Highway 11/17 Twinning

Avoiding Risk and Cost with Value Analysis

Canadian Society of Value Analysis Symposium

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Study Location

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Value Engineering Team

- **Faithful & Gould (1)** - VE Team Leader
- **MMM Group Limited (4)** - VE Project Manager/Hwy Engineering, Cost Modeling/Highway Engineering, Highway Engineering/CADD, Highway Planning/Traffic
- **MMM/Delphi MRC (1)** - Highway Safety
- **TBT Engineering (1)** - Geotechnical/Foundations
- **MTO (4)** - Planning & Design, VEC
- **Hydro One Networks Inc. (6)** - Senior Design Specialist, Environmental Planner/Engineer, Construction Foreman, Manager Asset Management, Customer Business Relations, Network Management

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Project Background

- This project is part of the four-laning of Highway 11/17 between Thunder Bay and Nipigon. The Planning and Preliminary Design Study was completed in 1995.
- Three Hydro One Networks Incorporated (HONI) high voltage transmission lines (steel towers, wood poles) run parallel to this section of highway, with two of these lines in close proximity. HONI low voltage distribution lines (wood poles) are present within the highway right-of-way, Bell and FOTS also present throughout.
- The 1995 preliminary design impacts the HONI transmission lines at a several locations, requiring numerous line relocations.

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Base Case Design

- Includes a combination of twinning and new alignment to create a four-lane median divided facility
- Median width varies from 15 m to 60 m, with standard 30 m used unless otherwise justified.
- Extensive profile correction on existing highway within twinning sections. Current design (1995 PDR) precedes (draft) Rural Freeway Design Guidelines (Oct. 2004). A number of horizontal and vertical elements do not satisfy these guidelines.
- HONI lines located in the median of the proposed highway

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Base Case Design

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Base Case Design Cost Estimate

Highway Construction	$77.0 M
HONI Relocations	$15.2 M

- 19 metal towers
- 42 wooden poles

Total Construction	$92.2 M

HONI transmission line relocations represent 17% of the total construction cost of the project!

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Project Risk Register

- Core VE Team members prepared the initial Project Risk Register immediately after study start
- During pre-workshop meetings, VE team brainstormed to identify Risks; determined Type “threat” or “opportunity”; Described the risk; established Risk Object e.g. cost & schedule; determined Risk Management.
- Risk Register reviewed first day of the workshop and expanded substantially. Resulting qualitative Project Risk Register places the importance on the management of specific risks.
- Results guided the VE Team in the brainstorming of the Creative Phase and development of project scenarios

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Site Visit

Workshop – Toronto

Phases:

- Information
- Functional Analysis
- Creative
- Evaluation
- Development
- Scenario
- Presentation

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Information Phase

- Introductions
- Reviewed MTO's goals and objectives/constraints on VE recommendations
- Pre-Workshop Information Package
- Presentation of Highway Safety Value Report
- Base Case design
- Review of HONI design requirements
- Qualitative Risk Register
- Q & A to increase VE team familiarity with project

