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Adding Value. Delivering Results.

Sisson Project

Summary of Tailings Management Alternatives

Assessment Methodology

Environment Canada (2013) Guidelines

- A 7-step process for completing mine waste disposal alternatives for projects which require an amendment to Schedule 2 of the Metal Mining Effluent Regulations (MMER).
- Objectives:
  - Minimize the environmental footprint of the disposal area
  - Objectively and rigorously consider all available options for mine waste disposal
  - Demonstrate that the use of a proposed water body as a Tailings Impoundment Area is the most appropriate option considering four key categories (Environmental, Technical, Socio-economic and Economic)

Assessment Methodology

7-Steps of the Alternatives Assessment Process

Step #	Description of Each Step
1	Identification of Candidate Alternatives
2	Pre-Screening of Alternatives
3	Characterization of Alternatives
4	Multiple Accounts Ledger
5	Value-Based Decision Process
6	Sensitivity Analysis
7	Documentation of Results

Assessment Methodology

Accounts, Sub-Accounts and Indicators

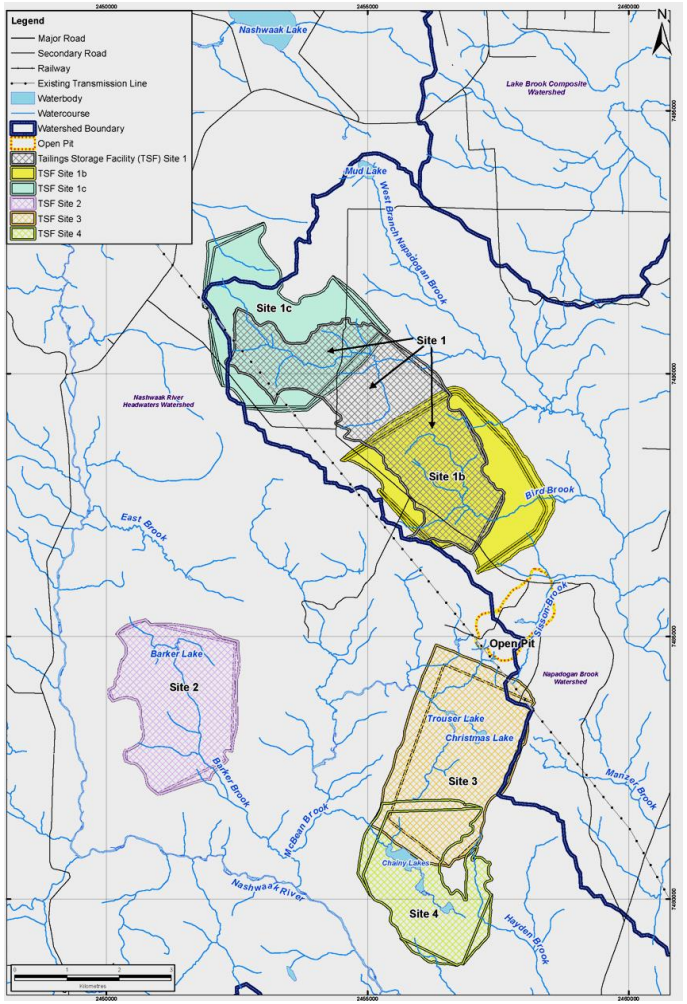
- Four categories (or Accounts):
  - Environmental, Technical, Socio-economic, Economic
- Each category (or Account) have several components (e.g.):

Account	Sub-Account	Indicator
Environmental	Water and Fisheries Resources	Area within Napadogan Brook Watershed
		Area of Permanent Aquatic Habitat Loss
		Number of Streams Impacted
	Terrestrial Habitat	Area of Permanent Loss of Interior Forest
		Area of Permanent Wetland Loss
	Air Quality	Greenhouse Gas Emissions
		Potential for Dust Emission

Identification of Candidate Alternatives

Step #1

- Threshold Criteria:
  - Distance – 10 km from plant site
- Three tailings technologies considered:
  - Un-thickened, conventional slurry tailings
  - Paste tailings
  - Filtered tailings
- Five TSF Locations considered:
  - Sites 1b, 1c, 2, 3 and 4
- Total of **15** candidate alternatives developed.



