Appendix J

Induced Voltage Study

Report on

Wolfe Island Wind Project
Pipeline Induced Voltage Study

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IMPORTANT NOTICE

1. INTRODUCTION

Canadian Renewable Energy Corporation (CREC) is developing a 198 MW wind farm on Wolfe Island, which is in Lake Ontario some seven kilometres from Kingston. The wind farm's 230 kV substation is connected by a combination of underground and submarine cables to Hydro One's Gardiner Transformer Station on the mainland.

As part of its application to the Ontario Energy Board for a Leave to Construct for the 230 kV transmission line, CREC has requested AMEC Americas Limited to carry out an induced voltage study. The purpose of the study is to determine the effect of the underground 230 kV cable on water pipelines lines in its vicinity in terms of induced voltage. The main objective is to determine if induced voltages are within safe limits for personnel in contact with the pipelines or their accessories. The study concluded that the induced voltage is well within safe limits, and therefore no mitigative measures are needed to reduce the induced voltages to safe limits.

AMEC has recently completed studies similar to the Wolfe Island Wind Project Induced Voltage Study. These include:

Determination of voltages induced in an 8 kV distribution line by a 27.6 kV line for a wind farm development in Ontario
Determination of voltages induced in eight steel pipelines ranging in diameter from 14” to 60” running in parallel with 34.5 kV, 72 kV, and 260 kV lines for up to 25 km for an oil sands development in Alberta

This report covers various aspects of the induced voltage study. The report contains six sections including this introduction. The other sections contain the following:

Section 2 A description of the physical arrangement of the electrical system and pipeline components relevant to the study and their main characteristics

Section 3 Study methodology

Section 4 Study results

Section 5 Conclusions

Section 6 List of additional documentation supporting the study

Figures appear at the end of the relevant section. The report also has an appendix providing site drawings and a single line diagram of the complete wind farm electrical system which assist in describing the physical facilities to which the induced voltage study applies.

2. PHYSICAL DESCRIPTION

Pipeline induced disturbances are essentially induced voltages on the pipeline metal. They are caused by the power line operating voltage and currents. Some of these voltages are induced when the pipeline is operating under normal steady state conditions, while other voltages occur only during short circuits on the transmission line. Both overhead and underground power lines can induce voltages on nearby metallic pipelines. A safety concern for a buried pipeline would be electrical shocks to personnel who are in contact with above ground metal accessories connected to underground sections of the pipeline.

The magnitude of voltages induced in a pipeline by an electrical transmission line depends on a number of factors including:

- Distance between the power line and pipeline
- Length of pipeline running in parallel to the power line
- Whether pipeline is above ground or buried and its depth
- Whether power line is above ground or buried and its depth
- Location and type of grounding of buried electrical cable shield
- Pipe characteristic (wall thickness, resistivity, permeability, coating resistance)
- Soil resistivity
- Voltage and current (steady state or fault) flowing in power line
- Power line characteristic (sky wire, tower grounding resistance)

A description of these factors follows.

2.1 ARRANGEMENT

The electrical single line diagram for the wind farm and connection to the Hydro One grid is given in the Appendix. A 34.5 kV collector system will deliver the energy from the eighty six 2.3 MW wind turbine generators to a substation on the island where the voltage will be stepped up to 230 kV. From there the energy will be transmitted via a 230 kV transmission line to Hydro One’s Gardiner Transformer Station in Kingston. The 230 kV line consists of 0.8 km of underground cable on Wolfe Island, 7.8 km submarine cable crossing to the mainland and 3.9 km underground cable from the north shore of Lake Ontario to Gardiner TS.

Site plans showing the routing of power lines and pipelines are also given in the Appendix. The proposed route for the transmission line is to come ashore on the west side of Sand Bay in Kingston approximately 500 m west of Sunnyacres Road on Invista’s property. The line will then continue north on Invista’s property, then west along the southern boundary of the DuPont property (approximately 425 m south of Front Road) to Sunnyacres Road. From there the underground cable will run north parallel to Sunnyacres Road to Front Road. It will then cross underneath Front Road and continue north on Correctional Services Canada land to Bath Rd., where it crosses underneath Bath Road and continues north on several privately owned properties to Gardiner TS.

There are three metallic water pipelines in the vicinity of the 230 kV underground cable. A 900mm Trunk Water line parallels the 230 kV underground cable along Sunnyacres Road to Front Road. A 150 mm Local Water line also parallels the 900 mm Trunk Water line up towards Front Road where it turns and continues west. A 300 mm Local Water line runs parallel to the cable for a short distance between Bath Road and the CN rail crossing. Other pipelines in the area are non-metallic, and hence are not relevant to the induced voltage study.

Two overhead distribution circuits run from Nylon Drive to Sunnyacres Road and then northward along Sunnyacres Road to Front Road. At Front Road it then continues northward on land owned by Correctional Services Canada until reaching Bath Road. One circuit is 44 kV and the other is 8.3 kV.

2.1.1 Pipelines South of Bath Road

Relative positions of the pipelines and power lines where they run in parallel are shown in Figure 2.1. The 150 mm Local Water pipeline is located 11.3 m to the west of the 44 kV overhead transmission line, and the 900 mm Trunk Water line is almost directly below the existing 44 kV line. The proposed 230 kV underground cable would be placed 25 m to the east of the 900 mm Trunk Water line. The approximate depths of the 150 mm Local Water line, 900 mm Trunk Water line, and 230 kV cable are 1.63 m, 1.95 m, and 1.17 m respectively.

The height above ground of the 44 kV distribution circuit is 10 m. The 8.3 kV distribution circuit has a negligible effect in terms of the induced voltage on the pipelines, and hence it is omitted from the study.

2.1.2 Pipeline North of Bath Road

Relative positions of the pipeline and power line where they run in parallel are shown in Figure 2.2. The 230 kV cable is located 8 m to the west of the 300 mm Local Water line. The depths of the 300 mm Local Water line and 230 kV cable are 1.63 m and 1.17 m respectively.

2.2 UNDERGROUND CABLE DETAILS

The proposed 230 kV underground cable is a single conductor 500 mm^2 245 kV TSLE type cable with the cross section shown in Figure 2.3. It weighs approximately 11.4 kg/m.

A typical trench detail for this type of cable is shown in Figure 2.4.

2.3 PIPELINE DETAILS

The specifications for the water lines considered in this study are summarized in Table 2.1.

Table 2.1: Pipeline Data

Pipe Name	Trunk Water	Local Water	Local Water
Diameter	900 mm	150 mm	300 mm
Wall Thickness	81 mm	38 mm	38 mm
Material	Hyprescon (concrete encased steel)	Cast Iron	Cast Iron
Product	Water	Water	Water
Pressure	<150 psi	<150 psi	<150 psi

2.4 GROUNDING SCHEME

The proposed grounding scheme for the 230 kV cable is as shown in Figure 2.5. The transmission line is grounded at Gardiner TS, the wind farm substation, and at the transition point between the underground and submarine cable.

The inside of the Hyprescon pipeline is lined with concrete and the outside of the pipe is comprised of cement-rich mortar. The steel in the pipe is completely enclosed by these materials.