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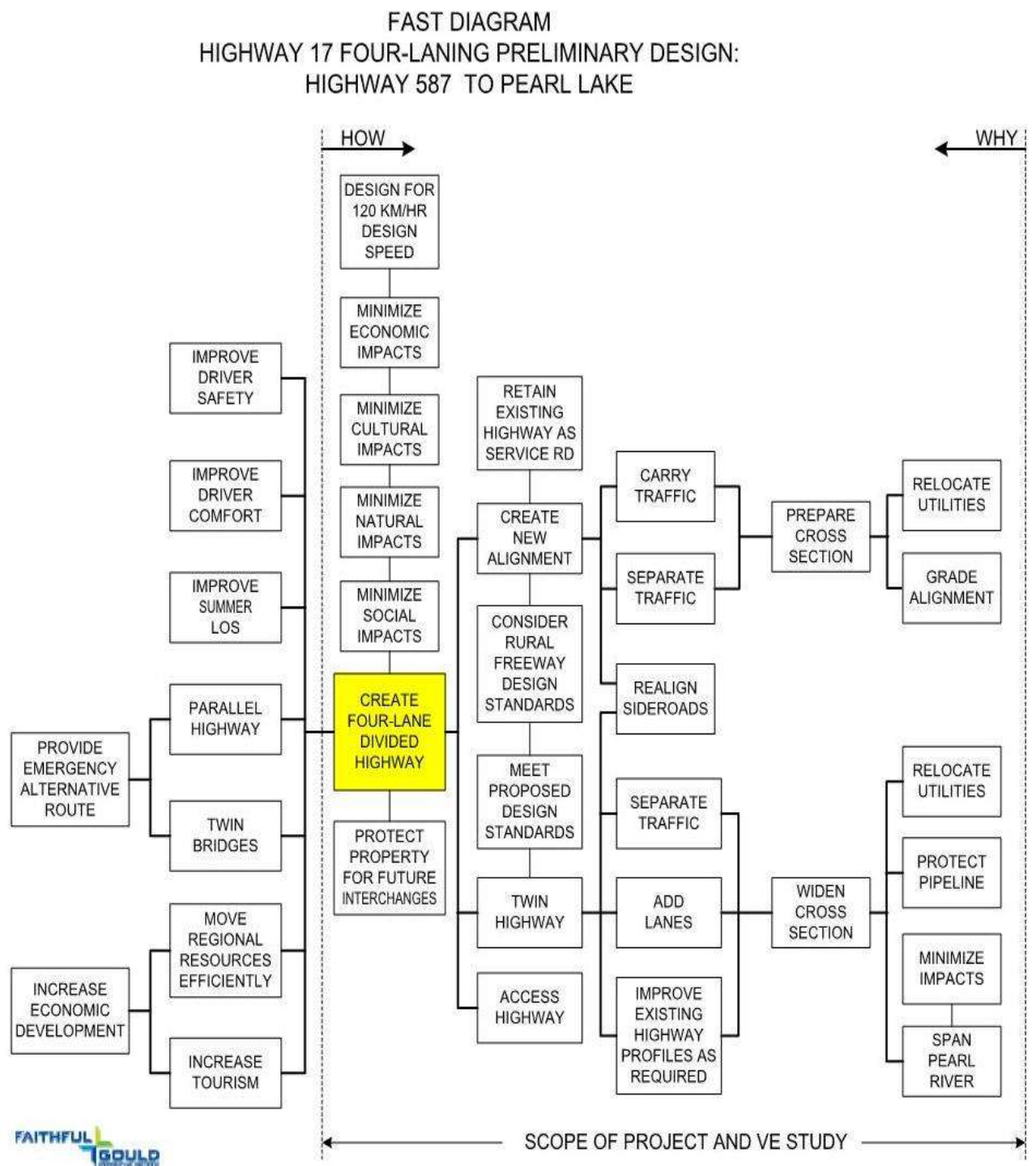
FAST Diagram



Project Risks

- Unknown soil conditions
- Delay in acquiring property
- Delay in obtaining EA approvals
- Delay in obtaining environmental permit approvals
- Delays associated with utility relocations
- Archaeological finds in corridor
- Protracted aboriginal consultations
- Timing of required HONI power outages
- TransCanada Pipelines Limited (TCPL) impacts
- Contaminated soil
- Environmental clearance geotechnical investigations
- Blasting risks – impacts on HONI infrastructure

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Performance Criteria

Based on the VE Team's understanding of key project issues, the following Performance Criteria were identified:

- Highway Safety and Operations
- Geometrics
- HONI Impacts
- Constructability
- Property Impacts
- Natural and Socio-Economic Environmental Sustainability
- Local Road Network Impacts

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Creative Phase

Value Target Areas:

- Horizontal Alignment
- Highway Cross-Section
- HONI Transmission Line Alignment
- Vertical Alignment
- Local Roads
- Risk/Opportunity Management

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VE Ideas

Value Target Area	Generated	Proposals	Design Suggestions	Combined w/Others	Already Being Done	Dismissed
Horizontal Alignment	26	9	0	1	0	16
Highway Cross Section	22	5	3	0	1	13
Transmission Line Alignment	18	1	5	1	0	11
Vertical Alignment	24	5	14	2	1	2
Local Roads	29	4	6	0	1	18
Risk/Opportunity Management	30	0	23	1	1	5
Total	149	24	51	5	4	65

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Design Suggestions

Highway Cross-Section

- Utilize steel beam guiderail and steepen fill slopes as appropriate
- Provide adequate access to HONI towers
- Widen rock cut at Pearl Lake for quarry

Transmission Line Alignment

- Locate towers and poles to avoid conflict with future interchanges
- Design and locate future interchanges to avoid conflict with HONI infrastructure
- Increase maximum spans between towers
- Optimize tower spacing