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Pre-Screening of Alternatives

Step #2 – Technology Exclusion

- Best practices for management of potentially acid generating materials precluded the consideration of Thickened (Paste) and Filtered Tailings in the next steps of the assessment.

Pre-Screening Criteria	Conventional Slurry Tailings	Thickened (Paste) Tailings	Filtered Tailings
Effectively prevents the onset of acidic conditions from potentially acid generating tailings and waste rock?	YES	NO	NO

Pre-Screening of Alternatives

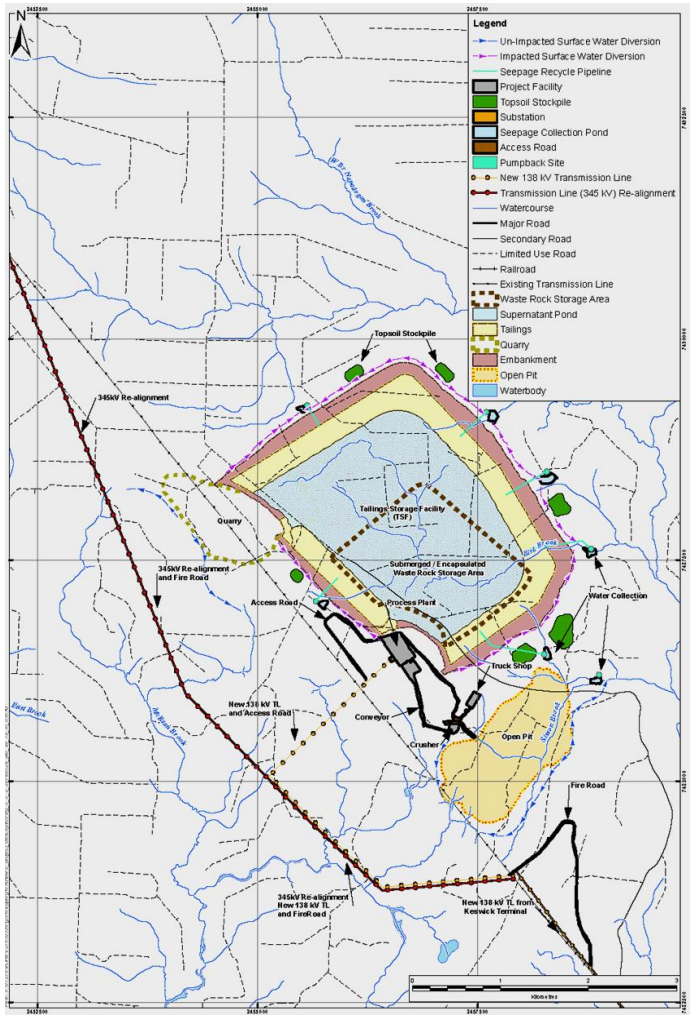
Step #2 – Location Exclusion

- Only one “fatal flaw” identified for TSF location screening
  - whether or not the TSF location covered a lake based on the following rationale:
    - Lakes were identified in the EIA as valuable resources with ecological, Aboriginal and recreational importance
    - Lakes are protected under the NB Water Classification Regulation (2002-13)