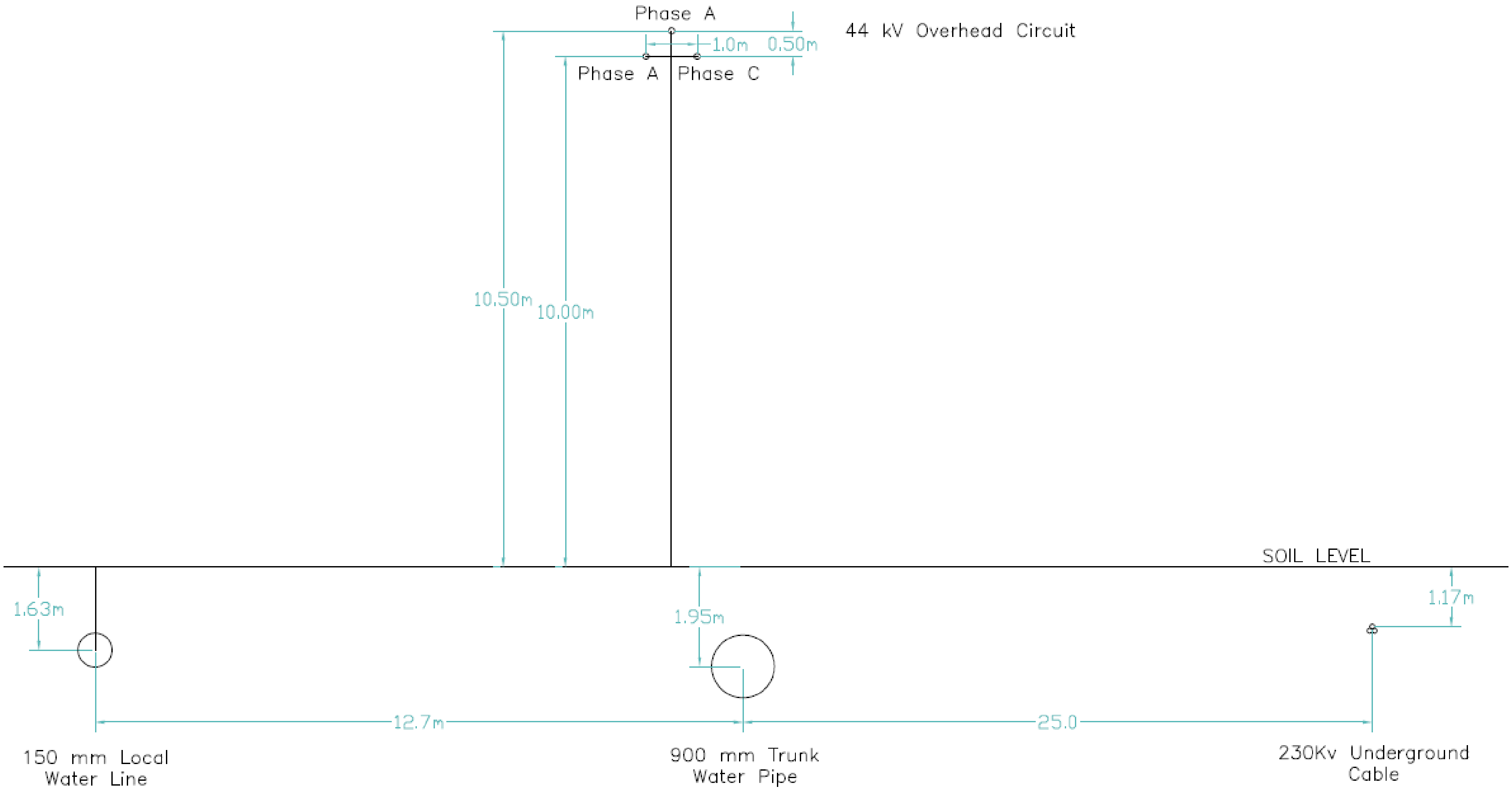

Figure 2.1: Cross Section of Proposed Cable and Pipelines

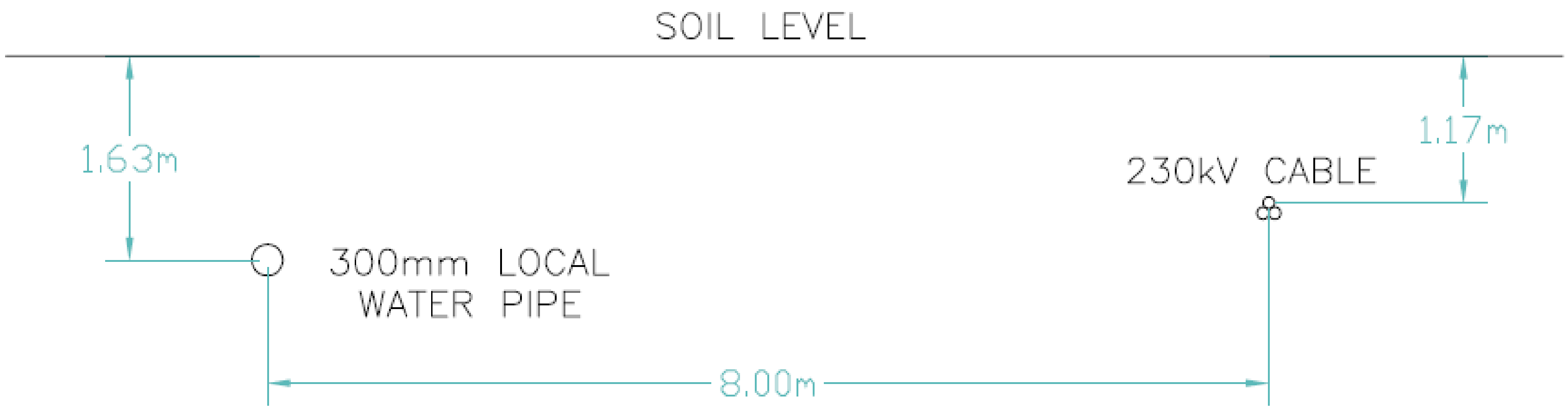

Figure 2.2: Cross Section of Proposed Cable and 300 mm Local Water Pipe

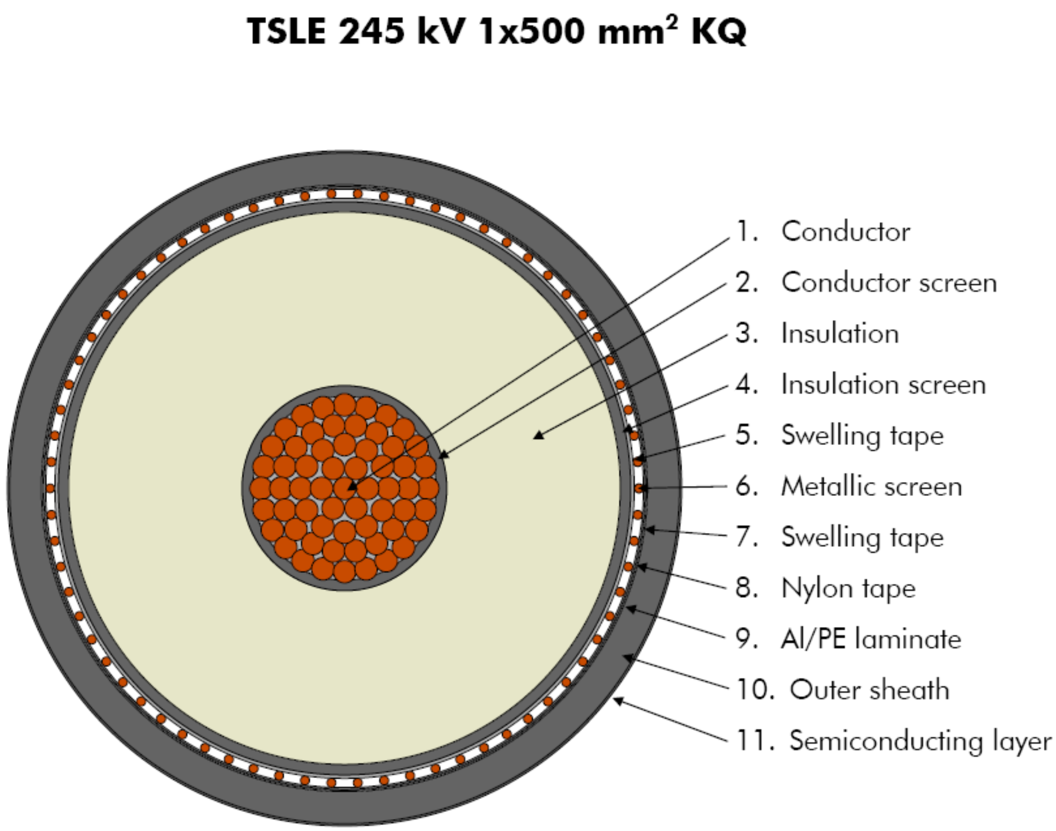

Figure 2.3: Underground Cable Cross Section

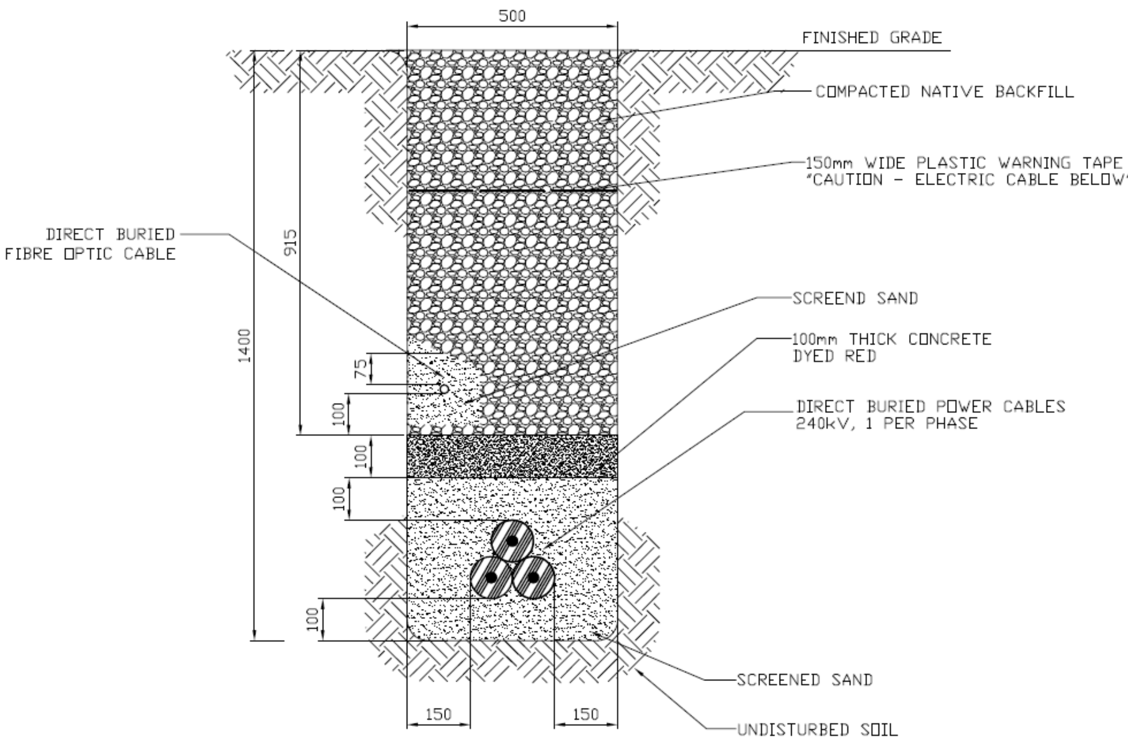

Figure 2.4: Typical Trench Detail for 230 kV Buried Cables

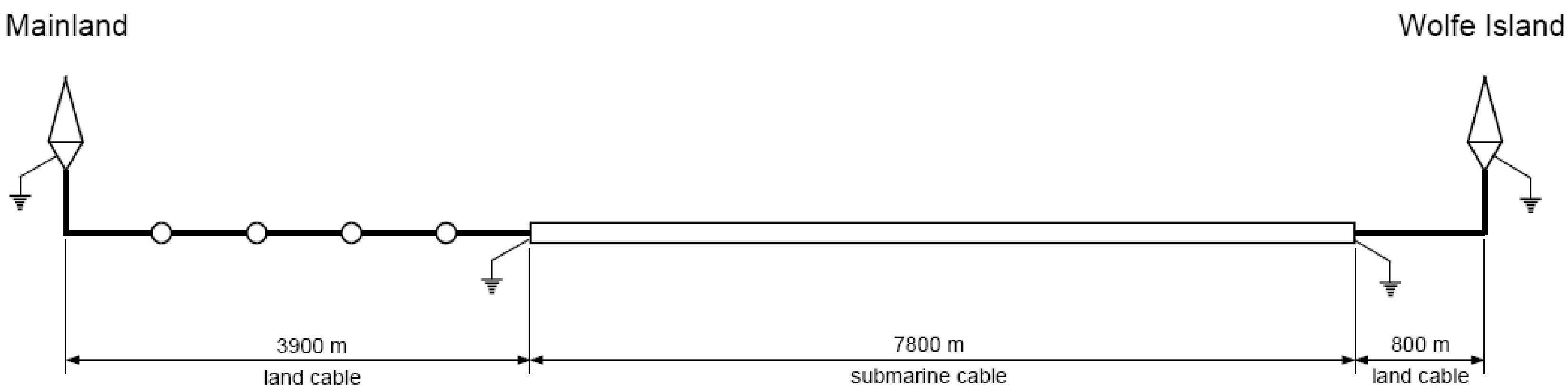

Figure 2.5: Grounding Scheme

3. METHODOLOGY

The CDEGS Software Package (Current Distribution, Electromagnetic Fields, Grounding and Soil Structure Analysis) was used to perform the calculations for the induced voltage study for the Wolfe Island Wind Farm. CDEGS is a set of integrated engineering software tools for analyzing power system grounding, electromagnetic fields, and electromagnetic interference. It computes conductor currents and electromagnetic fields generated by a network of energized conductors anywhere above or below ground for normal, fault, lightning, and transient conditions.

The circuits were modelled using the TRALIN and SPLITS modules. The TRALIN module computes line and cable constants (parameters) and performs induction analysis. It was used to calculate the power line parameters for the overhead and buried transmission lines, cables, and pipes. The SPLITS module calculates the detailed fault current distribution and performs EMI analysis. It was used to find AC voltage level on the pipeline due to the inductive interference between the transmission lines and pipelines.

3.1 PROCEDURE

The analysis is divided into two distinct cases (North and South of Bath Road). The first case examines the 900 mm Trunk Water and 150 mm Local Water pipelines and includes the effect of the existing 44kV overhead line. The second case simulates conditions with the 300 mm Local Water line, which is not affected by the overhead line.

In order to complete the induced voltage analysis, the proposed cable was divided into sections according to the presence of parallel underground pipelines. These sections are summarized in Figures 3.1 and 3.2.

3.2 ASSUMPTIONS

The following assumptions were used when modelling in TRALIN and SPLITS:

- Uniform soil resistivity of 100 ohm-meters (the true resistivity is unknown at this time). This assumption is based on typical values for this region.
- Conductor type for 44 kV line is ACSR-Pelican
- Ground impedance of Gardiner TS is 0.2 ohms
- Ground impedance at the transition point from underground to submarine cable is 0.2 ohms
- Load current for the 44 kV line is 500 A
- Load current for 230 kV cable is 500 A (based on the power output of the wind farm)
- The phase currents are assumed to be balanced
- Span length for 44 kV line is 25 m
- Cross section of the 44 kV line as per Figure 2.1
- 230 kV underground cable shield is connected at both ends to the grounding grid as per Figure 2.5

