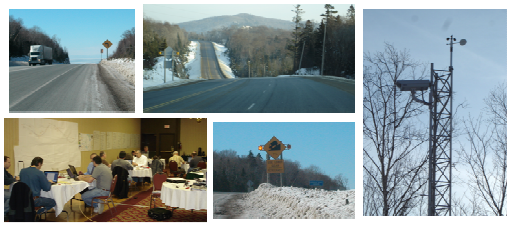
MTO Value Analysis

Northeastern Region



Winter Maintenance - Highway 17 Montreal River Hill Area

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Presentation to the Canadian Society for Value Analysis

Montreal November 20, 2007

Tom Fletcher P.Eng., CVS
VE facilitator
The Fletcher Group

Joseph Arcaro P.Eng., AVS
Vice President iTrans Consulting Inc.
Project Manager

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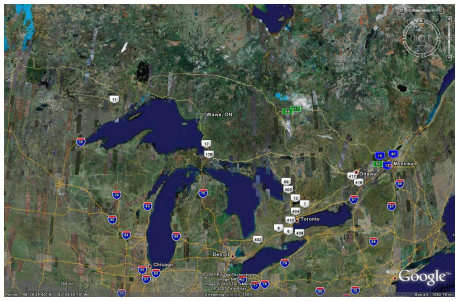
Location – Montreal River Hill



6

Location – N. Ont.

7

Location - Local

8

Wawa

- Gone Too Far

9

Lake Superior-vicinity Montreal River

10

Highway 17 – South Limit

11

Montreal River Hill – 6% grade

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Northern End of Project Limits

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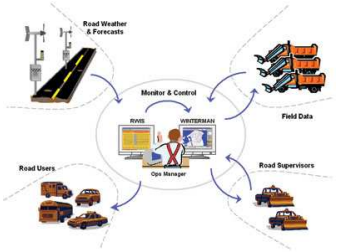
Current Winter Maintenance Program



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Challenges

- Highway 17 at the Montreal River Hill is only one of 3 hills between SSMarie and Wawa where closures occur
- “Solving Montreal River Hill without looking regionally only moves the problem to the next location”- Kevin Morphet, MTO
- December 4-8th, 2006 – Two closures along Highway 11 at hills north of Montreal River Hill
- January 11, 2007 closure at MRH

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Strategy for VA

- Evaluate from comprehensive perspective
- Maximize use of MTO maintenance experience
- Utilize former MTO maintenance supervisor with recent experience in winter maintenance contracting
- Utilize external expertise in state of the art technical solutions
- Added Environment Canada experience in meteorology and winter storm prediction

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The VA Team

- Mike Pearsall - MTO, Project Manager
- Kevin Morphet - MTO, ACE
- Orville Warnock - MTO, Maintenance Superintendent, East
- Ken Seabrook - MTO, Maintenance Superintendent, North
- Mickey Major - MTO, Maintenance Superintendent, New Liskeard
- Bill South - MTO, Traffic
- Sherryl M. - MTO, Patrol
- Joseph Arcaro - iTRANS, Project Manager
- Tom Fletcher - FG, CVS
- Geni Bahar - iTRANS, Safety
- Mike Griff - Maintenance Operation (Former MTO)
- Frank Spitzer - IBI, Maintenance Technology
- Denis Paquette - Environment Canada, Meteorologist
- Ting Ku - iTRANS, VA Coordinator/Technical Support
- OPP invited but could not attend

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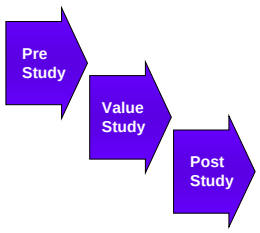
Value Analysis Methodology



- ***PRE-STUDY***
- ***VALUE STUDY***
  - ***Information Phase***
  - ***Function Analysis Phase***
    - ***Functional Performance Specification***
  - ***Creative Phase***
  - ***Evaluation Phase***
    - ***FMEA***
  - ***Development Phase***
- ***POST-STUDY***
  - ***Presentation***
  - ***Recommendation***
  - ***Implementation***