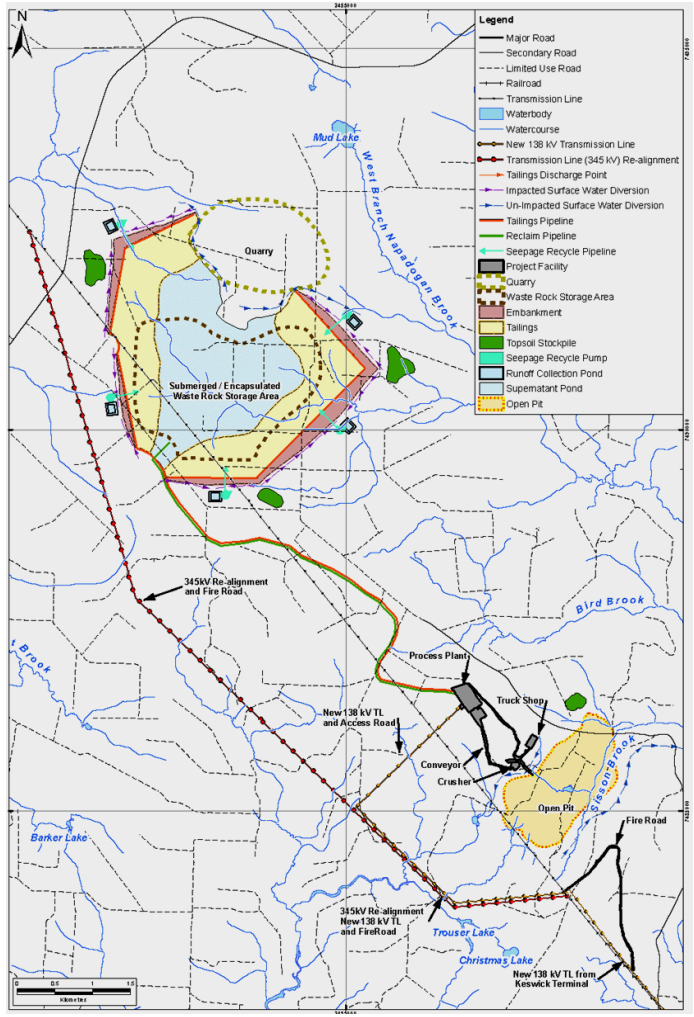
Pre-Screening Criteria	Site 1b	Site 1c	Site 2	Site 3	Site 4
Does the alternative cover any lakes?	NO	NO	YES	YES	YES

Pre-Screening of Alternatives

Step #2 – Remaining Alternatives



Slurry Tailings at TSF Site 1b



Slurry Tailings at TSF Site 1c

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Characterization of TSF Alternatives

Step #3

- TSF Alternatives were quantitatively and qualitatively characterized.
- Alternatives were characterized according to the four main categories under the Environment Canada (2013) Guidelines for the Assessment of Alternatives for Mine Waste Disposal:
  - Environmental
  - Socio-Economic
  - Technical
  - Economic