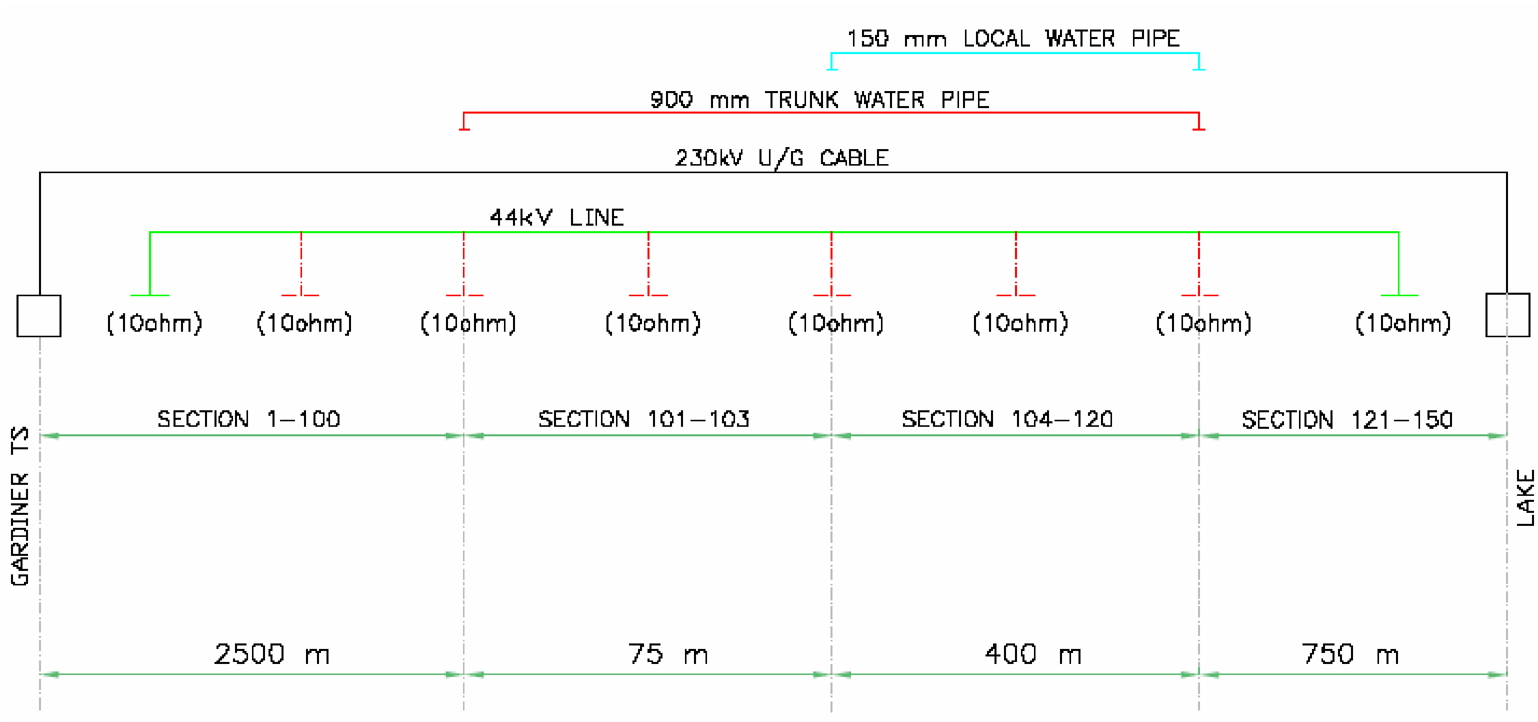

Figure 3.1: Cable Sections with 900 mm Trunk Water and 150 mm Local Water Pipelines

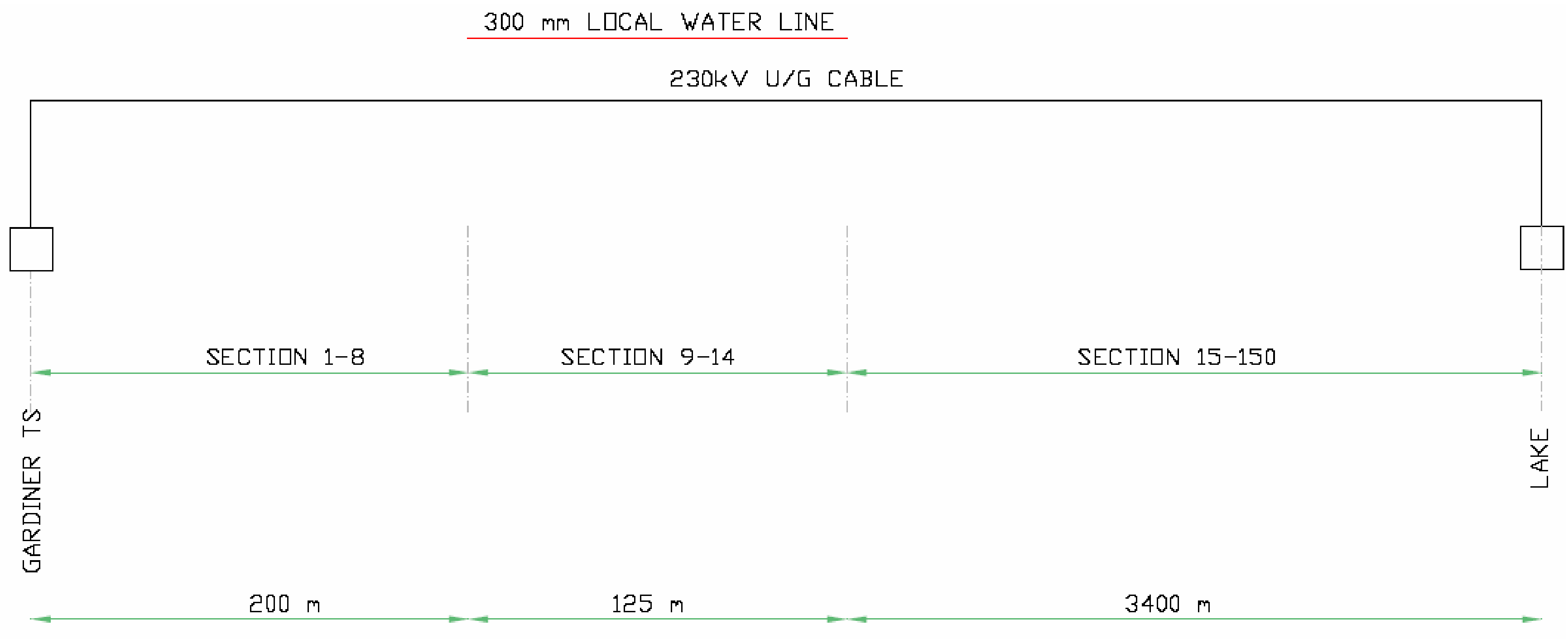

Figure 3.2: Cable Sections with 300 mm Local Water Pipeline

4. RESULTS

The results below were obtained using the CDEGS software, which provides graphs of the voltage induced in the pipelines. The two cases (north and south of Bath Road) are considered separately, and for each case a steady state and short circuit analysis are shown. The section numbers on the x-axis are as defined in Figures 3.1 and 3.2.

4.1 PIPELINES SOUTH OF BATH ROAD

4.1.1 Steady State Analysis

The induced steady state voltage for the 900 mm Trunk Water line and 150 mm Local Water line were studied with only the 44 kV overhead line energized, with only the 230 kV underground line energized, and with both lines energized. The results for the 900 mm Trunk Water pipeline are shown in Figures 4.1, 4.2 and 4.3, respectively. The respective results for the 150 mm Local Water pipeline are given in Figures 4.4, 4.5 and 4.6.

The induced voltage reaches a minimum at an intermediate point along the pipeline and a maximum at an end point. The graphs are not symmetrical because the pipeline does not run in parallel for the entire length of the transmission lines.

The maximum voltages are summarized in Table 4.1.

Table 4.1: Maximum Induced Voltage on Pipelines during Steady State Conditions

	Maximum Induced Voltage (V)	
	900 mm Trunk Water	**150 mm Local Water**
44 kV Line	1.8	2.1
230 kV Underground Cable	0.4	0.3
Combined Effect	1.9	2.4

The induced voltage from the 44 kV line is significantly higher than that of the 230 kV line due to varied dielectric (air versus soil) and the electric shielding (overhead versus shielded underground cable).

Based on CSA Standard C22.3 No. 6-M91 Section 3.2.3, the steady state induced pipeline voltage should be less than 15 V. The above calculated maximum induced voltages are well below the allowable limit.

4.1.2 Ground Fault Analysis

The induced voltages due to faults on the 900 mm Trunk Water line and 150 mm Local Water line were determined for a fault on the 230 kV underground cable. A ground fault current value of 10,000 A rms (symmetrical) was used in the calculations. This is 25% higher than the Hydro One value for the line-to-ground (symmetrical) fault current given in the Customer Impact Assessment, hence provides for future increases.

The ground fault of the 44 kV line was not analyzed because it is not part of the scope of the analysis, and simultaneous faults would not occur. It is possible that a fault on the 44 kV line would result in a higher induced voltage than one on the 230 kV line.

The worst case available 230 kV fault current at the Gardiner TS was used for all modelling locations.

The voltage induced in the 900 mm Trunk Water pipeline and the 150 mm Local Water pipe due to a fault on the 230 kV cable is shown in Figures 4.7 and 4.8 respectively. The results are summarized in Table 4.2.

Table 4.2: Maximum Induced Voltage on Pipelines during Fault Conditions

	Maximum Induced Voltage (V)	
	900 mm Trunk Water	**150 mm Local Water**
230 kV Underground Cable	45	33

Based on Ontario Electrical Safety Code Table 52, the maximum tolerable touch voltage for moist soil (100 ohm-metre resistivity) is 188 V for fault duration of 0.5 s. The above calculated maximum induced voltages are well below the allowable limit. The maximum time to interrupt the fault will be less than 0.5 seconds.