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The VA Process

- Site Visit – Sunday, December 10, 2006
- Workshop – 3 days Dec. 11-13, 2006 at Sault Ste. Marie
- Information Phase
  - Maintenance Presentation
  - Function Analysis System Technique - FAST
  - Functional Performance Specification - FPS
- Creative Phase (6 categories - 98 ideas)
- Evaluation Phase (59 carried forward)
- Development Phase (combined to develop 39 alternatives, generated 12 scenarios)
- Selection of Preferred Alternatives and/or Scenarios

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Information Phase

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Existing Conditions

- Two-Lane Undivided Highway (~3.4 km)
  - 3-lane cross-sections at passing lane locations
  - Grades up to 7% plus horizontal curves (>165 m / 500 ft change)
  - High percentage of heavy vehicles (~30%)
    - Increasing “just in time” delivery
    - More efficient and powerful diesel engines
  - Posted speed 90 km/h and 80 km/h advisory on curve
  - Significant rock cut shading
  - Scenic views of Lake Superior and surrounding area
    - Can be distracting

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Existing Conditions continued

- Weather Variations
  - Lake Superior proximity – lake effect weather
  - 100cm per hour snow event
  - Wide range of road conditions at a given time and elevation (micro-climates)
- Operational Issues
  - Trucks have problems climbing the hills during inclement conditions
  - Road closures due to weather/accidents
  - Limited/long detour options
  - No detour options once SB, south of Wawa

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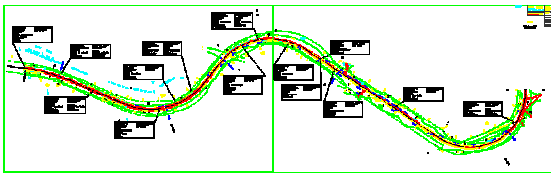
Highway 17
Montreal River Hill Collisions
(1999 to 2004)



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Traffic Volumes

- AADT – 2,150
- SADT – 2,900
- WADT – 1,600
- % Commercial – Approx 30%

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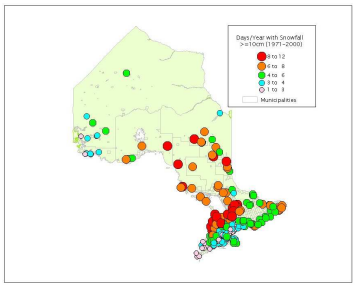
Field Investigations

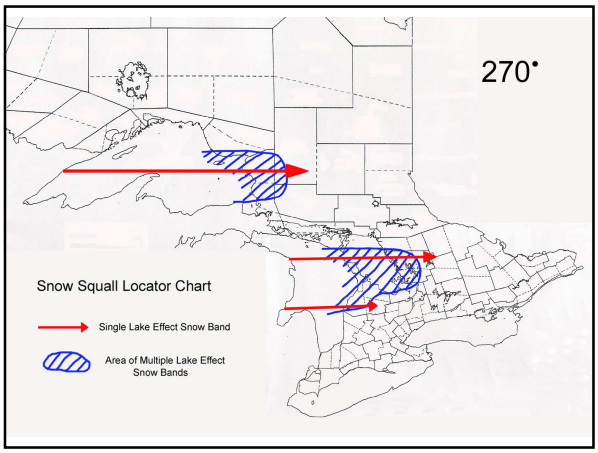
- Series of combined sharp curves and steep hills
- High speed corridor
- Heavy trucks
- Signage present, including flashers at the top of the hill
- some chevron signs blend into the background
- Rock cut shadings
- Limited pull-off area
- Snow banks forming against guiderails
- Snow runoff across the road
- Sun glares from runoff
- Raised pavement marking present, poor condition
- Scenic views of Lake Superior