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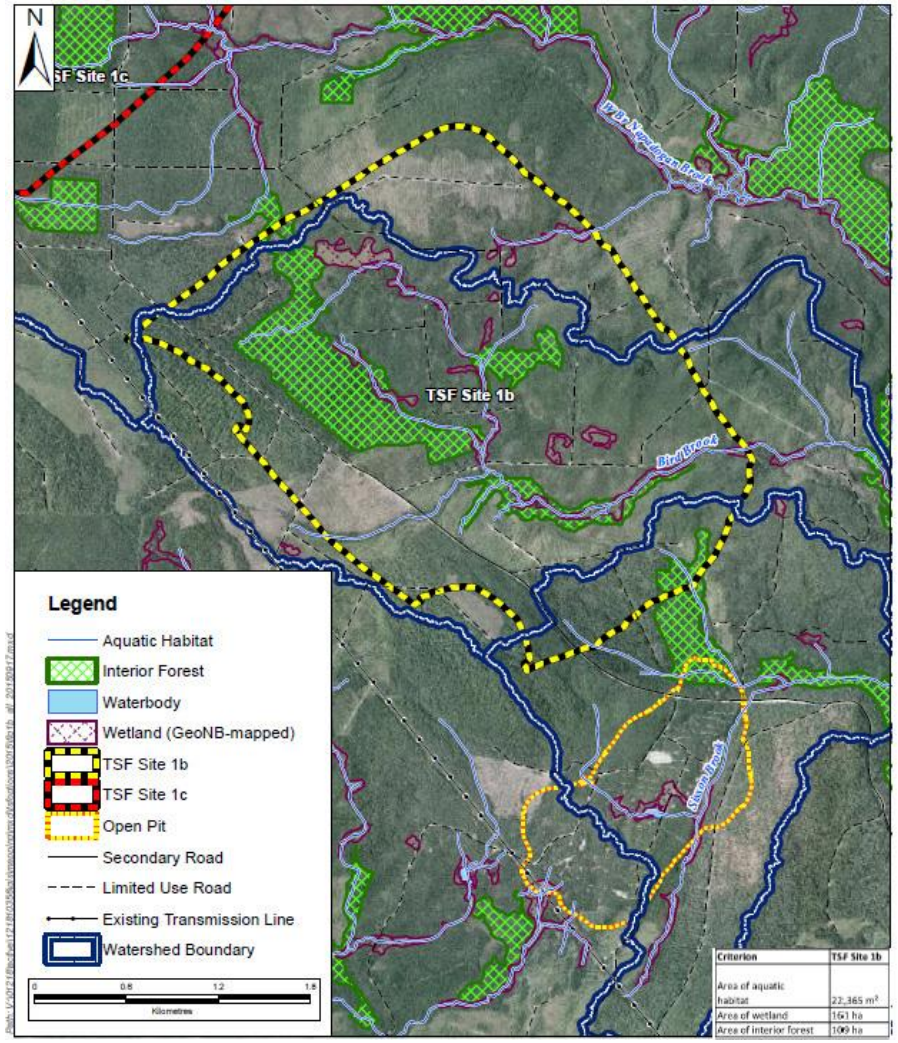
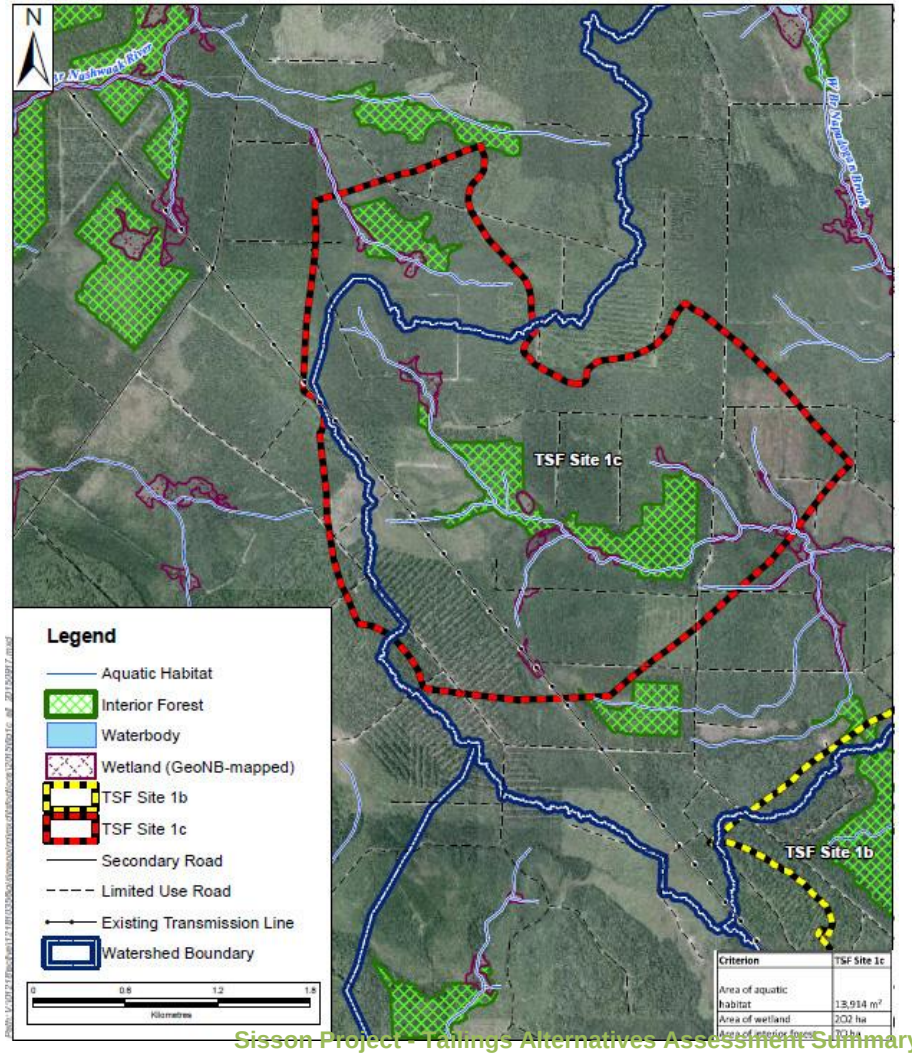
Characterization of TSF Alternatives

