hydro One

AR 18379

Project Definition Report

Study Estimate for Options

East-West Tie Expansion

Prepared by: Tina Kianzad
Revision 0 – Jun 4, 2010

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All costing information contained in this document are preliminary and were prepared for option assessment purposes only.

Revision History

Project Definition Report: East-West Tie Expansion

Rev #	Revision Date	Revision Summary
0	4 Jun 2010	First Issue

CONTENT

A. EXECUTIVE SUMMARY

This Project Definition Report has been prepared in response to the Preliminary Planning Specification (Rev. 02) dated March 15, 2010.

This document provides the study estimate of options for the project implementation.

The project will undertake the expansion of power transmission capabilities of the East-West Tie from its current west to east transfer limit of 325 MW to incorporate additional renewable resources in the Northwest. This will be done by adding extra transmission lines along the existing Right-of-Way of the 230 kV lines between Wawa TS and Lakehead TS that are currently in place. The expansion will proceed based on one of six proposed alternative designs, which may use a single-circuit, double-circuit 230 kV or HDVC +/- 250 kV technologies.

Development

Project originally awarded for $758K

Project has been partially awarded on Feb 2010 for $5,200K to start development work

Development completion date is May 2013

The estimated Development Cost is: $43,691K

Implementation

The expected in-service date of the proposed facilities is November, 2016.

The estimated Implementation Cost ($K):

Options	OHSW ($K)	OPGW ($K)
L1- Double - circuit 230kV transmission line - Wawa TS x Lakehead TS (400km), lattice X10 family Steel Tower	703,157	724,697
L2- Single - circuit 230kV transmission line - Wawa TS x Lakehead TS **(400km)**, lattice W1 family Steel Tower,	577,615	597,197
L3- Double - circuit 230kV transmission line - Wawa TS x Nipigon SS (300km), lattice X10 family Steel Tower,	538,860	556,237
L4- Single - circuit 230kV transmission line - Wawa TS x Nipigon SS (300km), lattice W1 family Steel Tower, 400m span	424,964	439,497
L5 - Double - circuit 230kV transmission line - Wawa TS x Nipigon SS (300km) & Single - circuit 230kV transmission line - Nipigon SS x Lakehead TS (100km), lattice X10 and W1 family Steel Tower	658,015	677,483
L6- A new Bipolar +/-250kV HVDC light transmission line - Wawa TS x Lakehead TS(400km) lattice steel tower +/-250kV bi-pole	1,216,286	1,215,874

Note: 400m span has been considered for all options

B. OBJECTIVE OF THE PLAN

The existing transmission system between Northwest and Northeast Ontario is referred to as the East-West Tie which comprises of a double-circuit 230 kV line between Wawa TS and Marathon TS. The transmission network extends west as a double-circuit 230 kV line between Marathon TS and Lakehead TS (circuits M23L and M24L) and between Lakehead TS and Mackenzie TS (circuits A21L and A22L).

Hydro One has started the development work for a new 230 kV line from the Nipigon area to the Town of Pickle Lake. This line will be connected to circuits M23L and M24L at a new switching station at Kama Bay referred to as Nipigon SS. The proposed East-West Tie Expansion will be connected to this new station.

The proposed new 230 kV AC line will help to meet the goals set out by the Ontario Government's Green Energy and Green Economy Act (GEGEA) that intend to increase the availability of renewable energy and make us of renewable energy sources in Ontario. A single-circuit 230 kV AC line will increase the West-to-East transfer limit from 325 MW to 475 MW. Using a double-circuit 230 kV line will increase the transfer limit to 625 MW. The choice of how line expansion will proceed will be broken down into 6 alternatives and will be chosen based on what meets the needs of renewable energy distribution best

Existing & Proposed Transmission Lines

C. SCOPE OF WORK

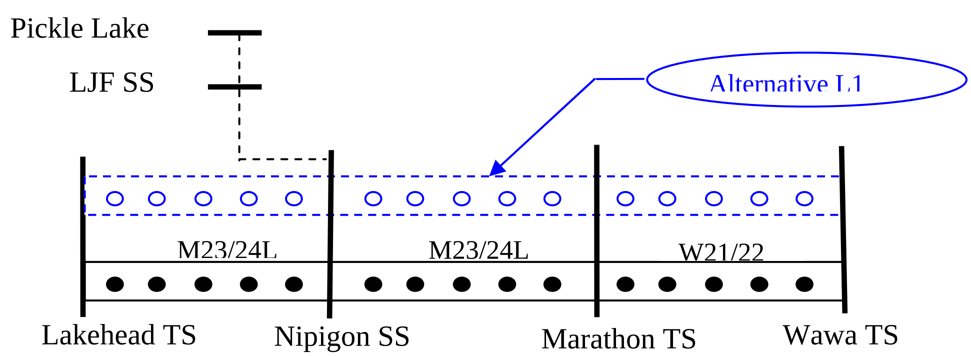
Scope of work under the implementation consists of the following:

C.1 Scope of Work _ Transmission Line

The transmission line requirements vary with the chosen implementation alternative. All lines meet Hydro One standards and have an ampacity of 1000 A and about 20 kA fault current. The following is an outline of line requirements for each alternative:

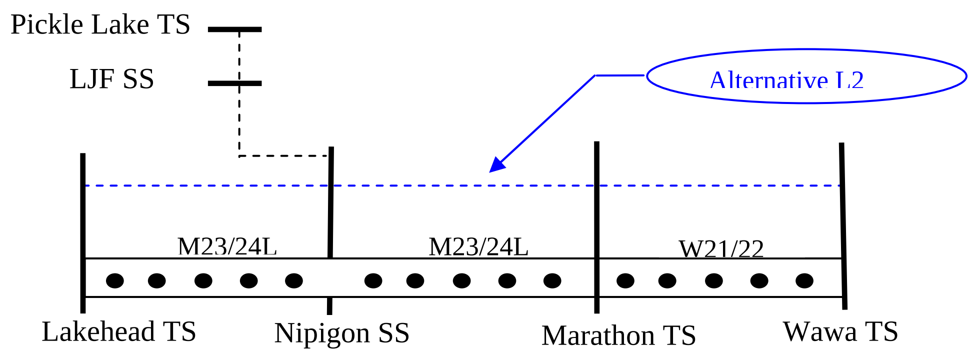
C.1.1 Alternative L1

Double-circuit 230kV transmission line along the existing ROW, between Wawa TS, Marathon TS, Nipigon SS and Lakehead TS including in & out to required station facilities at these stations.
Transmission line length is about 400Km, with an average span of 400m using Hydro One lattice steel double circuit X10 towers family.



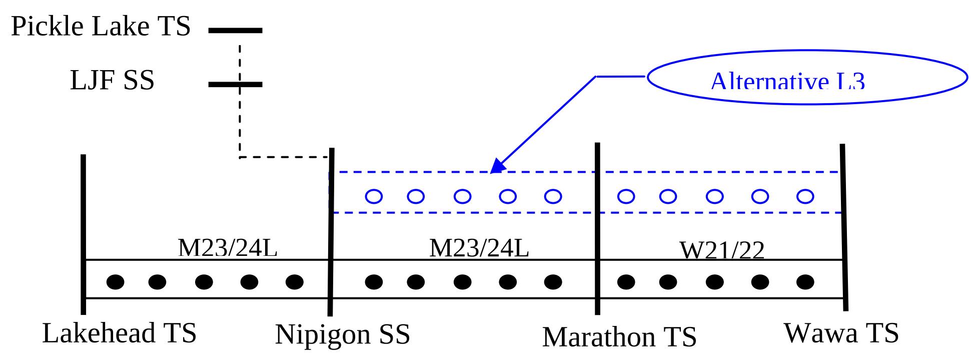
C.1.2 Alternative L2

Single-circuit 230kV transmission line along the existing ROW, between Wawa TS, Marathon TS, Nipigon SS and Lakehead TS including in & out to required station facilities at these stations.
Transmission line length is about 400Km with an average span of 400m using Hydro One lattice steel single circuit W1 towers family.