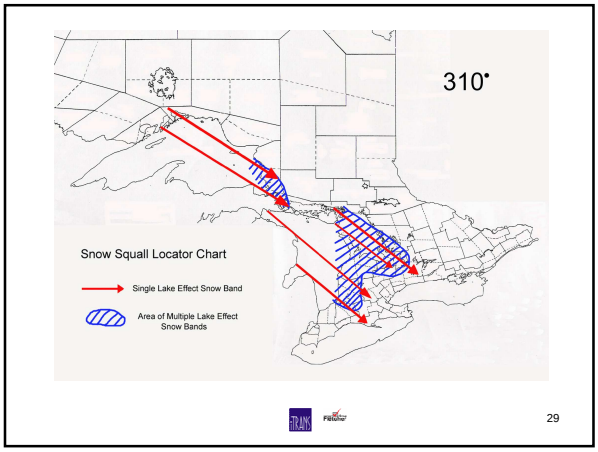
Local Knowledge

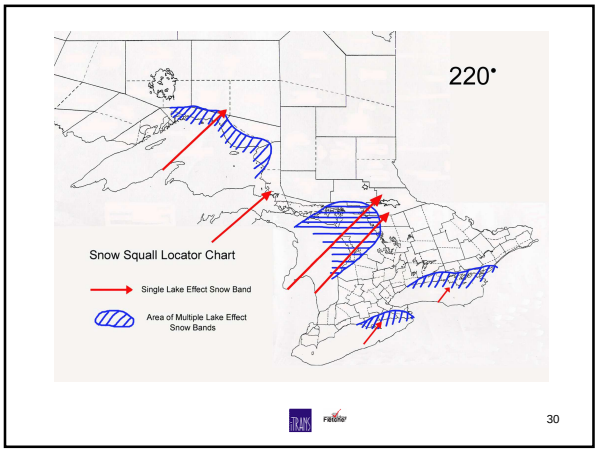
- Winter Maintenance provided through Managed Outsource Contract
- Montreal River Hill served by Batchawana and Agawa patrol yards
- Typically need 30 to 45 minutes to load appropriate equipments and materials
  - Contract requires loading by 30 minutes
  - May be shorter if on stand-by
- Two shifts covering 20 hours
  - Shift start at 8 am
  - Shift extension possible if required
- Available equipment varies depending on dispatch location
  - some issues with state of equipment
- ARWIS station located on Montreal River Hill helps reduce reaction time
  - Station maintenance is an issue
  - Connectivity to the station is also an issue
- About 45 min one way between Agawa and Batchawana yards
- Most incidents (~90%+) resolved with assistance from road patrol

Environment Canada Data




270°
Snow Squall Locator Chart
Single Lake Effect Snow Band
Area of Multiple Lake Effect Snow Bands


310°
Snow Squall Locator Chart
Single Lake Effect Snow Band
Area of Multiple Lake Effect Snow Bands
29


220°
Snow Squall Locator Chart
Single Lake Effect Snow Band
Area of Multiple Lake Effect Snow Bands
30

Montreal River Hill

- Climbing 7% grade in snow conditions

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Montreal River Hill- Closure


LONG LINE, LONG WAIT

NORTH-BOUND TRANSPORTS are halted along the North Gate Hill Tuesday morning on Highway 17 North as traffic was unable to negotiate the Montreal River Hill, about three kilometres north. The lineup remained for three hours, finally pushing ahead about 2 p.m.

WEATHER

INDEX

SPEED

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Summary – Highway 17 Closures

SSM District

Highway 17	1999-2000		2000-2001		2001-2002		2002-2003		2003-2004		2004-2005	
Segment	Hrs	No.	Hrs	No.	Hrs	No.	Hrs	No.	Hrs	No.	Hrs	No.
Elk Lake to SSM	13.5	3	10	3	32.9	4	27.8	3	24.3	4	4.3	2
SSM to Wawa	54.9	7	9	6	106.4	13	73.9	11	49.8	8	90	15
Wawa to W. River	10.5	2	5	3	19.2	6	20.8	5	23.5	4	12.3	3
W. River to Marathon	7	2	6.3	2	10	4	9.3	2	5	1	7.5	1
Marathon to Nipigon	53.1	8	25.2	2	20	2	9.5	2	0	0	0	0

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What We Discovered

- Over 40 problems documented requiring action
- Highly experienced competent MTO staff
- No simple answers

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Functional Analysis & FPS

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Mission Statement

- Ensure the quality, safety and reliability of timely travel on a daily basis from Sault Ste. Marie to Wawa on Highway 17, specifically in the vicinity of the Montreal River Hill, while minimizing the effect of the environment.