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Design Suggestions

Mitigate Risks/Enhance Opportunities

- Ensure sufficient time for DB contract
- Relocate HONI facilities before tendering construction contract
- Combine topographic survey for highway and HONI
- Early and frequent consultation with First Nations
- Design Pearl River crossing as a No-HADD facility
- Submit Navigable Waters application at 30% DB ready stage

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Design Suggestions

Mitigate Risks/Enhance Opportunities

- Acquire all property in advance of DB tender
- Complete all archaeological studies in advance of DB tender
- Complete TESR in advance of DB tender
- Complete legal survey in advance of DB tender
- Place all HONI ROW on MTO property if possible
- Obtain TCPL approvals during DB ready stage
- Complete contaminated soil investigations during DB ready stage
- Provide DB design with sufficient geotechnical information in Pearl Lake area
- Supply granular material to HONI for access roads related to project
- Obtain approval for wayside pits in advance

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Design Suggestions

Mitigate Risks/Enhance Opportunities

- Place HONI ROW on crown land
- Advance shared contracts with HONI for clearing, grading, etc.
- Separate Pearl Lake area as separate contract
- Combine EA for highway and HONI
- Combine property acquisition and archaeology for highway and HONI
- Consider aboriginal economic opportunities related to project

Horizontal Alignment

- Investigate pros/cons of TCPL relocation v. HONI relocation at Tower-282 (approx. 2 km west of Pearl River)

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Scenarios

- The various VE ideas were combined into scenarios for comparison to the base case design
- Each scenario was evaluated using the identified Performance Measures

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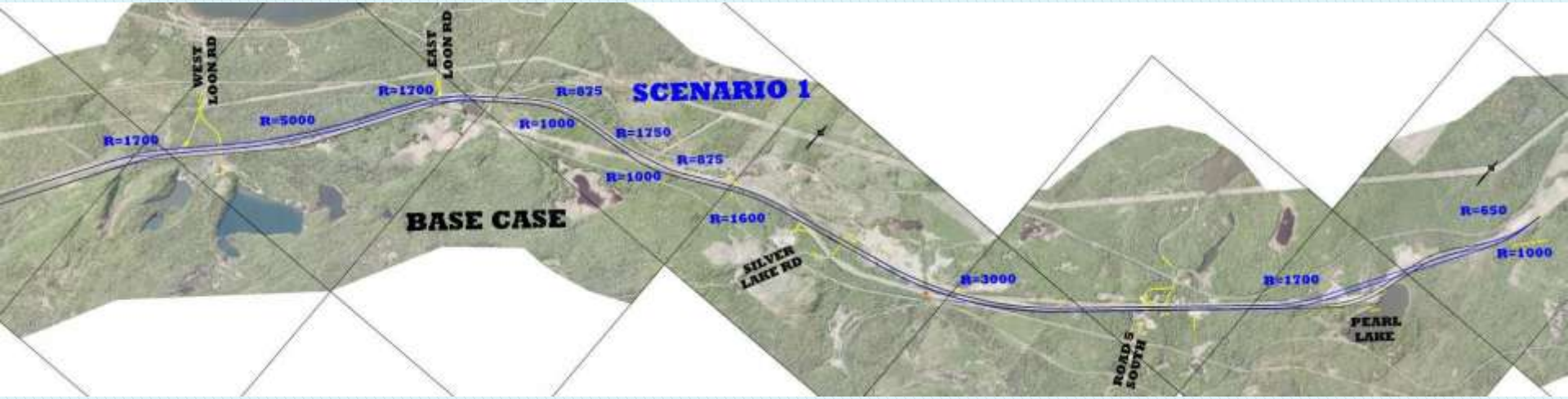
Scenario 1 – Optimized Base Case