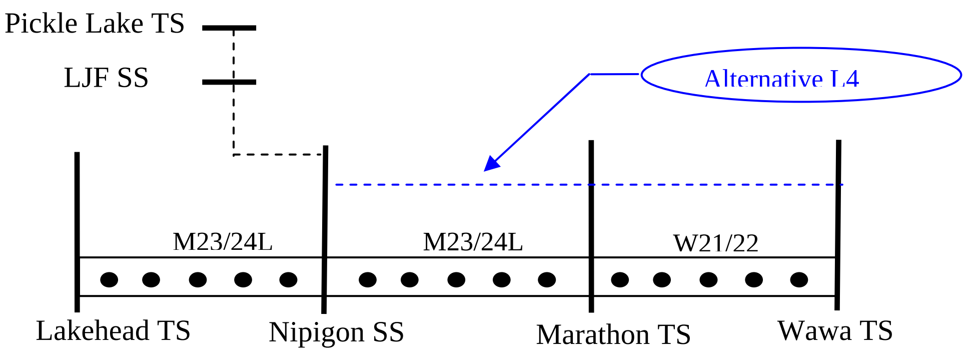
C.1.3 Alternative L3

Double-circuit 230kV transmission line along the existing ROW, between Wawa TS, Marathon TS and Nipigon SS including in & out to required station facilities at these stations.
Transmission line length is about 300Km with an average span of 400m using Hydro One lattice steel double circuit X10 towers family.



C.1.4 Alternative L4

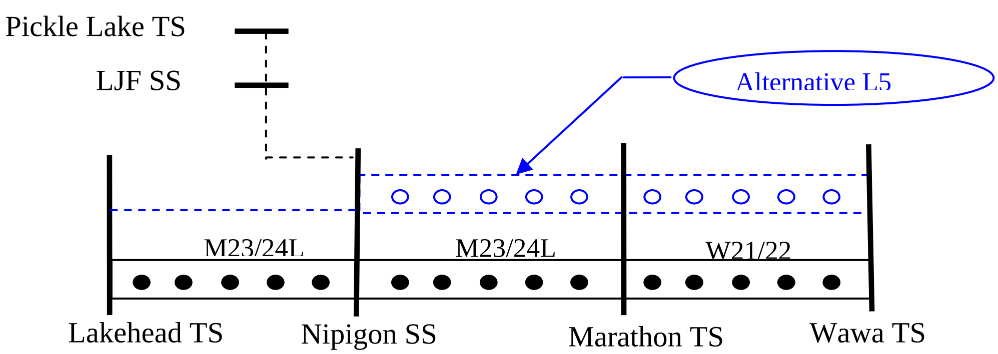
Single-circuit 230kV transmission line along the existing ROW, between Wawa TS, Marathon TS and Nipigon SS including in & out to required station facilities at these stations.
Transmission line length is about 300Km with an average span of 400m using Hydro One lattice steel single circuit W1 towers family.



C.1.5 Alternative L5

Double-circuit 230kV transmission line along the existing ROW, between Wawa TS, Marathon TS and Nipigon similar to alternative L3 above plus a new single circuit 230kV line between Nipigon SS and Lakehead TS including in & out to required station facilities at these stations.
There is about:

- 300Km double circuit transmission line with an average span of 400m using Hydro One lattice steel double circuit X10 towers family and
- 100Km of single circuit transmission line with average span of 400m using Hydro One lattice steel single circuit W1 tower family



❖ **Power System Conditions _ Alternatives L1 to L5**

- System Frequency 60Hz
- Nominal System Voltage 230kV
- Fault Current about 20kA

❖ **Line Rating Alternatives _L1 to L5**

The 230 kV transmission lines in this project will use 795 MCM ACSR Drake conductors. Maximum operating continuous temperature is assumed to be 93°C, and the summer rating is about 1000Amps. The maximum operating temperature for ground clearance shall be 127 ºC (emergency summer rating)

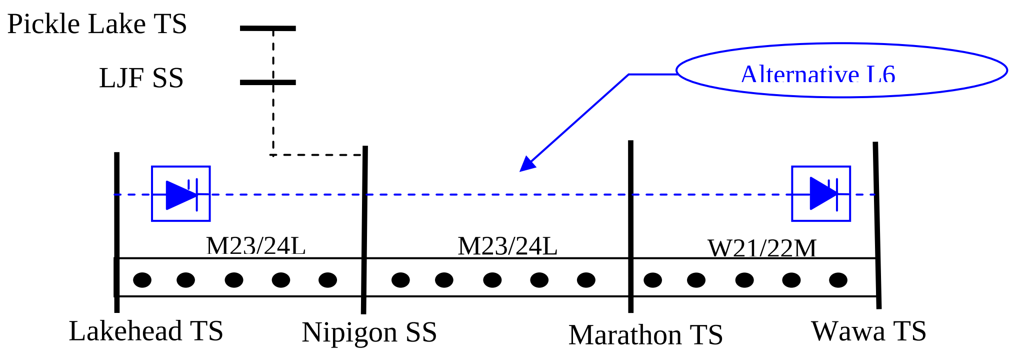
- **Lightning Protection and Grounding _Alternatives L1 to L5**

Adequate lightning protection shall be provided for transmission line as per Hydro One standards. Shield wires shall be installed on the transmission lines and will be taken into the substation. For double circuit transmission line there shall be one ground wire and one OPGW, while for single circuit transmission line there shall be one OPGW.

C.1.6 Alternative L6

A new Bipolar +/-250kV HVDC light transmission line (with up to 400MW capacity) shall be constructed along the existing ROW, between Wawa TS, and Lakehead TS. A ground return path option is considered for a high degree of flexibility of operation.

Transmission line length is about 400Km with an average span of 400m using lattice steel tower +/- 250kV bi-pole and one earth return conductor at mid point. Converter station and required AC connection facilities to these stations are included in station scope of work. There shall be two overhead shield wires, one OPGW and one Alumoweld ground wires. HVDC towers shall be designed for this specific application. Typical arrangement of HVDC tower is shown in Appendix A



Nominal system voltage	+/-250kV DC
Switching surge	400kV (Typical value from CSA C22.3-01)
Conductor	ACSR Drake, 795 MCM 26/7 strands
Insulator type	DC Fog type insulators, high creepage, NGK cat# CA-735EZ or equivalent
Insulator string suspension	V type, 160kN, 2x16 discs

Insulator string Tension	Deadend type, 160KN, 2x16 discs
Configuration	Horizontal, one conductor per phase
No of poles	2 (+/-250KV phase to metallic earth return conductor)
Earth return conductor	1
Shield wires	2, 7#6 Alumoweld wires or One 7#6 Alumoweld wire and One OPGW, 48 Fibers, equivalent to 7#6 Alumoweld

C.2 Scope of Work _ Stations

C.2.1 Wawa TS

Wawa TS is located just east of the town of Wawa. Project covers to convert the existing 5-breaker 230 kV ring bus to a 2-bus, 3-diameter arrangement, with 3 line-terminations (4 breakers) per diameter. The existing breakers or the existing transmission line terminations have to be relocated to provide additional span for additional breaker position. Both options require extensive modifications and outage requirements.