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Functional Analysis

- Based on Functions Analysis, major functions identified as follows:
  1) Forecast Road Conditions
  2) Maintain Road
  3) Enhance Safety of Travelers
  4) Respect Environment
  5) Manage Road
- Sub-functions identified for each major functions

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Basic Functions + Mission

- Total of 82 functions identified
  - Basic
  - Secondary/Technical
  - Esteem
  - Constraints
- Key Mission Items
  - Efficiency
  - Safety
  - Reliability/consistency over a whole year
  - Timeliness
  - Enjoyment of a superior route/views
  - Meeting drivers' expectations
  - Respect for the environment

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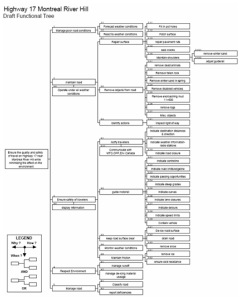
Functional Analysis/FAST



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Functional Performance Specifications

- For each Function we developed a Characterization of the Needs, which included the following:
  - Criteria – What is to be measured in terms of performance
  - Performance Level – What is to be achieved
  - Flexibility – Allowable deviation from stated performance level ranging from (F0 – no flexibility, F3 – maximum flexibility

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FPS – Forecast Road Conditions

	A	B	C	D	E	F	G
10	1	**Forecast road conditions**					
11	1.1	Forecast weather conditions		frequency of forecast	minimum 2 xs /day	F1	for critical areas of highway, see AMEC reports
12					spot 48 hours, 3 hour interval		
13							
14	1.2	React to weather conditions		response time	1/2 hour	F1	to the site, 1.8 hours route time
15	1.3	review Current conditions		road conditions	as needed	F1	
16				atmospheric conditions	as needed	F1	
17	1.4	surveillance video		response time	real time	F1	do you need the info

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Performance Evaluation – Base Case

	A	B	C	I	J	K	L	M	N
9				**Satisfaction of needs**	**Score Minimum- 1 Maximum- 5**	**Weighted Factor Derived from Paired comparison**	**Total Points (J*K)**	**Max Score**	**Notes**
10	1	**Forecast road conditions**		Score	1.8	6	10.8	30	
11	1.1	Forecast weather conditions		Are you doing any forecasting presently	2.0				major function for consideration at workshop
12									
13									
14	1.2	React to weather conditions		How well do you react?	1.0				

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Creative Phase

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Target Areas

- The following key target areas were identified:
  - Forecast Weather (FW)
  - React to Weather (RW)
  - Notify Travelers (NT)
  - Guide Motorists (GM)
  - De-ice Roads (DR)
  - Remove Snow (RS)

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Creative Phase

- 6 target areas identified
- 98 ideas generated

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Evaluation Phase

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Evaluation Phase

- 40 problem statements
- 98 creative ideas
- 59 ideas carried forward
- FPS indicated poor performance of functions
- FMEA identified high risk functions

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1) Forecast Road Conditions

1. Forecast weather conditions
   - EC model needs better local data for predicting storms and intensity
   - Local conditions vary dramatically
   - 160 metre of relief in area (micro climates)
   - MNR has meteorologist in SS Marie
2. React to weather conditions
   - 1.8 hour turn around with present equipment
   - OPP closing more frequently
3. Review current Conditions
4. Review ARWIS camera surveillance video

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Forecast Weather (FW)

Note: Highlighted Ideas moved/merged to other Ideas.