Criterion	TSF Site 1b	TSF Site 1c
Environmental		
Drainage to Napadogan Brook watershed	100% drains to Napadogan Brook watershed	80% drains to Napadogan Brook watershed
Area of impacted aquatic habitat	22 Ha	14 Ha
Area of impacted wetlands	161 Ha	202 Ha
Area of impacted interior forest	109 Ha	70 Ha
Total GHG emissions	16.5 kt CO_2e/yr	64.0 kt CO_2e/yr
Socio-Economic		
Aboriginal land use impacts	Multiple use with some hunting and fishing locations. TSF site footprint is 785 ha.	Multiple uses with one hunting location to the SE. TSF site footprint is 750 Ha.
Technical		
Storage Efficiency	10.7	10.0
Road & pipeline distance from Plant Site	1 km	5 km
Surplus water management at closure	Gravity drainage to Open Pit through overflow spillway	Water pumped to Open Pit using reclaim water barge, pumps and pipeline.
Economic		
Capital Costs	$101.9M	$128.1M
Operating Costs	$139.9M	$382.1M
Closure Costs	$20.5M	$20.6M
Wetland compensation costs	$1.7M	$1.1M

Characterization of TSF Alternatives

Areas of Aquatic Habitat, Interior Forest & Wetland Loss





Multiple Accounts Ledger

Step #4 – Accounts, Sub-Accounts and Indicators

- Accounts – four main categories
  - Environmental, Technical, Socio-economic, Economic
- Sub-Accounts – these are considered **evaluation** criteria
  - developed from the same criteria used to characterize each alternative
  - Should be:
    - Impact Driven; Differentiating; Relevant; Understandable; Non-redundant; Independent
- Indicators – these are **measurement** criteria
  - Measurements can be either quantitative or qualitative

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Multiple Accounts Ledger

Step #4 – Environmental and Socio-Economic

Account	Sub-Account	Indicator
Environmental	Water and Fisheries Resources	Area within Napadogan Brook Watershed
		Area of Permanent Aquatic Habitat Loss
		Number of Streams Impacted
	Terrestrial Habitat	Area of Permanent Loss of Interior Forest
		Area of Permanent Wetland Loss
	Air Quality	Greenhouse Gas Emissions
		Potential for Dust Emission
Socio-Economic	Land and Resource Use	Traditional Use by Aboriginal Persons
		Use by Non-Aboriginal Persons
	Archaeology	Archaeological Potential

Multiple Accounts Ledger

Step #4 – Technical and Economic

Account	Sub-Account	Indicator
Technical	Storage Efficiency	Storage Efficiency
	Ease of Operation	Length of Road/Pipeline Required
		Number of Personnel Required
		Amount of Mechanical Equipment Required
		Susceptibility to difficulties caused by weather
	Ease of Closure	Water Management Requirements
		Reclamation of Disturbed Areas
Economic	Mining Costs	Capital Costs
		Operating Costs
		Closure and Reclamation Costs
	Environmental Costs	Fish Habitat Offset Costs
		Wetland Compensation Costs