Building the arrangement of 4 diameters with three breakers in each one (as existing arrangement) would be a better solution.

C.2.1.1 Alternative L1, L3, L5, one double 230 kV Circuits, 2 new line terminations

- 6-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manual vertical break disconnect switches, compatible with the breaker ratings. .
- 2-230 kV motorized 2000 Ampere, 40kA, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 6-230 kV CVTs
- 6-230 kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- Two sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit (This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 3000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed to be suitable for the new breaker installations.
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductors per phase to a total conductor length of 1000 meter is required.

Communications are assumed to be available based on existing microwave or OPGW.

Modifications and additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Additions and modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be sandy clay based, with bedrock within one meter below surface. Rock footings may be assumed in 50% of the locations; the remainder shall be split as auger or spread footings where soil depth permit.

C.2.1.2 Alternative L2 and L4, one single 230 kV Circuit, 1 new line terminations

- 4-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manual vertical break disconnect switches, compatible with the breaker ratings.
- 1-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 3-230 kV CVTs.
- 3 230kV surge arresters.
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- One set of wave trap and coupling capacitor each for one phase of single circuit with line matching unit (This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 2000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed to be suitable for the new breaker installations.
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductor per phase to a total conductor length of 1000 meter is required

Communications are assumed to be available based on existing microwave or OPGW.

Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be sandy clay based, with bedrock within one meter below surface. . Rock footings may be assumed in 50% of the locations; the remainder shall be split as auger or spread footings where soil depth permit.

C.2.1.3 Alternative L6, HVDC +/-250kV Light Transmission Line between Wawa TS and Lakehead TS

❖ **Site Requirements:**

A land size of approximately 200 meter by 125 meter is required for the installation of "DC substation" adjacent to existing Wawa TS is required. In addition to this, ac harmonic filters and shunt capacitor banks have to be included to the existing substation. The new arrangements to the Wawa TS will also require expansion of AC station property by about 200 meter by 125 meter.

❖ **Electrical Requirements**

- The DC substation comprises of converters and DC filters connected to converter transformers.
- A Converter Valve station complete with converter arrangement.
- DC filters with Smoothing reactor connected to the DC incoming side.
- Bus works and terminations for the above arrangement to be connected to the converter transformers.
- A new ground grid is required to be installed with approximately 6000 meters of 4/0 conductor.
- Site preparation including drainage and other environmental requirements for the identified location close by the existing substation is required.
- Noise barrier walls suitable with fire fly requirements are required for both converter transformers.
- Oil containment system is required for the oil filled converter transformers.
- Protection system for the HVDC converter control, converter transformer protection as required to be provided in a separate HVDC control and relay room.
- Station service requirements with duel 100kVA transformer and auto change over switch is required.
- Station 250V dc supply for the control and protection in the order of approximately 400AH battery bank with charger in duplicate is required.
- SCADA and communication is required to be provided to have access to OGCC at Barrie.

❖ **AC Substation Additional Requirements**

The AC output from converter transformers is connected to the existing AC System through AC Harmonic filters. Additional shunt capacitor banks are required to meet the reactive power requirements. Bus works and terminations for the above arrangement are required. New 250V, 250AH dual DC battery bank, chargers and a DC Distribution board is required. Station service requirements with duel 100kVA transformer and auto change over switch is required

A new ground grid is required to be installed with approximately 4000 meters of 4/0 conductor and suitably connected to the existing ground. Grounding requirements of the equipments to the ground grid would require another 1000 meters of 4/0 conductor approximately.

❖ Line Terminations

The line Terminations at Wawa TS are similar to Option L1 as follows:

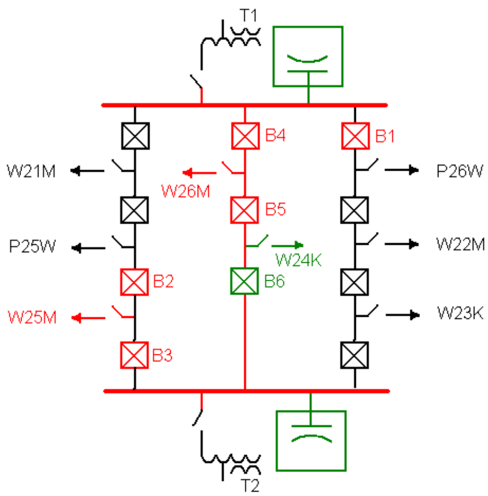
- 6-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manual vertical break disconnect switches, compatible with the breaker ratings. .
- 2-230 kV motorized 2000 Ampere, 40kA, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 6-230 kV CVTs
- 6-230 kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- Two sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 3000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed to be suitable for the new breaker installations.
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductors per phase to a total conductor length of 1000 meter is required.

Communications are assumed to be available based on existing microwave or fiber circuit.

Modifications and additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Additions and modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be sandy clay based, with bedrock within one meter below surface. Rock footings may be assumed in 50% of the locations; the remainder shall be split as auger or spread footings where soil depth permit..



Alternative	New Facilities	
	W25M, B1 ,B2, B3	W26M, B4, B5
L1	X	X
L2	X	
L3	X	X
L4	X	
L5	X	X
L6	Converter Station & AC Connections	

– Existing
– New
– Future

C.2.2 Marathon TS

Marathon TS is located about 2 km north of the town of Marathon Project covers to convert the existing 4-breaker 230 kV ring bus to a 2-bus, 3-diameter arrangement, with 3 line-terminations (4 breakers) per diameter.

C.2.2.1 Alternative L1, L3 and L5 two double 230 kV Circuits, 4 new line terminations

- 7-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 4-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 12-230 kV CVTs
- 12 230kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- Four sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 3000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed to be suitable for the new breaker installations.

- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductor per phase to a total conductor length of 2000 meter is required

Communications are assumed to be available based on existing microwave and new fiber circuits.

Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be sandy clay based, with bedrock within one meter below surface. Rock footings may be assumed in 50% of the locations; the remainder shall be split as auger or spread footings where soil depth permit.

C.2.2.2 Alternative L2 and L 4, two single 230 kV Circuits, 2 new line terminations

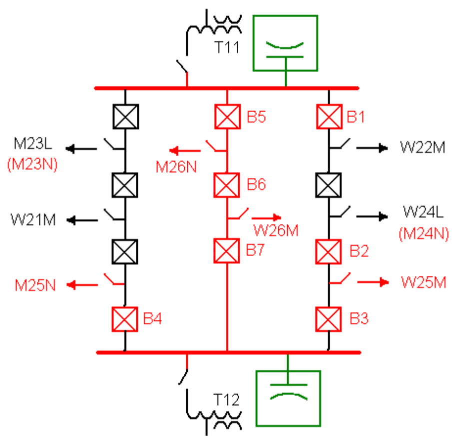
- 4-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 2-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 6-230 kV CVTs
- 6 230kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- Two sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 2000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed to be suitable for the new breaker installations.
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductor per phase to a total conductor length of 1000 meter is required
-

Communications are assumed to be available based on existing microwave or new fiber circuits.
Additions to the existing P&C system are required in redundant A and B systems. Assume the

A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be sandy clay based, with bedrock within one meter below surface. . Rock footings may be assumed in 50% of the locations; the remainder shall be split as auger or spread footings where soil depth permit.