FW-1	Hire meteorologist	7	Y	
FW-2	Staff training	10	Y	
FW-3	Improve data gathering equipment	10	Y	FW-8,9,11
FW-4	Improve access to data	10	Y	FW-10,13
FW-5	Hire Expert to interpret data	7	Y	
FW-6	Maintain existing sites	10	Y	
FW-7	Add new ARWIS sites (one at top)	8	Y	
FW-8	Expand existing system (1000 m redundancy hardwire)	8	Y	-> FW-3
FW-9	Add color/real-time cameras	10	Y	->FW-3
FW-10	Improve data communication system	10	Y	->FW-4
FW-11	Duplicate sensors	9	Y	->FW-3
FW-12	Additional sensors for ARWIS	see FW-8	Y	->FW-8 -> FW-3
FW-13	Add connection real-time to office, yard, and MTO vehicle)	10	Y	->FW-4
FW-14	Monitor weather 24/7	10	Y	
FW-16	Correct ARWIS meta-data (wrongly located)	10	Y	
FW-17	Activate auto-alarm on ARWIS system (turn switch on)	10	Y	
FW-19	Case studies for weather presentation to staff (train)	10	Y	
FW-20	Review historical trends from ARWIS data	see FW-2	Y	-> FW-2

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React to Weather (RW)

RW-1	Increase patrols	
RW-2	Increase/reuse equipment compliment - Larger capacity spacers	FW-3,9,11,17,21,22,24
RW-3	Local storage of equipment	-> RW-2
RW-5	Measure road friction during winter (part of ITS)	
RW-6	Have contract staff to road patrols (liability)	
RW-7	Review trends from maintenance logs (download spreaders)	
RW-9	Change patrol vehicle to a 2-ton with salt spread and pre-wet tank	-> RW-2
RW-10	Chute design (ensure where salts are going where it should be)	
RW-11	Dual spinner units	-> RW-2
RW-12	Staff training on new technology/equipment	
RW-13	Use of broadcast spreading	
RW-14	Sub-patrol at bottom of hill	
RW-15	2-way spreading	
RW-16	Develop decision tree	
RW-17	Zero-velocity spreader	-> RW-2
RW-21	European plow blades	-> RW-2
RW-22	Underslung plow	-> RW-2
RW-23	FAST system on hill	
RW-24	Double plow unit (both in front)	-> RW-2
RW-25	Properly adjust plow blades (training)	
RW-26	Scheduled DLA	
RW-27	Scheduled staff (anticipated storm event)	

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Base Case Risk Assessment

- Failure Modes and Effects Analysis carried out to identify areas of risk. These functions include:
  - React to weather
  - Surveillance video
  - Identify actions (inspect ROW)

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FMEA- Road Conditions

	A	B	C	Q	R	S	T	U	V	W	X
4		FUNCTION DESCRIPTION		Failure Mode & Effects Analysis (FMEA) for current Procedures- For each major function identified in Value Analysis Workshop [2]							
5				Potential Failure Mode	Potential Effects of Failure on User	Severity	Potential Causes/Mechanism of Failure	Occurrence	Detection Method- easily or high if can't detect-driver	Detection	R P N
10	1	Forecast road conditions									
11	1.1	Forecast weather conditions		no communication	loss of life	10	power failure	2	No advance warning	10	200
12											
13											
14	1.2	React to weather conditions		cannot respond to site	loss of life	10	weather variability within patrol area causes black ice or rapid snow/ice accumulation	7	cannot detect visibly or by feel until too late	8	560
15	1.3	review Current conditions									
16											
17	1.4	surveillance video		camera not working	slower response time, loss of life	10	power failure, connectivity	8	polling of camera	8	640

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VE-FPS-FMEA

- Function Analysis
- FPS
- FMEA (Risk)
- QA/QC

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Scenario Development

- In developing the scenarios, it was apparent that alternatives could be categorized into the following:
  - Low Cost / Early Wins
  - Medium Cost / Mid-term Alternatives
  - High Cost / Long Term Alternatives
  - Related to Managed Outsource Contract
  - Related to Additional Staff Training
  - Related to the Addition of Full Time Equivalent