4.1.3 Sensitivity Analysis

The change in voltages induced in the pipelines due to changes in soil resistivity and distance that the pipeline is parallel to the 230 kV power cable were determined.

4.1.4 Change in Soil Resistivity

The base case soil resistivity used for the above calculations is 100 ohm-meters. Changes in induced voltage for soil resistivities of 10 ohm-meters and 1,000 ohm-meters were calculated. The results are given in Table 4.3.

Table 4.3: Sensitivity to Changes in Soil Resistivity

	Change in Voltage (V)		
Soil Resistivity (ohm-meters)	10	100	1,000
Steady State			
900 mm Trunk Water Pipeline	0.01	--	0.03
150 mm Local Water Pipeline	0.07	--	0.03
Ground Fault			
900 mm Trunk Water Pipeline	2.0	--	7.4
150 mm Local Water Pipeline	12.6	--	5.9

The results show that soil resistivity has little influence on induced pipeline potentials.

The steady state induced voltages are still well below the 15 V limit specified in CSA Standard C22.3 No. 6-M91 Section 3.2.2 regardless of soil resistivity. The ground fault induced voltages are well below the maximum touch voltage of 166 V for a soil resistivity of 10 ohm-meters and 405 V for a soil resistivity of 1,000 ohm-meters specified in Ontario Electrical Safety Code Table 52.

It should be noted that the range of soil resistivity of 10 to 1,000 ohm-meters is extremely wide. The actual soil resisitivity, which will be measured at a later date for use in grounding design calculations, will in all likelihood be within this range.

4.1.5 Change in Parallel Distance

The voltage induced in a pipeline increases as the distance that the pipeline is in parallel to a powerline increases. The highest voltage will occur if the pipeline parallels the entire length of the powerline. The worst case situation (ie maximum length in parallel of 3,725 m) was modelled for the 900 mm Trunk Water and 150 mm Local Water pipelines for both steady state and ground fault conditions.

The results for the steady state case are given in Figures 4.9 and 4.10. They show that even if each of the water pipelines was in parallel with the 230 kV cable for its entire length south of Bath Road the induced voltage under steady state conditions is much less than the 15 V limit specified in CSA Standard C22.3 No. 6-M91 Section 3.2.2.

The results for the ground fault case are given in Figures 4.11 and 4.12. The graphs show that if either pipeline was parallel to the entire 3,725 m length of the 230 kV cable, the induced voltage would exceed the maximum tolerable touch voltage for moist soil (100 ohm-metre resistivity) of 188 V based on Ontario Electrical Safety Code Table 52. To stay within the 188 V maximum tolerable touch voltage, the maximum distance in parallel to the 230 kV cable is 3,050 m for the 900 mm Trunk Water pipeline and 3,475 m for the 150 mm Local water pipeline is. These distances compare to the likely parallel lengths of 475 m for the 900 mm Trunk Water line and 400 m for the 150 mm Local Water line.

4.2 PIPELINE NORTH OF BATH ROAD

4.2.1 Steady State Analysis

The induced steady state voltage for the 300mm Local Water line is studied with only the 230 kV underground cable energized. The results are given in Figure 4.13.

The maximum steady state induced voltage on the 300 mm Local Water line due to the 230 kV underground cable is 0.004 V. Since the pipeline is only in parallel with the cable for approximately 125 m, the induced voltage is essentially negligible.

Based on CSA Standard C22.3 No. 6-M91 Section 3.2.3, the steady state induced pipeline voltage should be less than 15 V. The above calculated maximum induced voltage is well below the allowable limit.

4.2.2 Ground Fault Analysis

The induced voltages on the 300 mm Local Water line were determined for a ground fault on the 230 kV underground cable. As for the pipelines south of Bath Road (see section 4.1.2) a fault current of 10,000 A at the Gardiner TS was assumed.
The results are shown in Figure 4.14. The maximum induced voltage on the 300 mm Local Water line due to a ground fault on the 230 kV underground cable is 0.7 V.

Based on Ontario Electrical Safety Code Table 52, the maximum tolerable touch voltage for moist soil (100 ohm-metre resistivity) is 188 V for fault duration of 0.5 s. The above calculated maximum induced voltage is well below the allowable limit.

4.2.3 Sensitivity Analysis

The induced voltages on the pipeline north of Bath Road under steady state and fault conditions determined in sections 4.2.1 and 4.2.2 are much lower than the induced voltages on the pipelines south of Bath Road. Hence conclusions resulting from the sensitivity analysis presented in section 4.1.3 for the pipelines south of Bath Road are relevant to the 300 mm Local Water pipeline north of Bath Road.

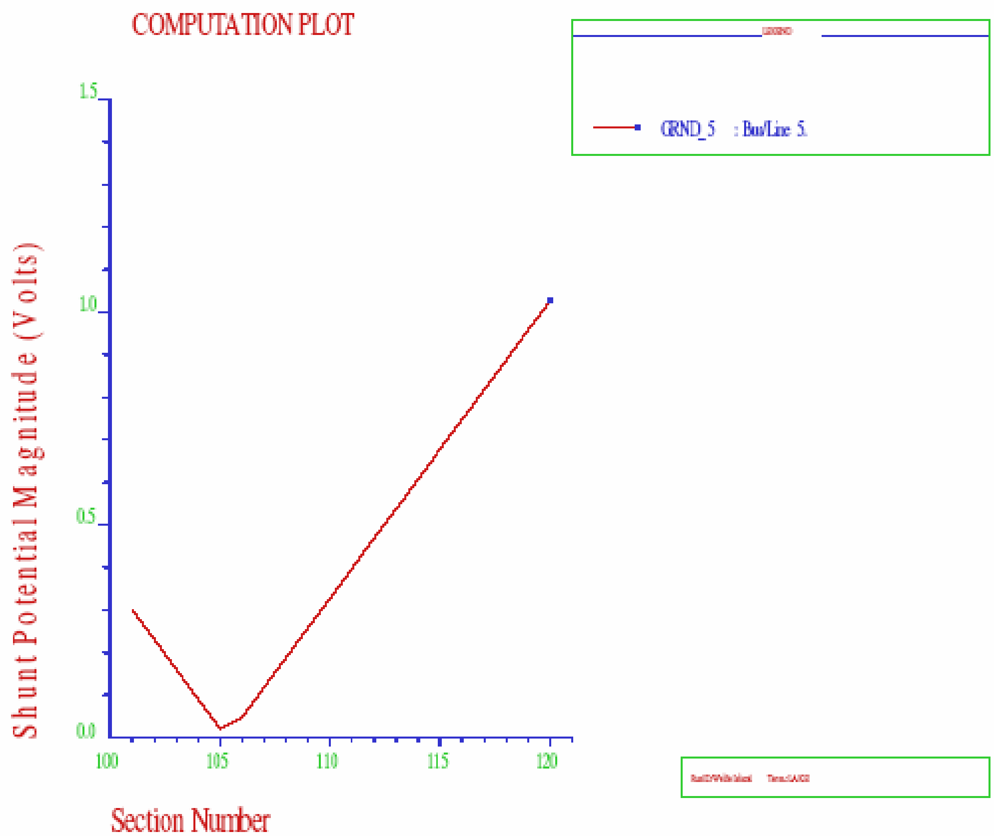

Figure 4.1: Induced Steady State Voltage for 900 mm Trunk Water Pipeline due to the 44 kV Line