Alternative	New Facilities	
	W25M, M25L, B1, B2, B3, B4	W26M, B5, B6, M26L, B7
L1	X	X
L2	X	
L3	X	X
L4	X	
L5	X	X
L6		

– Existing
– New
– Future

C.2.3 Nipigon SS

It is assumed that Nipigon SS will already be built under the "Northwest Transmission Expansion" project to include 9 line terminations It is assumed there will be adequate space both in the yard and control building to accommodate the work under this plan including the additional Protection and SCADA Panels.

C.2.3.1 Alternative L1, two double 230 kV Circuits, 4 new line terminations

- 7-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 4-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 12-230 kV CVTs
- 12 230kV surge arresters
- Additional bus work and structures to accommodate the third diameter. Note HONI uses 8 inch IPS bus as standard.

- Four sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 3000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed in the existing proposal.

Communications are assumed to be available on commissioning the new substation.

Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be clay based, with bedrock many meters below surface. Conventional spread or augured footings may be used.

C.2.3.2 Alternative L2- two single 230 kV or L3- one double 230kV Circuits, 2 new line terminations

- 5-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 2-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 6-230 kV CVTs
- 6 230kV surge arresters
- Two sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Additional bus work and structures to accommodate the third diameter. Note HONI uses 8 inch IPS bus as standard.
- Ground grid 4/0 copper conductor and connection to equipment 2000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed in the existing proposal.
-

Communications are assumed to be available on commissioning the new substation.
Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be clay based, with bedrock many meters below surface. Conventional spread or augured footings may be used.

C.2.3.3 Alternative L4, one single 230 kV Circuit, 1 new line termination

- 4-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 1-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 3-230 kV CVTs
- 3 230kV surge arresters
- One set of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Additional bus work and structures to accommodate the third diameter. Note HONI uses 8 inch IPS bus as standard. .
- Ground grid 4/0 copper conductor and connection to equipment 2000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed in the existing proposal.

Communications are assumed to be available based on commissioning the new substation.
Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be clay based, with bedrock many meters below surface. Conventional spread or augured footings may be used.

C.2.3.4 Alternative L5 - one single and one double 230 kV Circuit, 3 new line terminations

- 6-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 3-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 9-230 kV CVTs
- 9 230kV surge arresters

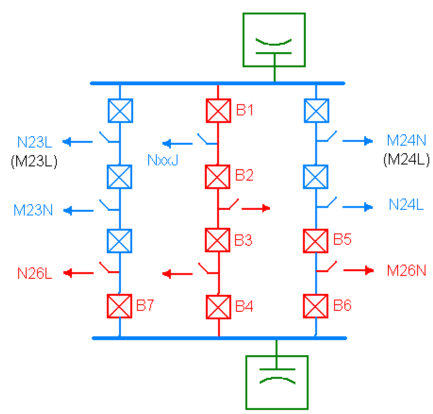
- Three sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Additional bus work and structures to accommodate the third diameter. Note HONI uses 8 inch IPS bus as standard.
- Ground grid 4/0 copper conductor and connection to equipment 3000 meters
- Space for new panels in the control panel, existing AC station service and DC supply is assumed as designed in the existing proposal.
-

Communications are assumed to be available based on commissioning the new substation.

Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be clay based, with bedrock many meters below surface. Conventional spread or augured footings may be used



Alternative	New Facilities			
	M25N, B1, B2, B3, B5	N25L, B4	M26N, B6	N26L, B7
L1	X	X	X	X
L2	X	X		
L3	X		X	
L4	X			
L5	X	X	X	
L6				

– Will be built under North West Project
– New
– Future

C.2.4 Lakehead TS

Lakehead TS is located approximately 15km east of the city of Thunder Bay. The station 230kV East area has two existing folding diameters with three breakers in each one (Bay 11 to 14). The third diameter that is now allocated for deferred Birch T.S project (Bay 9 and 10) will be used to accommodate the new Lakehead project. Project covers to ass a new diameter for 2 new line terminations.

C.2.4.1 Alternative L1 One double 230 kV Circuit, 2 new line terminations

- 3-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 2-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 6-230 kV CVTs
- 6 230kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- Two sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 1500 meters
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductor per phase to a total conductor length of 1000 meter is required
- Space for new panels in the control panel, existing AC station service and DC supply is assumed to be suitable to be suitable for the new breaker installations.

Communications are assumed to be available based on existing microwave or new fiber circuits.
Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be glacial till subsoil. Conventional spread or pile footings may be used

C.2.4.2 Alternative L2, L5 One single 230 kV Circuit, 1 new line termination

- 2-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 1-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 3-230 kV CVTs
- 3 230kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.

- One set of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 1000 meters
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductor per phase to a total conductor length of 1000 meter is required
- Space for new panels in the control panel, existing AC station service and DC supply is assumed to be suitable for the new breakers installation.

Communications are assumed to be available based on existing microwave or new fiber circuits.
Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.
Soils in the area are understood to be glacial till subsoil. Conventional spread or pile footings may be used

C.2.4.3 Alternative L6, HVDC +/-250kV Light Transmission Line between Wawa TS and Lakehead TS

A similar set of facilities as mentioned for Wawa TS HVDC, are required for the converter station at the Lakehead substation, as below:

❖ **Site Requirements:**

A land size of approximately 200 meter by 125 meter is required for the installation of "DC substation" adjacent to existing Lakehead TS is required. In addition to this, ac harmonic filters and shunt capacitor banks have to be included to the existing substation. The new arrangements to the Lakehead TS will also require expansion of AC station property by about 200 meter by 125 meter.

❖ **Electrical Requirements:**

- Components in the DC SUBSTATION:
- The DC substation comprises of converters and DC filters connected to converter transformers.
- A Converter Valve station complete with converter arrangement.
- DC filters with Smoothing reactor connected to the DC incoming side.
- Bus works and terminations for the above arrangement to be connected to the converter transformers.

- A new ground grid is required to be installed with approximately 6000 meters of 4/0 conductor.
- Site preparation including drainage and other environmental requirements for the identified location close by the existing substation is required.
- Noise barrier walls suitable with fire fly requirements are required for both converter transformers.
- Oil containment system is required for the oil filled converter transformers.
- Protection system for the HVDC converter control, converter transformer protection as required to be provided in a separate HVDC control and relay room.
- Station service requirements with duel 100kVA transformer and auto change over switch is required.
- Station 250V dc supply for the control and protection in the order of approximately 400AH battery bank with charger in duplicate is required.
- SCADA and communication is required to be provided to have access to OGCC at Barrie.

❖ AC Substation additional requirements

The AC output from converter transformers is connected to the existing AC System through AC Harmonic filters. Additional shunt capacitor banks are required to meet the reactive power requirements. Bus works and terminations for the above arrangement are required. New 250V, 250AH dual DC battery bank, chargers and a DC Distribution board is required. Station service requirements with duel 100kVA transformer and auto change over switch is required

A new ground grid is required to be installed with approximately 4000 meters of 4/0 conductor and suitably connected to the existing ground. Grounding requirements of the equipments to the ground grid would require another 1000 meters of 4/0 conductor approximately.

❖ The Line Terminations

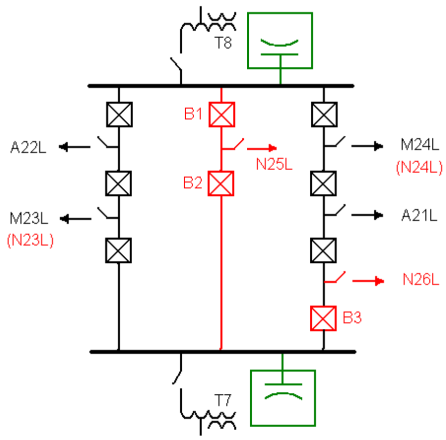
The Line Terminations are similar to Option L1 as follows.