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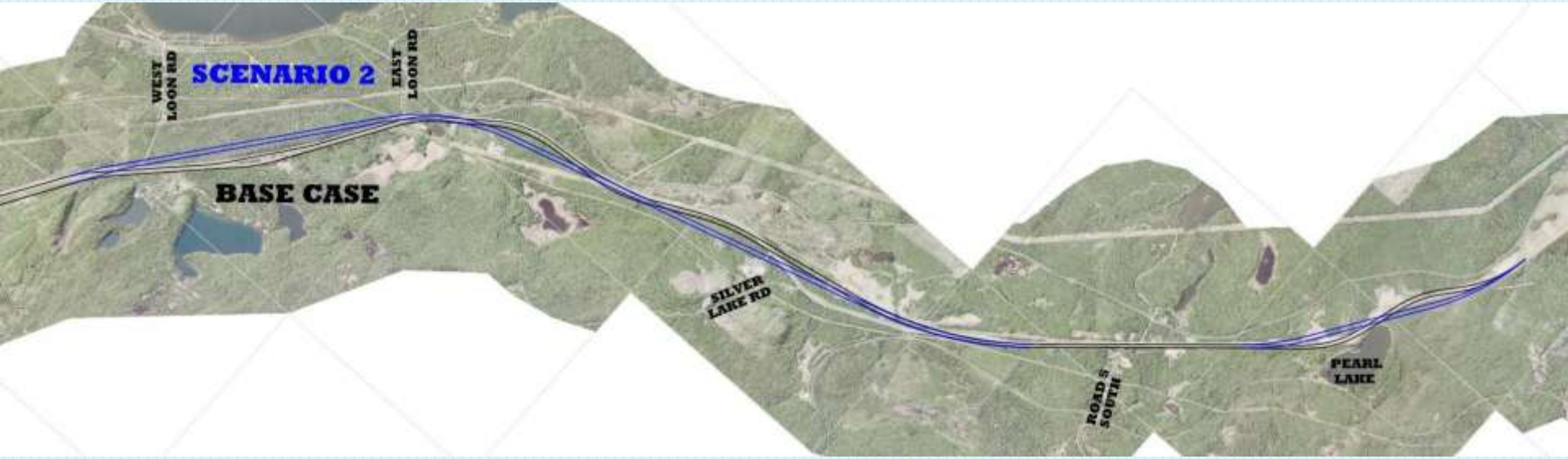
Scenario 2 – Rural Freeway Standard



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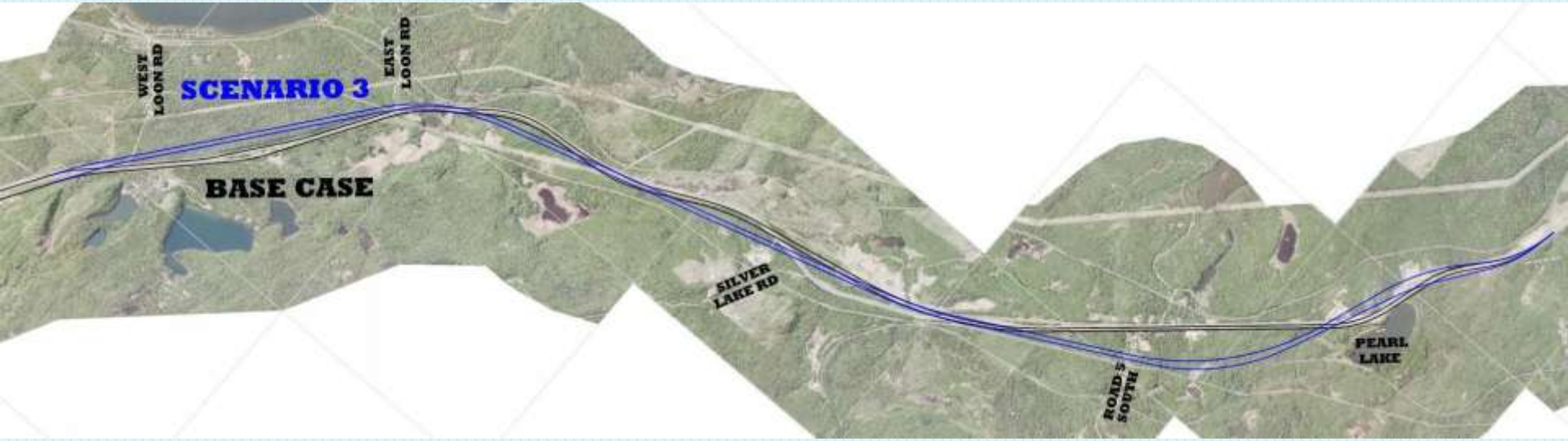
Scenario 3 – Loon and Pearl Bypasses