Multiple Accounts Ledger

Step #4 – Excluded Indicators

Environmental	Socio-Economic	Technical
Footprint Area	Safety	Metal Leaching and Acid Generation
Catchment Area	Noise	Stability of Embankments
Environmentally Sensitive Areas	Aesthetics	Ease of Construction
Downstream Water Quality		
Consequences of Dam Failure		

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Multiple Accounts Assessment

Step #5 – Scores and Weightings

- Each indicator is given a score, which provides insight into which alternative is likely better for each particular indicator.
- Each sub-account and indicator have weightings applied, which, when combined with the indicator scores, allow for an assessment of the combined impacts of each alternative being considered.

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Multiple Accounts Assessment

Step #5 – Weightings and Base Case Scale

- A weighted “base case” scale was developed with weightings as summarized below, and was applied to the four Accounts:

Account	Environment Canada Guidelines Scale	Base Case Scale
Environmental	6	44
Socio-Economic	3	22
Technical	3	22
Economic	1.5	12
TOTAL	**13.5**	**100**

Multiple Accounts Assessment

Step #5 – Base Case Results

- A base case analysis was implemented with the account weightings and sub-account/indicator weightings.

Account	TSF Site 1b	TSF Site 1c
Environmental	239	176
Socio-Economic	103	132
Technical	129	94
Economic	67	60
TOTAL	**538**	**462**

- TSF Site 1b has the highest score and is the preferred alternative.

Sensitivity Analyses

Step #6

- Sensitivity analyses were completed to determine how the MAA results would change by varying relative weights.
- Sensitivity cases considered equal weighting of accounts and sub-accounts and then a progression of relative importance in environmental and socio-economic accounts with decreasing relative importance in the technical and economic accounts.

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Sensitivity Analyses

Step #6 – Sensitivity Cases Considered

Account	Sensitivity Case Weights					
	1	2	3	4	5	6
Environmental	25	30	60	60	70	80
Socio-Economic	25	20	30	30	30	20
Technical	25	30	5	10	0	0
Economic	25	20	5	0	0	0
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

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Sensitivity Analyses

Step #6 – Sensitivity Case Results

Sensitivity Case	Total Merit Score	
	TSF Site 1b	TSF Site 1c
1	**539**	482
2	**538**	479
3	**523**	466
4	**524**	463
5	**520**	460
6	**528**	440

- TSF Site 1b has the highest scores for all the sensitivity cases and therefore remains the preferred alternative.

Sensitivity Analyses

Step #6 – Indicator Sensitivity Cases (Socio-economic)

- Sensitivity analyses were completed to determine how the MAA results would change if the indicator scores for Traditional Use by Aboriginal Persons and Archaeology sub-accounts were varied.
- Sensitivity analyses were carried out by Base Case and Sensitivity Weighting Case #5.

Sub-Account	Base Case		Scenario 1		Scenario 2	
	Site 1b	Site 1c	Site 1b	Site 1c	Site 1b	Site 1c
Traditional Use by Aboriginal Persons	5	6	4	6	3	6
Archaeological Potential	4	6	3	6	2	3

Sensitivity Analyses

Step #6 – Socio-economic Indicator Sensitivity Results

Sensitivity Case	Base Case		Scenario 1		Scenario 2	
	Site 1b	Site 1c	Site 1b	Site 1c	Site 1b	Site 1c
Base Case Weightings	**538**	462	**523**	462	**508**	462
Sensitivity Case #5	**520**	460	**500**	460	**480**	460

- Following the Indicator sensitivity analysis for the Socio-economic Account, alternative Site 1b remains the preferred candidate.