- 3-230 kV 3000 ampere 40 kA 900 kV BIL rated dead tank breakers each with two associated manually operated vertical break disconnect switches, compatible with the breaker ratings.
- 2-230 kV motorized 2000 Ampere, 1050 kV BIL vertical break line disconnect switches with motor operated grounding switches.
- 6-230 kV CVTs
- 6 230kV surge arresters
- 8 inch IPS pipe for additional bus work and structures to accommodate the above new diameters is required.
- Two sets of wave trap and coupling capacitor each for one phase of single circuit with line matching unit(This may not be required if OPGW alternative is used)
- Ground grid 4/0 copper conductor and connection to equipment 1500 meters
- Addition or replace the existing strain main buses rated 1000A with 2 x 3603 MCM aluminum conductor per phase to a total conductor length of 1000 meter is required
- Space for new panels in the control panel, existing AC station service and DC supply is assumed to be suitable to be suitable for the new breaker installations.

Communications are assumed to be available based on existing microwave or new fiber circuits.
Additions to the existing P&C system are required in redundant A and B systems. Assume the A system uses SEL 421 relays, the B system will use equivalent GE Multilin relays. Existing bus protections will have to be expanded and modified.

Modification for existing Telecommunication and SCADA are required.

Soils in the area are understood to be glacial till subsoil. Conventional spread or pile footings may be used.



	New Facilities	
Alternative	N25L, B1, B2	N26L, B3
L1	X	X
L2	X	
L3		
L4		
L5	X	
L6	Converter Station and AC Connections	

– Existing
– New
– Future

C.3 Scope of Work _ Exclusions

The following work is **NOT** included in the scope of work:

- Work at Networks' other facilities other than minor relay setting changes
- No connection of generation facilities to the grid
- No connection of First Nations communities to the grid
- No unusual anti-cascade requirements or contamination levels are included
- No temporary bypass included for this project
- Financial assistance to First Nations and Métis communities in the capital project.
- No labor hours are included for Asset Management, Aboriginal Affairs and Corporate Legal and regulatory

C.4 Scope of Work _ Environmental

The Scope of environmental engineering work is to ensure that environmental due diligence is exercised throughout the life-cycle of this project. Services provided will ensure that this project remains in full compliance with all legislated and corporate environmental requirements during the planning, design, and construction stages of the project. Services will also ensure that the constructed components of the facility are in full compliance at the In-Service stage. The estimate covers both all required internal resources (hours, cost and expenses) and all cost of required external contracts/ services.

C.5 Scope of Work _ Corporate communication

The scope of Corporate Communications works is to provide support to the process, communicate and consult with affected communities and stakeholders through various communication channels. By ensuring effectiveness of the communications and consultation program, products and activities, the desired outcome is to engender support for the project and to address and resolve any potential issues that could result in regulatory intervention and delays in project approvals.

C.6 Scope of Work _ Real Estate

Execution of the property acquisitions including the required internal Hydro One Real Estate resources (hours/expenses)

D. ASSUMPTIONS

The labor hours and expenses are included for Real Estate, and Corporate Communication staff.

The main assumptions are as follows:

D.1 Assumptions _ Lines

- It is assumed that all TS and SS sites will be approved and purchased by Hydro One.
- Additional easement will be obtained as needed by Hydro One at the TS, SS and ROW of the new line.
- Line R/W brushing, trimming, and site clearing will be required for almost entire line length. Acre-for –acre reforestation has not been accounted
- Outages will be available as required.
- Hydro One will provide lay down area(s) for transmission line material and allow for roadside drop off.
- The soil condition is mostly rocky, covered with trees, river and lake crossings, most of the transmission line route is inaccessible by vehicle. The soil condition, terrain and constructability have been estimated without geotechnical reports on the basis of visual observation.
- It is assumed that generally there will be truck /surface delivery of line material, However transportation of line material and tower erection by

helicopter will also be required.

- Standard Hydro One lattice steel tower structures will be used. Structure drawings shall be provided by Hydro One.
- No improved appearance double circuit steel poles will be used.
- The last span of transmission conductor and OHGW for each circuit will be carried into the substations as a slack span.
- The meteorological loadings for this project will be CSA Heavy Loading.
- No under build work is included in the estimate.
- No provision for concurrent engineering has been made.
- Double overhead shield wire is assumed in all (D/C options).
- Communication cable is considered under separate estimate (1x OPGW & 1x OHSW).
- Cost for temporary facilities (bypasses, temporary lines, temporary supply etc.) is not included in the estimate.
- No unusual anti-cascade requirements or contamination levels are included.
- Cost of four (4) storage yard set up is considered in each option of 400Km lines and three (3) are considered for 300Km lines options.

D.2 Assumptions _ Stations

- Winter construction cost is included for all substations (for all options)
- For HVDC options (Lakehead and Wawa substations) instead of 100 kVA, 1 MVA station service transformer is assumed.
- Line route will be further refined and a preferred route will be selected by August 2010 as the studies progress. It is assumed that the final route will generally have longer straight sections and avoid large water bodies.
- Cost for relay settings is not included.
- All approvals, access and P&L are available when required.
- Project will proceed in a continuous manner without interruptions or delays.
- No concrete foundation is required for the line.

D.3 Assumptions _ Environmental

- It is assumed that the duration of the Individual EA process is 3 years (i.e. development phase: January 2010 to December 2012), and construction phase would occur May 2013 to November 2016 for a duration of 2.5 years.
- The project will be released with sufficient time to plan and implement the Environmental Assessment (EA) process prior to the requirement to begin construction in order to meet the in-service date of November 2016.
- This estimate includes all required station and line-related work.
- Conceptual Engineering and/or Engineering Consultant will provide the necessary technical design to complete the EA (e.g., basic layout sketch, conceptual tower designs).
- It is assumed that Stage 3 and 4 archaeological assessments will be carried

out after EA Act approval and therefore are not included in this estimate.

- No provision has been included for issues associated with specific property ownership concerns.
- Additional costs will be required to develop mitigation plans to address any unforeseen issues identified during monitoring.
- Any additional requirements that could affect timing and costs will be identified as early as possible. If necessary, a scope change will be submitted to adjust the costs accordingly.
- Consultant costs are estimates only. The consultants will be required to submit a budget estimate proposal for the project and the estimate may need to be adjusted accordingly.
- ES&A expenses include travel, accommodation, meals and other incidental costs, which are captured under "Travel and Sundry" on the attached Material/Equipment Table. It is assumed that Travel and Sundry constitute 20% of Engineering Hours x $140/hr labour rate.
- There are no contingencies provided for in this estimate.