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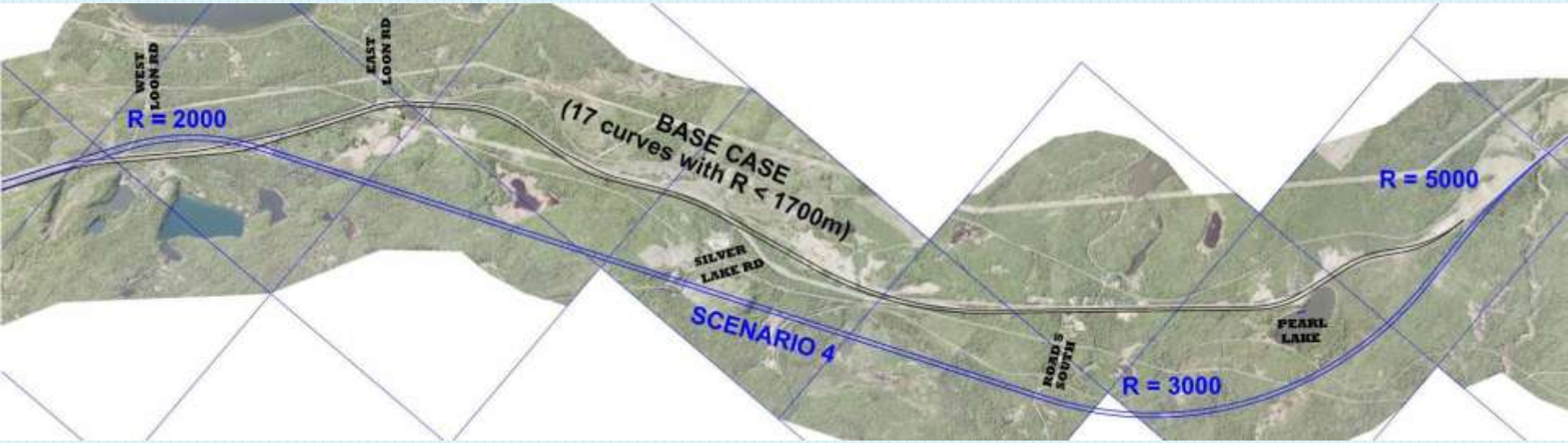
Scenario 4 – South Bypass



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Scenario Evaluation

1. HOW WELL DOES THE SCENARIO SATISFY THE PERFORMANCE CRITERIA (ENTER RATING FROM 1-10, 10=BEST) 2. ENTER ASSIGNED WEIGHT TIMES RATING IN SUB TOTAL 3. SUM ACROSS AND RANK	Performance Criteria	Constructability	Natural and Socio-Economic Environment	Safety & Traffic Operations	Property	Geometrics	Local Road Network Impacts	HONI Transmission Line Impacts	Total Performance (P)	Total Capital Cost - $ M (C)	P/C
SCENARIOS	Weight	9	15	24	5	24	8	15			
BASE CASE	Rating 1-10	3.77	5.00	4.30	8.00	5.10	5.00	3.00			
	Sub Total	33.93	75.00	103.20	40.00	122.40	40.00	45.00	460	92.2	4.9
SCENARIO 1: OPTIMIZED BASE CASE	Rating 1-10	5.00	4.00	4.50	9.00	5.00	5.30	6.00			
	Sub Total	45.00	60.00	108.00	45.00	120.00	42.40	90.00	510	77.0	6.6
SCENARIO 2: RURAL FREEWAY STANDARDS	Rating 1-10	5.92	5.00	5.00	6.00	8.60	5.30	7.00			
	Sub Total	53.28	75.00	120.00	30.00	206.40	42.40	105.00	632	82.1	7.7
SCENARIO 3: LOON AND PEARL BYPASSES	Rating 1-10	6.15	7.00	6.50	5.00	8.60	4.60	5.00			
	Sub Total	55.35	105.00	156.00	25.00	206.40	36.80	75.00	660	82.3	8.0
SCENARIO 4: SOUTH BYPASS	Rating 1-10	7.08	7.00	7.00	5.00	10.00	5.70	9.00			
	Sub Total	63.72	105.00	168.00	25.00	240.00	45.60	135.00	782	82.6	9.4

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Construction Costs (millions)

SCENARIOS	HIGHWAY	UTILITY (HONI)	TOTAL CONSTRUCTION
BASE CASE	$77	$15.2	$92.2
SCENARIO 1	$70.9	$6.1	$77.0
SCENARIO 2	$76.5	$5.6	$82.1
SCENARIO 3	$79.8	$2.5	$82.3
SCENARIO 4 SOUTH BYPASS	$81.4	$1.2	$82.6

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Recommended Scenario

Scenario 4 - South Bypass represents the best performing and best value solution

The scenario offers a number of key benefits

- Minimizes HONI transmission tower relocations (2 towers)
- Improved constructability (largely green fields construction)
- Alignment satisfies Rural Freeway Guidelines and provides full flexibility to implement cross-section enhancements
- Minimizes environmental impacts on Pearl River
- Well suited to DB delivery
- Avoids Pearl Lake foundation concern

