/tonne

CALCULATED VALUES

Total Reclaimed Asphalt Pavement (RAP)	11,623.5	tonnes
Total Asphalt Emulsion	189.0	tonnes
TOTAL TONNAGE	11,812.5	tonnes
Total Energy - Binder	1,240,312.5	MJ
Total Energy - Aggregate	0.0	MJ
Total Energy - Manufacture	70,875.0	MJ
Total Energy - Transport	885,937.5	MJ
Total Energy - Laydown	106,312.5	MJ
TOTAL ENERGY	2,303,437.5	MJ

Appendix B – Best Practices Checklist

ORBA Best Practices Checklist					
Please indicate which of the following programs/initiatives are in place in your organization or have been implemented in the project/work which is the subject of the Award submission					
Program/Initiative	**In Place Company Wide**	**In Place at Specific Project**	**Not Implemented**	**Not Applicable**	**Points Available**
Site Maintenance Plan				✓	2
Quality Management System		✓			2
Environmental Management System	✓				2
Environmental Training Program	✓				2
Recycling/Reuse Policy	✓ *Mentioned throughout environmental procedures*				2
Bio-Fuel/Renewable Fuel/Energy Policy			✓		2