D.4 Assumptions _ Real Estate

- Assumed right-of-way to be 150 feet in width.
- Assumed distance from Wawa TS to Marathon TS is 170km
- Assumed distance from Marathon TS to Nipigon SS is 130km
- Assumed distance from Nipigon SS to Lakehead TS is 100km
- Rates per acre applied using Whitefish Appraisal (2006) for Rural Residential Land Rates
- Assumed compensation for Commercial/Industrial properties equal to residential properties.
- Average home prices taken from CMHC report (Lakehead to Nipigon section), Marathon Housing (Nipigon to Marathon to Wawa section)
- Assumed average vacant lot parcel to be 100 acres (1 property per km)
- Inflation applied to Rural Residential Land Rates
- Survey costs not factored in
- No costs recognized for environmental remediation, woodlot compensation for ROW area
- No costs recognized for any First Nation Land Claims
- Assumed no Land Acquisition Compensation Principles applied.
- Assumed rights within First Nation reserve would equal to land rental payments for 10 years at market rate
- Property counts are based on reviews using Google Earth Images
- Injurious Affection is assumed 15% as per Bruce x Milton project
- Calculations are estimates based on current available information
- Total Acquisition Costs assumed to be 25% of Total Land Costs
- Off-corridor access roads assumed to be 3 roads/km (based on Bruce to Milton project)
- Estimate doesn't differentiate between single and double circuit line

D.5 Assumptions _ Corporate Communication

- Estimates include work to be undertaken for Study Estimate for Options (construction to in-service).
- Schedule based on consultation with 9 communities/municipalities
- Hydro One staff will oversee logistical planning of PIC's and at least one (1) Hydro One Communications staff will attend all PIC's.
- A minimum of a series of five (5) PIC's will be held in 6 locations (depending on route preference) to ensure adequate representation along the length of the transmission route.
- Hydro One Communications staff will create and maintain/post all project information on the project website.

E. LINE TECHNICAL COMPARISON TABLE

Technical Comparison Table for Lines	
L1	Transmission line length is about 400Km, with an average span of 400m using Hydro One lattice steel double circuit X10 towers family.
L2	Transmission line length is about 400Km with an average span of 400m using Hydro One lattice steel single circuit W1 towers family.
L3	Transmission line length is about 300Km with an average span of 400m using Hydro One lattice steel double circuit X10 towers family.
L4	Transmission line length is about 300Km with an average span of 400m using Hydro One lattice steel single circuit W1 towers family.
L5	300Km double circuit transmission line with an average span of 400m using Hydro One lattice steel double circuit X10 towers family and 100Km of single circuit transmission line with average span of 400m using Hydro One lattice steel single circuit W1 tower family
L6	Transmission line length is about 400Km with an average span of 400m using lattice steel tower +/- 250kV bi-pole and one earth return conductor at mid point. Converter station and required AC connection facilities to these stations are included in station scope of work. There shall be two overhead shield wires, one OPGW and one Alumoweld ground wires. HVDC towers shall be designed for this specific application

F. STATION TECHNICAL COMPARISON TABLE

Technical Comparison Table for Stations

Requirements	Unit	Wawa TS L1	Wawa TS L2	Wawa TS L3	Wawa TS L4	Wawa TS L5	Wawa TS L6	Marathon TS L1	Marathon TS L2	Marathon TS L3	Marathon TS L4	Marathon TS L5	Marathon TS L6	Nipigon SS L1	Nipigon SS L2	Nipigon SS L3	Nipigon SS L4	Nipigon SS L5	Nipigon SS L6	Lake Head TS L1	Lake Head TS L2	Lake Head TS L3	Lake Head TS L4	Lake Head TS L5	Lake Head TS L6
230kV/3000A (900kV/40kA BIL) **Dead Tank Breakers**	Each	6	4	6	4	6	6	7	4	7	4	7	X	7	5	5	4	6	X	3	2	X	X	2	3
230kV associated **Manual** vertical break **Disconnect Switches** compatible with the breaker ratings	Each	12	8	12	8	12	12	14	8	14	8	14	X	14	10	10	8	12	X	6	4			4	6
230kV/2000A (1050kV/40kA BIL) **Motorized** vertical break line **Disconnect Switches** with motor operated grounding switches	Each	2	1	2	1	2	2	4	2	4	2	4	X	4	2	2	1	3	X	2	1	X	X	1	2
230 kV **CVTs**	Each	6	3	6	3	6	6	12	6	12	6	12	X	12	6	6	3	9	X	6	3	X	X	3	6
230 kV **Surge Arresters**	Each	6	3	6	3	6	6	12	6	12	6	12	X	12	6	6	3	9	X	6	3	X	X	3	6
8" IPS Pipes for additional bus work and structures to accommodate the new diameters	Required	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	✓	✓
Sets of **Wave Trap** and **Coupling Capacitor** each for one phase with line matching unit (*may not be needed if OPGW alternative chosen)	Set	2	1	2	1	2	2	4	2	4	2	4	X	4	2	2	1	3	X	2	1	X	X	1	2
Ground Grid 4/0 copper conductor and connection to equipment inside station	Meter	3000	2000	3000	2000	3000	3000	3000	2000	3000	2000	3000	X	3000	2000	2000	2000	3000	X	1500	1000	X	X	1000	1500
Space for new panels in **Control Panel**,	Square Meter	Available	Available	Available	Available	Available	Available	Available	Available	Available	Available	Available	X	Available	Available	Available	Available	Available	X	Available	Available	X	X	Available	Available
Space for new panels in **AC Station Service**	Square Meter	Available	Available	Available	Available	Available	200m x125m	Available	Available	Available	Available	Available	X	Available	Available	Available	Available	Available	X	Available	Available	X	X	Available	200m x125m
Space for new panels in **DC supply**	Square Meter	Available	Available	Available	Available	Available	200m x125m	Available	Available	Available	Available	Available	X	Available	Available	Available	Available	Available	X	Available	Available	X	X	Available	200m x125m
Add to/Replace existing **Strain Main Buses** rated 1000A with 2 x 3603 MCM aluminum conductors per phase	Meter	1000	1000	1000	1000	1000	1000	2000	1000	2000	1000	2000	X	X	X	X	X	X	X	1000	1000	X	X	1000	1000
Communication is available based on existing microwave /or new OPGW	Required	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	✓	✓
Modifications and Additions to existing **P&C system** is required in redundant A and B (A system: SEL421 relay), (B system: Equivalent GE Multilin relays)	Required	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	✓	✓
Expansion/ Modification of existing **Bus Protection**	Required	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	✓	✓
Additions and Modifications to existing **Telecommunications** and **SCADA** are required	Required	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	✓	✓
Soil condition		Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Sandy clay with 1m bed rock 50% rock footing	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	Clay/1m Bed rock/Rock footing 50%	X	clay/ many meters bed rock	clay/ many meters bed rock	clay/ many meters bed rock	clay/ many meters bed rock	clay/ many meters bed rock	X	Glacial till subsoil / Conventional spread/ pile footing	Glacial till subsoil / Conventional spread/ pile footing	X	X	Glacial till subsoil / Conventional spread/ pile footing	Glacial till subsoil / Conventional spread/ pile footing
Add AC harmonic filters and shunt capacitor banks to substation	Required	X	X	X	X	X	✓						X						X					X	✓
Converter valve station with converter arrangement	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
DC filters with smoothing reactor	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
Bus work and terminations to be connected to converter transformers	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
New ground grid , 4/0 conductor for new DC and AC supply station	meters	X	X	X	X	X	11000												X					X	11000
Site preparation including drainage and other environmental requirements for the identified location close to existing station	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
Noise barrier walls suitable with fire fly requirements for converter transformers	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
Oil containment system for oil filled converter transformers	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
Protection system for HDVC converter control, converter transformer protection to be provided in a separate HVDC control and relay room	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
Station service duel 100 kVA transformer and auto change over switch	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
Station 250V dc supply for the control and protection in the order of approximately 400AD battery bank with charger in duplicate	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓
SCADA and communication is required to be provided to have access to OGCC at Barrie	Required	X	X	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓

G. RISKS ASSESMENT

A risk assessment, mitigation and monitoring plan will be developed at the project planning stage. For these Study Estimates, no risk differences have been identified since all options use the same corridor for the Lines and all Station work is similar and contained with the existing fenced area and existing building spaces. However several risk areas are identified for all options as following

A quantitative assessment of the Risk will be done for the preferred Alternative. For these studies a 20% contingency has been assumed to cover the Risk.