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Scenarios

Scenario	Description of Scenario
	Base Case
A1	Minor Capital Works items that have been identified (excluding Rock Cut)
A2	Minor Capital Works items from A1 and including Rock Cut
B	Service Montreal River Hill First – Includes alternatives that enhance early detection and winter maintenance service to the hill
C	SafeLane Surface Overlay – Trademark Product from Cargill Industries (US) – used primarily on bridge decks
D	Install Fixed Automated Spray Technology (FAST) System – currently installed on select bridges in Ontario
E1	Enhanced Notification to Motorists During an Event - without a truck pull-off area
E2	Enhanced Notification to Motorists During an Event - with a truck pull-off area
F	Alternatives that can be applied to Full Length of Corridor between SSM and Wawa (or SSM District)
G1	Same as F - without Meteorologist (assume use of MNR staff meteorologist)
G2	Same as G1 - with a sub-patrol yard near base of Montreal River Hill (assume use of MNR staff meteorologist)
H1	Collection of various low-medium cost items (A1 + E1 Notification items + B Data Collection items of B, with Add'l Equipment)
H2	Same as H1 - without additional equipment

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Summary – Scenario FPS Assessment

	Base	E1 Notify Motorist (no pull-off area)		E2 Notify Motorist (w pull-off area)		F Alt'ns Applied to Hwy/SSM		G1 Same as F no Meteorologist		G2 Same as G1 w sub-patrol yard		H1 Low-mod Cost (A1+E1+B) w Add'l Equip		H2 Same as H1 No Add'l Equip	
FUNCTION DESCRIPTION	Total	Score	Total	Score	Total	Score	Total	Score	Total	Score	Total	Score	Total	Score	Total
Forecast road conditions	10.8	1.8	10.8	1.8	10.8	4.2	25.2	4.2	25.2	5.0	30.0	4.0	24.0	3.4	20.4
Maintain road	187.5	3.8	187.5	3.8	187.5	3.8	187.5	3.8	187.5	4.1	204.2	3.8	187.5	3.8	187.5
Enhance safety of travelers	82.3	2.50	95.0	2.6	97.5	3.2	122.9	3.2	122.9	3.4	127.9	2.8	105.1	2.6	100.1
Respect Environment	24.0	4.0	24.0	4.0	24.0	4.0	24.0	4.0	24.0	4.0	24.0	4.0	24.0	4.0	24.0
Total Performance	**304.6**		**317.3**		**319.8**		**359.6**		**359.6**		**386.1**		**340.6**		**332.0**
Initial Capital Cost ($1000)	**0**		**463**		**7,463**		**946**		**946**		**2,446**		**709**		**709**
Annual Cost ($1000)	**90**		**15**		**15**		**252**		**172**		**172**		**115**		**15**