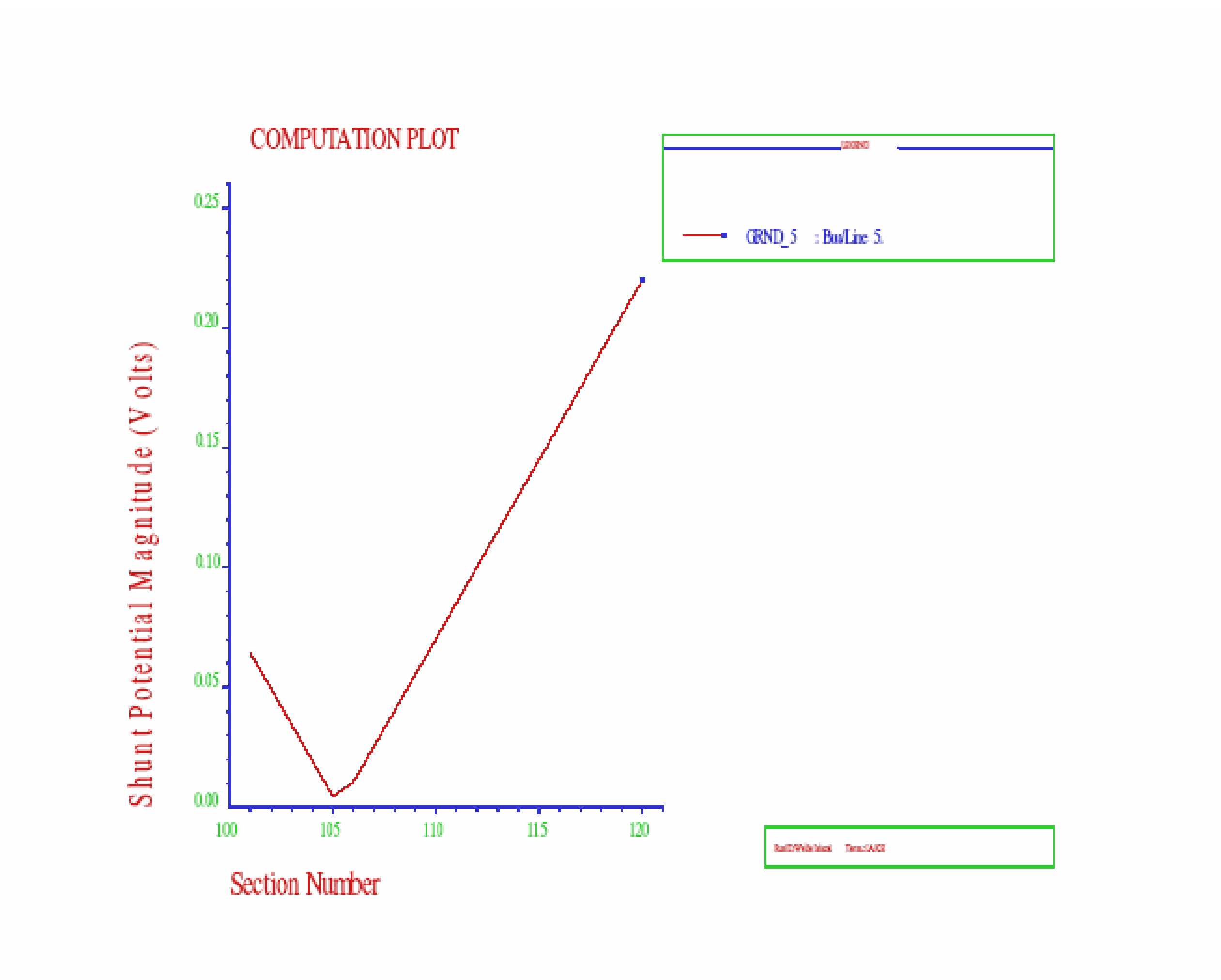

Figure 4.2: Induced Steady State Voltage for 900 mm Trunk Water Pipeline due to the 230 kV Underground Cable

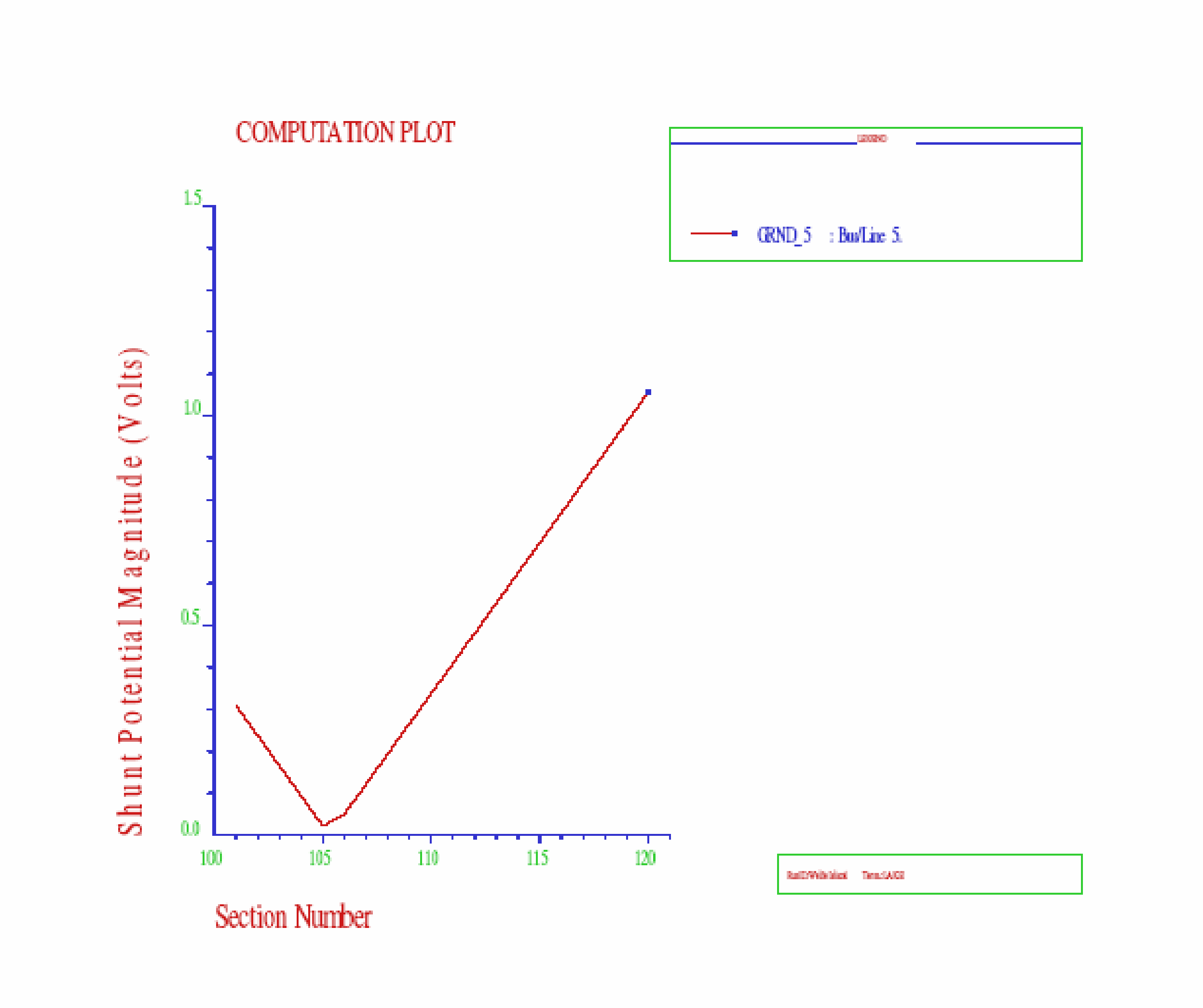

Figure 4.3: Induced Steady State Voltage for 900 mm Trunk Water Pipeline due to both the 230 kV Underground Cable and 44 kV Line