Risk Assessment for Alternatives L1, L2, L3, L4, L5

ID	Description	Impact	Mitigation	Probability				
				Lines	Wawa	Marathon	Nipigon	Lakehead
1	EA and Section 92 approval not received on time	Delay to the planned I/S date and may Increase escalation costs	Delay I/S date or overtime	H	H	H	H	H
2	Any expropriation not completed on time	Reduced access to route	Use helicopter to fly in	H	N/A	N/A	N/A	N/A
3	Insufficient preliminary engineering done	Inadequate scope, quantities undetermined	Do sufficient preliminary engineering for preferred plan	M	M	M	M	M
4	It is assumed that 60% of line material will be flown in to the tower location	Helicopter costs will increase , but road access costs will decrease to offset partially	More detail examination of preferred plan and /or allow for in contingency	H	N/A	N/A	N/A	N/A
5	Tower assembly area undetermined	Additional land acquisition and increase property costs	Investigate in more detail for preferred route	M	N/A	N/A	N/A	N/A
6	Outage not available to match schedule	Delay schedule and increase cost	Keep in communication with IESO, be ready to redirect works to alternative tasks	M	M	M	M	M
7	Equipment and Material cost may increase due to project delay or global increase in demand for similar material and equipment	Schedule delay and may increase cost	Increase contingency to accommodate	M	M	M	M	M

Risk Assessment for Alternatives L1, L2, L3, L4, L5

ID	Description	Impact	Mitigation	Probability				
				Lines	Wawa	Marathon	Nipigon	Lakehead
8	Not knowing all long lead items	Construction delay	Check lead time, redirect workers to alternative tasks	N/A	M	M	M	M
9	Lack of bidders for construction and material supply due to remote location or too much other work	Higher than expected construction and delivery costs	Issue tender early , increase contingency to accommodate	M/H	M/H	M/H	M/H	M/H
10	CN labour costs may increase	Overall higher project costs	Increase contingency tin preferred plan	M/H	M/H	M/H	M/H	M/H
11	Weather condition	Delay I/S date and increase CN cost for additional mob/demob	Reschedule activity, regards to weather forecasting, increase contingency	H	M	M	M	M
12	Union issues	Increase CN cost and ,ay delay I/S date	Allow for contingency	M	M	M	M	M
13	Shortage of skilled labour	Project Delay, increase costs and reduce Quality	Increase quality inspections and increase contingency	L	L	L	L	L

Risk Assessment for Alternative L6

ID	Description	Impact	Mitigation	Probability				
				Lines	Wawa	Marathon	Nipigon	Lakehead
1	EA and Section 92 approval not received on time	Delay to the planned I/S date and may Increase escalation costs	Delay I/S date or overtime	H	H	N/A	N/A	H
2	Any expropriation not completed on time	Reduced access to route	Use helicopter to fly in	H	M/H	N/A	N/A	M/H
3	Insufficient preliminary engineering done	Inadequate scope, quantities undetermined	Do sufficient preliminary engineering for preferred plan	M	M	N/A	N/A	M
4	It is assumed that 60% of line material will be flown in to the tower location	Helicopter costs will increase , but road access costs will decrease to offset partially	More detail examination of preferred plan and /or allow for in contingency	M	N/A	N/A	N/A	N/A
5	Tower assembly area undetermined	Additional land acquisition and increase property costs	Investigate in more detail for preferred route	M	N/A	N/A	N/A	N/A
6	Outage not available to match schedule	Delay schedule and increase cost	Keep in communication with IESO, be ready to redirect works to alternative tasks	L	L	N/A	N/A	L
7	Equipment and Material cost may increase due to project delay or global increase in demand for similar material and equipment	Schedule delay and may increase cost	Increase contingency to accommodate	L	L	N/A	N/A	L
8	Not knowing all long lead items	Construction delay	Check lead time, redirect workers to alternative tasks	M	M	N/A	N/A	M
9	Lack of bidders for construction and material supply due to remote location or too much other work	Higher than expected construction and delivery costs	Issue tender early , increase contingency to accommodate	M	L	N/A	N/A	L
10	CN labor costs may increase	Overall higher project costs	Increase contingency tin preferred plan	M	M	N/A	N/A	M
11	Weather condition delay	Delay I/S date and increase CN cost for additional mob/demob	Reschedule activity, regards to weather forecasting, increase contingency	H	M	M	M	M
12	Union issues	Increase CN cost and may delay I/S date	Allow for contingency	M	M	M	M	M
13	Shortage of skilled labor	Project Delay, increase costs and reduce Quality	Increase quality inspections and increase contingency	L	L	N/A	N/A	L
14	Locations of Converter Stations and the AC filters areas are undetermined	Additional land acquisition and increased property and access costs. Possibly additional EA approval and Class 92	Investigate in more detail for the preferred plan.	M/H	M/H	N/A	N/A	M/H
15	Construction sites too muddy.	Increase material and construction costs.	Refrain from construction during spring break up. Reschedule activity.	L	L	N/A	N/A	L

H. PRELIMINARY SCHEDULE

Issue scope of development work	Oct 2009
Issue preliminary planning spec and options	Feb 2010
Partial Award to proceed with EA (5,958 K)	Feb 2010
Award for balance of development work	Jun 2010
Notify public of EA Initiation	Jun 2010
Issue study estimate for options	Jun 2010
Identify reference plan	Jul 2010
Begin title search	Jun 2010
Issue detailed planning specification	Jul 2010
Submit EA TOR to MOE (final revision)	Oct 2010
Submit Section 92	Feb 2011
Finalize preferred route	Aug 2011
Lidar Survey	Aug 2011
Finalized detail estimate	Oct 2011
Submit EA report	Sep 2012
Section 92 approval in place	Feb 2012
Begin Voluntary Acquisition of property	Sep 2012
Preliminary award to purchase long lead items	May 2013
EA approval in place	May 2013
Issue final Planning Spec and Release project	May 2013
Begin expropriation	May 2013
Start Construction	May 2014
In-Service Date	Nov 2016

I. COST BREAKDOWN

I.1 Development

Description	Estimated Cost ($K)
Project Management	960
Engineering	17,994
Environmental	2,532
Material	2,455
Real Estate	269
First Nations & Métis Relations	15,592
Corporate Communications	1,053
Legal & Regulatory	2,836
Total Estimated Cost	**43,691**

Note: The above includes all estimate preparation costs.

Cash flow- Development ($K)

Year	2009	2010	2011	2012	2013
Development Estimated cost	107	5,892	14,150	13,483	10,059

I.2 Implementation

East - West Tie Expansion
Line & Station _ Capital & MFA ($K)

Options	L1	L2	L3	L4	L5	L6
2 OHSW	703,157	577,615	538,860	424,964	658,015	1,216,286
1 OHSW & 1 OPGW	724,697	597,197	556,237	439,497	677,483	1,215,874

East - West Tie Expansion (OHSW) _ Line & Station ($K)

Options	L1	L2	L3	L4	L5	L6
Project Management	14,555	13,107	12,302	11,234	14,250	13,056
Real Estate	15,127	15,127	9,679	9,679	15,127	15,127
Engineering	20,325	17,491	15,858	13,623	19,699	17,850
Procurement	122,320	85,086	96,949	62,683	111,180	524,996
Construction	349,627	297,033	264,041	216,329	328,272	322,776
Stations & Operations	278	248	198	187	260	284
Risk	85,492	71,872	66,553	54,052	79,968	143,651
Interest	52,840	42,609	40,650	31,397	49,396	105,860
Overhead	42,592	35,042	32,631	25,780	39,862	72,686
Gross Investment Cost	703,157	577,615	538,860	424,964	658,015	1,216,286
Removals	0	0	0	0	0	0
Capital & MFA	703,157	577,615	538,860	424,964	658,015	1,216,286