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Cost Summary

No.	Description	FPS	Rank	FPS Incr.	Initial Cost ($1,000)	Annual Cost ($1,000)	Annual Cost NPV ($1,000)	Total Winter Mtce Cost (NPV)
	Base Case	304.6	14	0	$ -	$ 80.0	$ 768.0	$ 768.0
A1	Capital Works (excluding Rock Cut)	312.2	12	8	$ 215.0	$ -	$ -	$ 983.0
A2	Capital Works (including Rock Cut)	314.8	11	10	$ 615.0	$ -	$ -	$ 1,383.0
B	Service Montreal River Hill First	372.9	2	68	$ 1,641.0	$ 121.5	$ 1,166.4	$ 3,575.4
C	SafeLane Overlay	322.7	7	18	$ 3,000.0	$ 30.0	$ 288.0	$ 4,056.0
D	Install FAST System	322.7	7	18	$ 2,400.0	$ 120.0	$ 1,152.0	$ 4,320.0
E1	Notify Motorists During an Event (No Pulloff Areas)	317.3	10	13	$ 463.0	$ 15.0	$ 144.0	$ 1,375.0
E2	Notify Motorists During an Event (With Pulloff Areas)	319.8	9	15	$ 7,463.0	$ 15.0	$ 144.0	$ 8,375.0
F	Alternatives that can be applied to Full Length of Corridor	359.6	3	55	$ 946.0	$ 252.5	$ 2,424.0	$ 4,138.0
G1	Same as F - without Meteorologist	359.6	3	55	$ 946.0	$ 172.5	$ 1,656.0	$ 3,370.0
G2	Same as G1 - with Sub-patrol Yard	386.1	1	82	$ 2,446.0	$ 172.5	$ 1,656.0	$ 4,870.0
H1	A1+ E1 Notification+B Data Collection w Add'l Equipment	340.6	5	36	$ 709.0	$ 115.0	$ 1,104.0	$ 2,581.0
H2	Same as H1 - without additional equipment	332.0	6	27	$ 709.0	$ 15.0	$ 144.0	$ 1,621.0

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Performance-Value Summary

No.	Description	FPS	Net Cost Incr. (NPV)	Net Cost Rank	First Year Cost	1st Year Cost Rank	Perf/ NPV	RK	Ch Perf/ Ch Cost (NPV)	RK	Ch Perf/ 1st Yr $	RK
	Base Case	304.6	$ -	1	$ 80.0	1	397	1			0	
A1	Capital Works (excluding Rock Cut)	312.2	$ 215.0	2	$ 215.0	2	318	2	35	1	35	6
A2	Capital Works (including Rock Cut)	314.8	$ 615.0	4	$ 615.0	4	228	3	17		17	
B	Service Montreal River Hill First	372.9	$ 2,807.4	8	$ 1,762.5	9	104		24	3	39	4
C	SafeLane Overlay	322.7	$ 3,288.0	9	$ 3,030.0	12	80		6		6	
D	Install FAST System	322.7	$ 3,562.0	11	$ 2,520.0	10	75		5		7	
E1	Notify Motorists During an Event (No Pull off Areas)	317.3	$ 607.0	3	$ 478.0	3	231	4	21	4	27	
E2	Notify Motorists During an Event (With Pull off Areas)	319.8	$ 7,607.0	13	$ 7,478.0	13	38		2		2	
F	Alternatives that can be applied to Full Length of Corridor	359.6	$ 3,370.0	10	$ 1,198.5	8	87		16		46	2
G1	Same as F - without Meteorologist	359.6	$ 2,602.0	7	$ 1,118.5	7	107		21	4	49	1
G2	Same as G1 - with Sub-patrol Yard	386.1	$ 4,102.0	12	$ 2,618.5	11	79		20	6	31	
H1	A1+ E1 Notification+B Data Collection w Add'l Equipment	340.6	$ 1,813.0	6	$ 824.0	6	132		20	6	44	3
H2	Same as H1 - without additional equipment	332.0	$ 853.0	5	$ 724.0	5	205	5	32	2	38	5

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Preferred Scenario

- The preferred Scenario is H1. It includes a variety of items, including low cost/early wins. H1 address the following:
  - Physical improvements at the site
  - Improvement in weather/road condition data collection and interpretation capabilities
  - Low cost measures to further notify motorists
  - Increased compliment in equipment and application methods and frequencies
  - Allows for the review on the value of additional equipment after the first season

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Post Workshop

- Presentation - February 15, 2007
- Implementation – Recommendations accepted and implemented for winter season

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SUMMARY

- VE- (FA + FPS + FMEA) very effective in reviewing winter maintenance procedures by
  - Identifying creative ideas
  - Evaluating complex scenarios
  - Optimizing processes
  - Documenting decision making process
  - Producing justifiable recommendations
  - Achieving high percentage of acceptance

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Highway 17
Montreal River Hill
Winter Maintenance Procedures

Questions ??

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