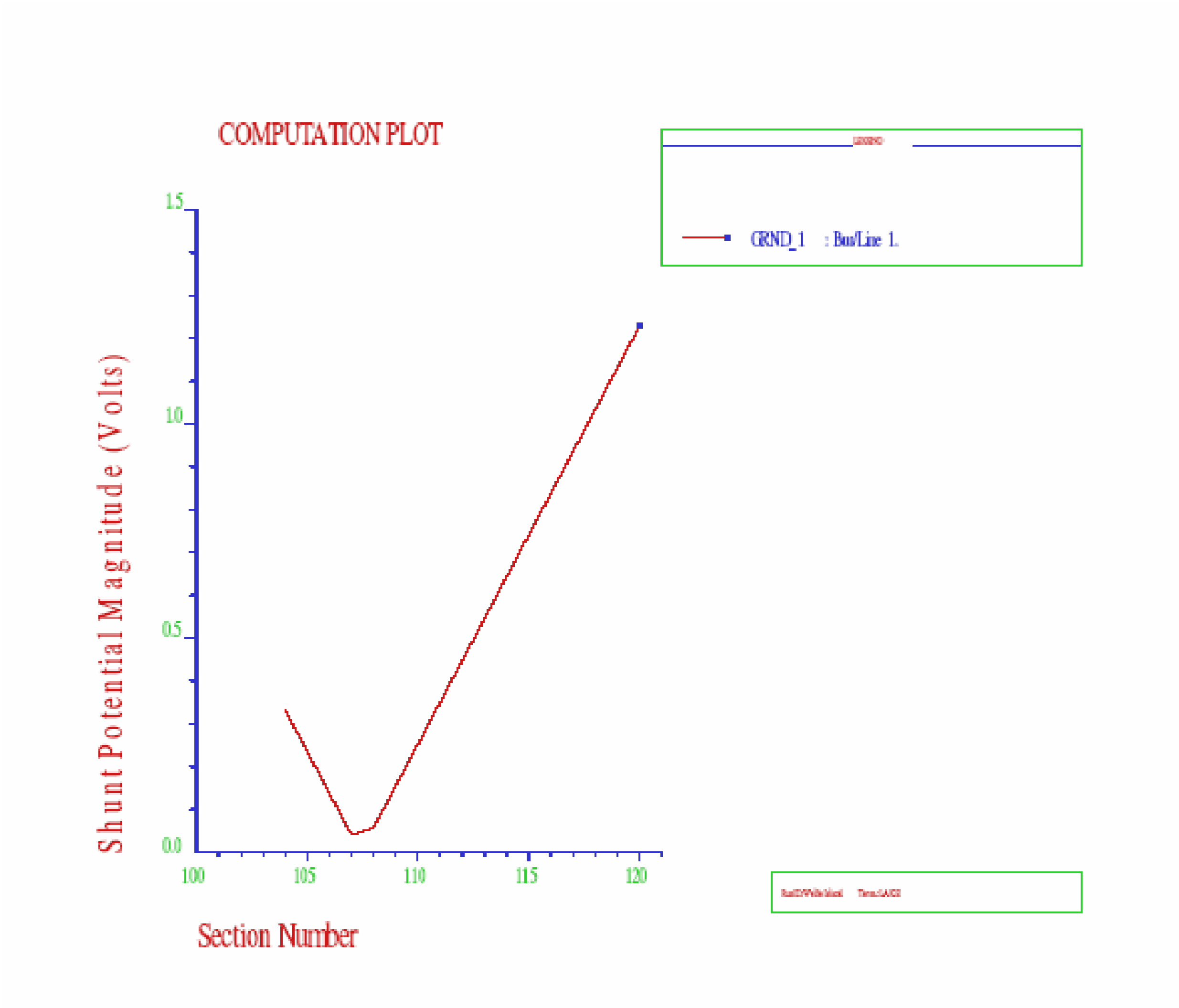

Figure 4.4: Induced Steady State Voltage for 150 mm Local Water Pipeline due to the 44 kV Line

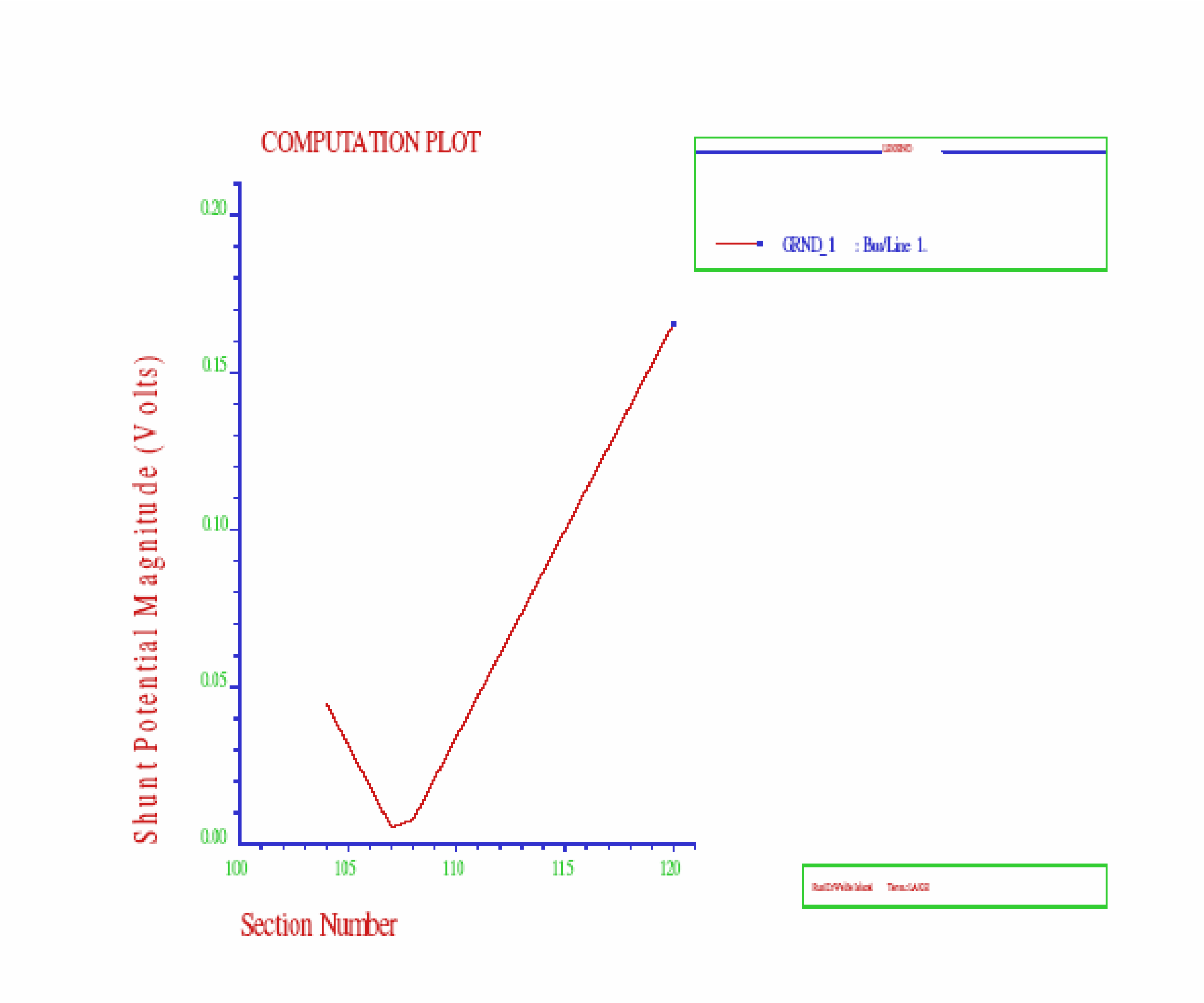

Figure 4.5: Induced Steady State Voltage for 150 mm Local Water Pipeline due to the 230 kV Underground Cable