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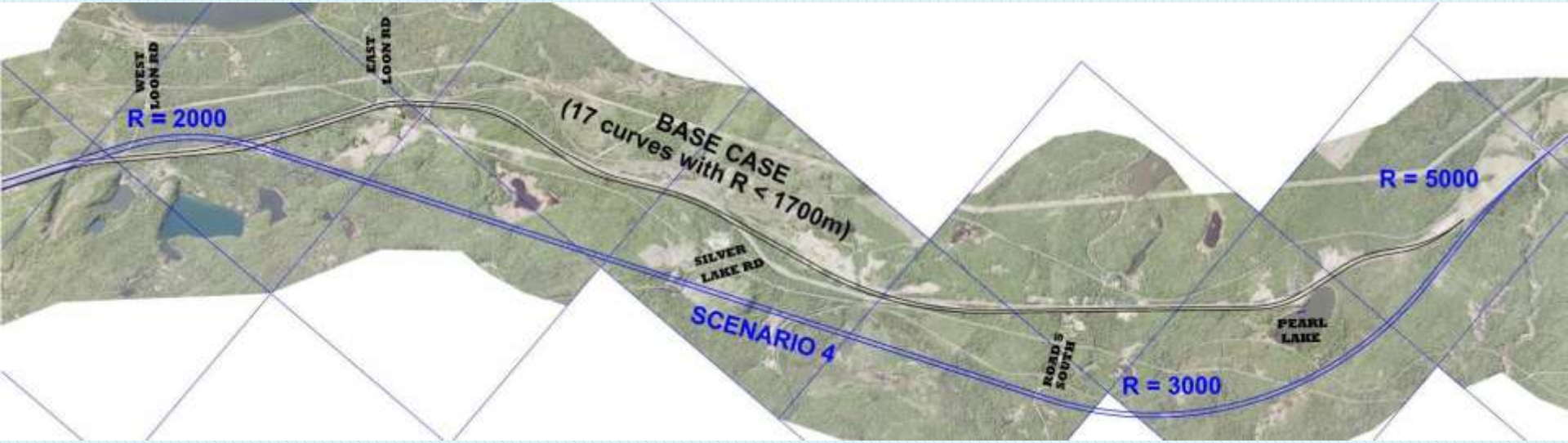
Recommended Scenario



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Risk Register

Risk	Type: threat or opportunity	Description	Risk Object	RISK MANAGEMENT Threat: Avoid, Mitigate, Transfer Opportunity: Enhance, Exploit, Share
Unknown subsoil	Threat	Unknown detrimental subsoil are found during DD	cost & schedule	Mitigate: More boreholes and avoid south side of existing highway at Pearl Lake
Archeological finds	Threat	Project delay due to Archeological finds within the ROW	cost & schedule	Avoid: avoid areas with high archeological potential Mitigate: investigate potentially impacted areas asap
Coordination of HONI relocations and highway work	Opportunity	Opportunity to coordinate property acquisition, clearing, pre-grading, etc. to facilitate HONI relocates	cost & schedule	Exploit: Seek opportunities to coordinate
TransCanada Pipelines	Threat	Highway crosses pipeline and requires approval from TCPL	cost & schedule	Mitigate: Schedule TCPL coordination asap
DFO approvals (Pearl Lake)	Threat	Potential HADD, additional mitigation or compensation work required	cost & schedule	Mitigate: Initial early consultation with DFO

Lessons Learned – Project Specific

- Old PPD need to be updated due to outdated scopes of work and costs
- Utilities are major risks e.g. HONI, TransCanada Pipelines, Bell
- Challenging to obtain input from utilities
- Understand implications of utility relocations e.g. cost sharing, payment, timeframes
- Subsurface quantities e.g. rock, muskeg are always risk items
- Require input from various internal and external groups
- Consider advanced contracts to mitigate risk

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Lessons Learned – General

- The sooner you consider risk the better
- Risk assessment and mitigation measures should be included in all phased VE, PPLD, DD, construction and operation/maintenance
- Generic risk registers are useful, e.g. highway four-laning
- Allocate risk to the most appropriate party e.g. MTO, construction contractor, sub-contractor, material supplier, utility
- Require the appropriate expertise to complete a valid risk assessment e.g. sub-contractors, utilities
- Do not over mitigate minor risk items
- Reflect on past experience
- Select the best delivery method wrt to project e.g. DBB, DB
- Prepare contract specific terms to address risk items

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Questions

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