Line & Station (OHSW) _Cash Flow ($K)

Option	2013	2014	2015	2016	2017	2018	Total
L1	5,689	91,422	299,205	301,123	5,716	0	703,155
L2	4,982	71,350	242,083	254,291	4,910	0	577,616
L3	4,468	71,220	229,118	229,733	4,320	0	538,859
L4	3,919	53,113	177,139	187,192	3,600	0	424,963
L5	5,545	85,234	279,190	282,646	5,400	0	658,015
L6	4,869	234,603	575,333	396,241	5,240	0	1,216,286

East - West Tie Expansion (OHSW)_LINES ($K)

Options	L1	L2	L3	L4	L5	L6
Project Management	9,545	8,406	7,786	6,966	9,301	8,410
Real Estate	15,127	15,127	9,679	9,679	15,127	15,127
Engineering	13,702	11,616	10,381	8,689	13,259	12,389
Procurement	102,354	72,055	82,087	52,599	93,308	72,462
Construction	332,488	284,999	252,141	207,458	313,488	287,058
Stations & Operations	0	0	0	0	0	0
Risk	77,682	66,101	60,598	49,441	72,880	66,564
Interest	46,600	37,934	35,844	27,639	43,677	38,330
Overhead	38,597	32,110	29,613	23,460	36,248	32,372
Gross Investment Cost	636,096	528,348	488,129	385,932	597,290	532,711
Removals	0	0	0	0	0	0
Capital & MFA	636,096	528,348	488,129	385,932	597,290	532,711

Line (OHSW) _Cash Flow ($K)

Option	2013	2014	2015	2016	2017	2018	Total
L1	3,767	76,526	271,377	279,171	5,254	0	636,095
L2	3,220	59,945	222,461	238,184	4,538	0	528,348
L3	2,842	59,505	208,351	213,462	3,968	0	488,128
L4	2,405	43,794	161,805	174,624	3,303	0	385,931
L5	3,656	71,391	254,250	263,016	4,977	0	597,290
L6	3,433	60,831	223,998	239,864	4,586	0	532,712

East - West Tie Expansion (OHSW) _ Station ($K)

Options	L1	L2	L3	L4	L5	L6
Project Management	5,010	4,701	4,516	4,268	4,949	4,646
Real Estate	0	0	0	0	0	0
Engineering	6,623	5,875	5,477	4,934	6,440	5,461
Procurement	19,966	13,031	14,862	10,084	17,872	452,534
Construction	17,139	12,034	11,900	8,871	14,784	35,718
Stations & Operations	278	248	198	187	260	284
Risk	7,810	5,771	5,955	4,611	7,088	77,087
Interest	6,240	4,675	4,806	3,758	5,719	67,530
Overhead	3,995	2,932	3,018	2,320	3,614	40,314
Gross Investment Cost	67,061	49,267	50,731	39,032	60,725	683,575
Removals	0	0	0	0	0	0
Capital & MFA	67,061	49,267	50,731	39,032	60,725	683,575

Station (OHSW) _Cash Flow ($K)

Option	2013	2014	2015	2016	2017	2018	Total
L1	1,922	14,896	27,828	21,952	462	0	67,060
L2	1,762	11,405	19,622	16,107	372	0	49,268
L3	1,626	11,715	20,767	16,271	352	0	50,731
L4	1,514	9,319	15,334	12,568	297	0	39,032
L5	1,889	13,843	24,940	19,630	423	0	60,725
L6	1,436	173,772	351,335	156,377	654	0	683,574

East - West Tie Expansion (OPGW) _ Line & Station ($K)

Options	L1	L2	L3	L4	L5	L6
Project Management	14,489	13,032	12,223	11,142	14,195	13,078
Real Estate	15,127	15,127	9,679	9,679	15,127	15,127
Engineering	21,086	18,108	16,347	14,052	20,420	18,187
Procurement	123,146	86,265	98,259	63,432	111,863	513,092
Construction	364,272	310,000	275,360	226,156	341,580	334,204
Stations & Operations	276	242	211	174	260	252
Risk	88,166	74,322	68,703	55,907	82,345	143,630
Interest	54,224	43,859	41,760	32,283	50,637	105,630
Overhead	43,912	36,242	33,695	26,673	41,056	72,674
Gross Investment Cost	724,698	597,197	556,237	439,498	677,483	1,215,874
Removals	0	0	0	0	0	0
Capital & MFA	724,698	597,197	556,237	439,498	677,483	1,215,874

Line & Station (OPGW) _Cash Flow ($K)

Option	2013	2014	2015	2016	2017	2018	Total
L1	5,815	92,986	307,838	312,115	5,944	0	724,698
L2	5,039	72,745	250,078	264,224	5,110	0	597,196
L3	4,499	72,460	236,275	238,508	4,495	0	556,237
L4	3,913	53,943	183,094	194,796	3,750	0	439,496
L5	5,651	86,586	287,001	292,636	5,609	0	677,483
L6	4,894	233,486	574,502	397,698	5,294	0	1,215,874

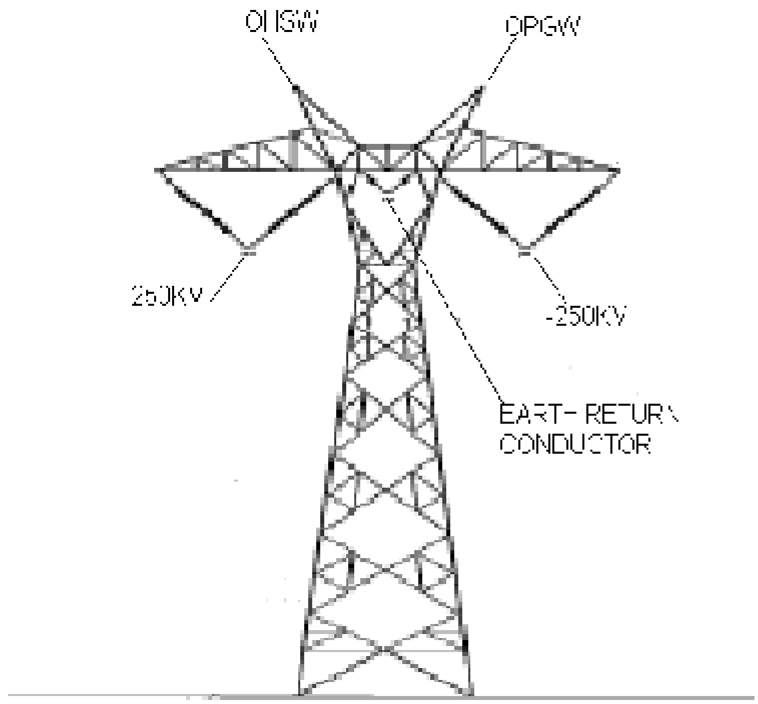
Any change in the scope of work, as defined in this proposal, may result in a change to the project costs and the project schedule. All scope changes to this project must be in writing to E&CS, which will advise of any cost and schedule impacts. No scope changes will be implemented until written approval has been received from Asset Management accepting new cost and schedule impacts.

J. Appendix A

SNC•LAVALIN T&D

Study Estimates
HONI East-West Tie Expansion

APPENDIX A



TYPICAL ARRANGEMENT OF A ±250KV HVDC TOWER