Summary and Conclusions

Step #7 - Documentation

- **15** candidate alternatives identified
- Pre-screening evaluation revealed that slurry tailings disposal at TSF Site 1b or 1c is the preferred alternative
- MAA results suggest that **Site 1b** is the preferred TSF location
- Sensitivity analyses verify that **Site 1b** is the preferred TSF location

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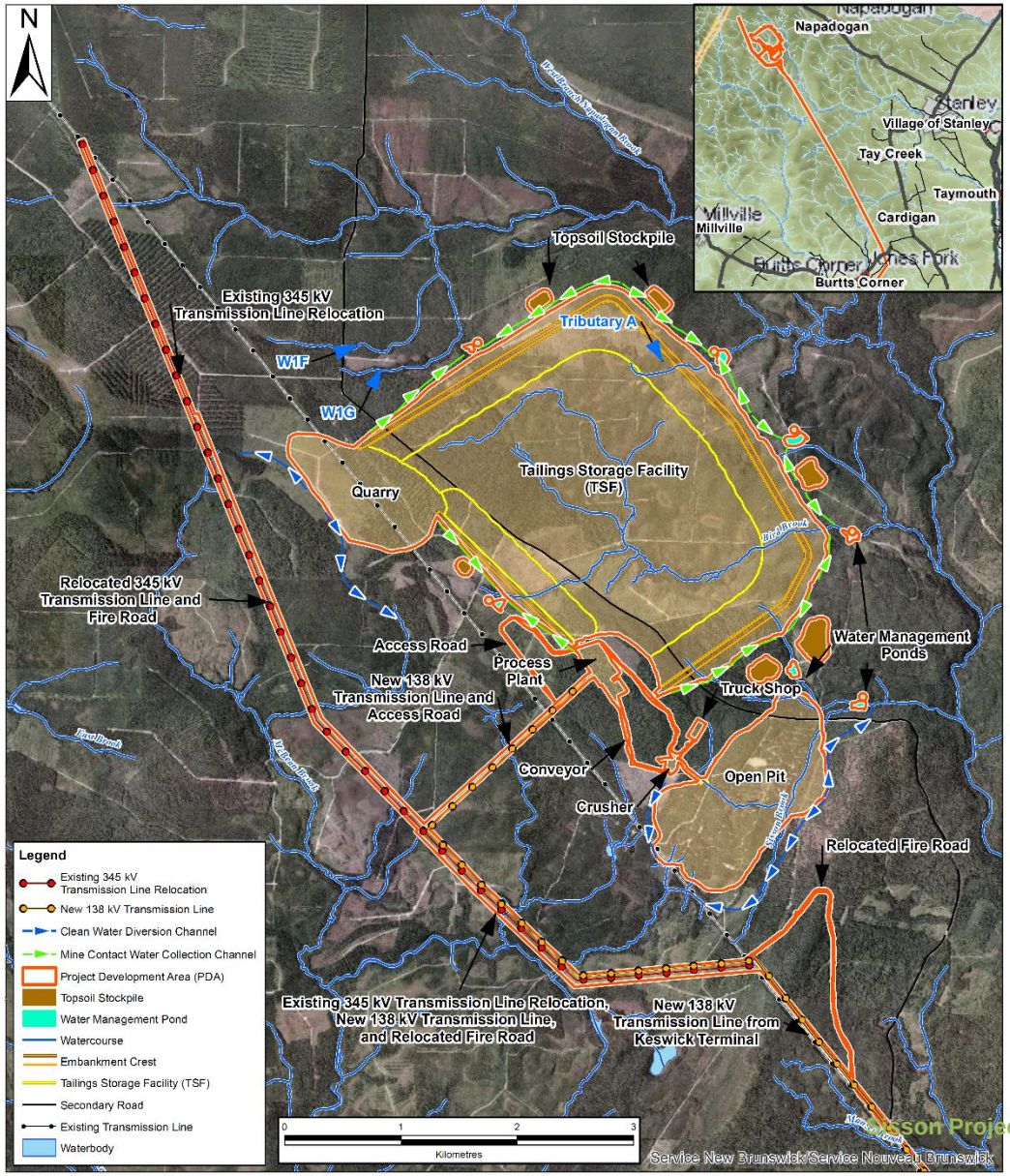
Summary and Conclusions



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