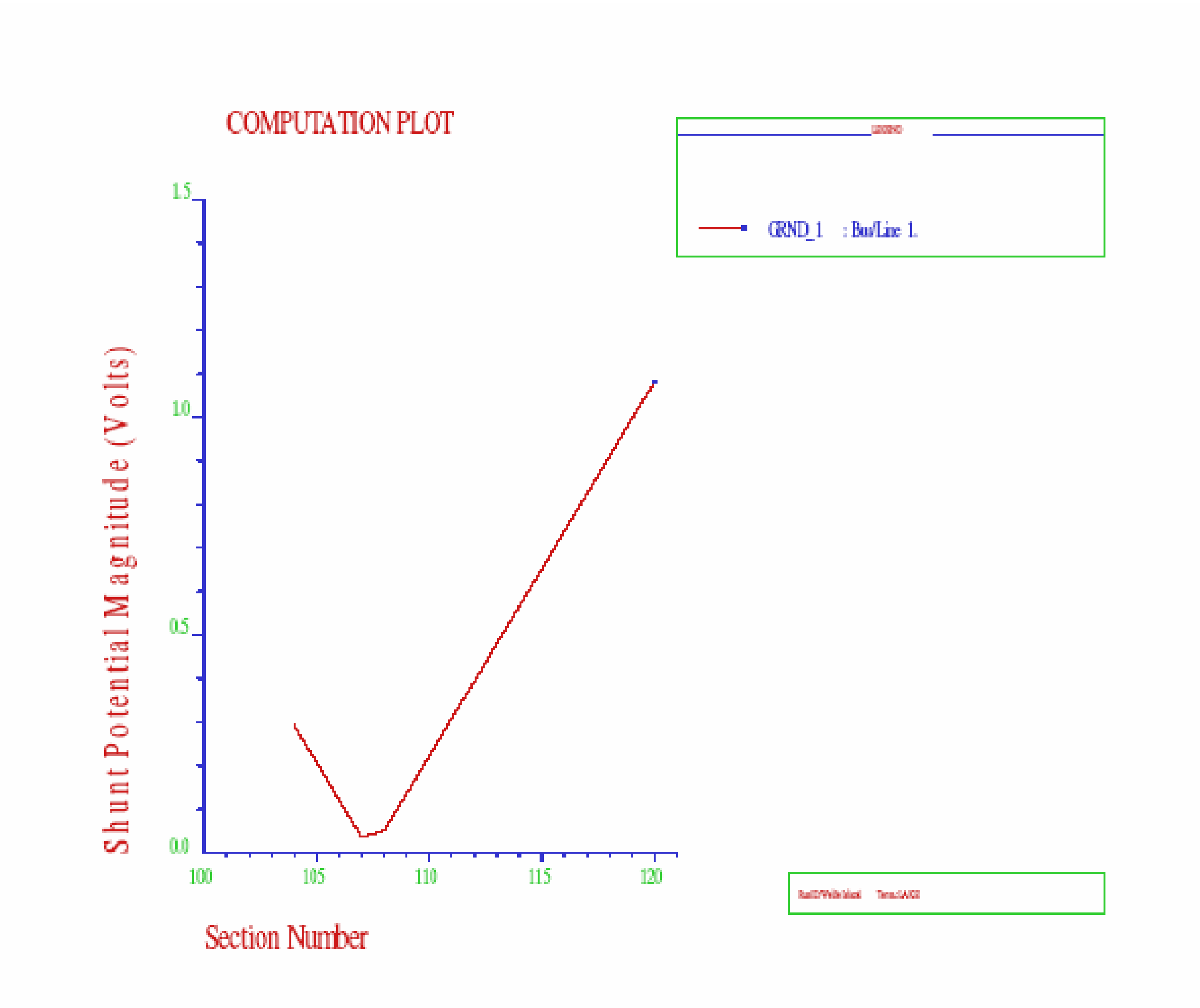

Figure 4.6: Induced Steady State Voltage for 150 mm Local Water Pipeline due to the 230 kV Underground Cable and 44 kV Line

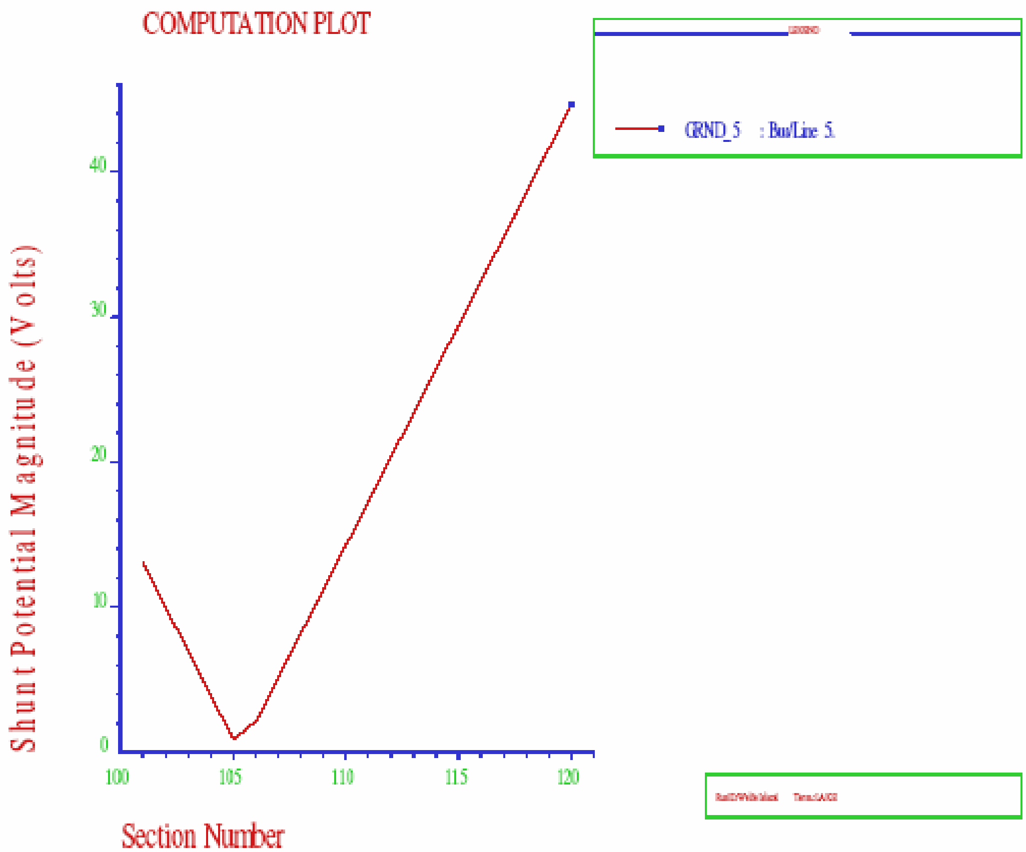

Figure 4.7: Induced Voltage on the 900 mm Trunk Water Pipeline due to a fault on the 230 kV Underground Cable

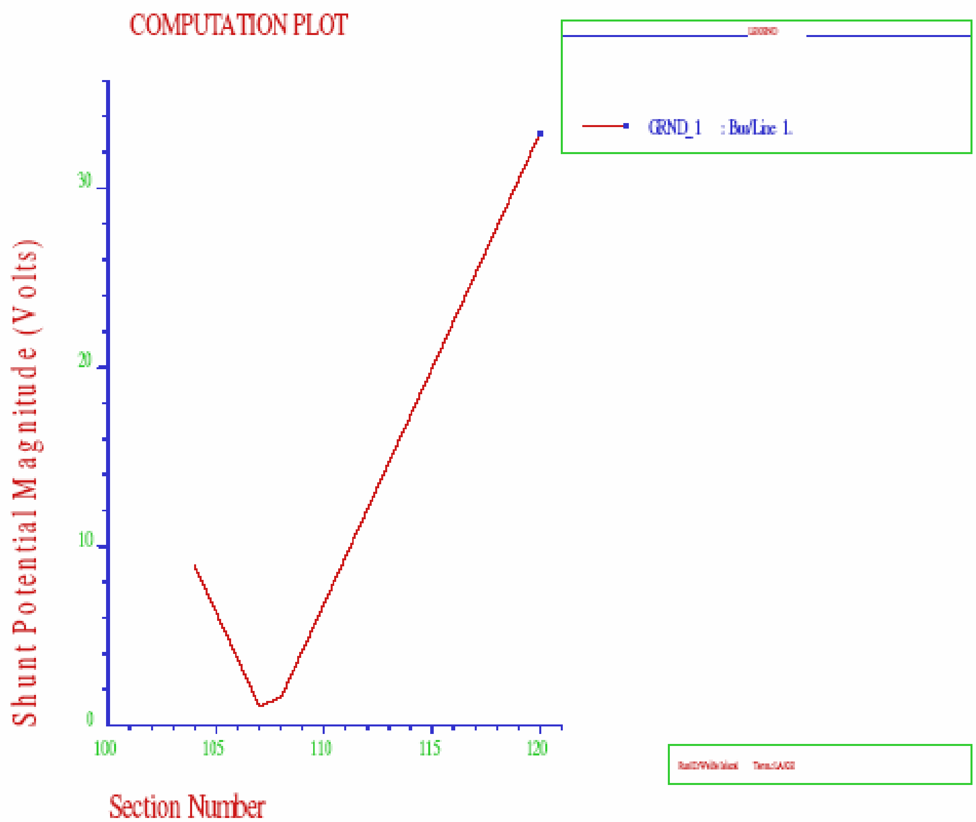

Figure 4.8: Induced Voltage on the 150 mm Local Water Pipe due to a fault on the 230 kV Underground Cable

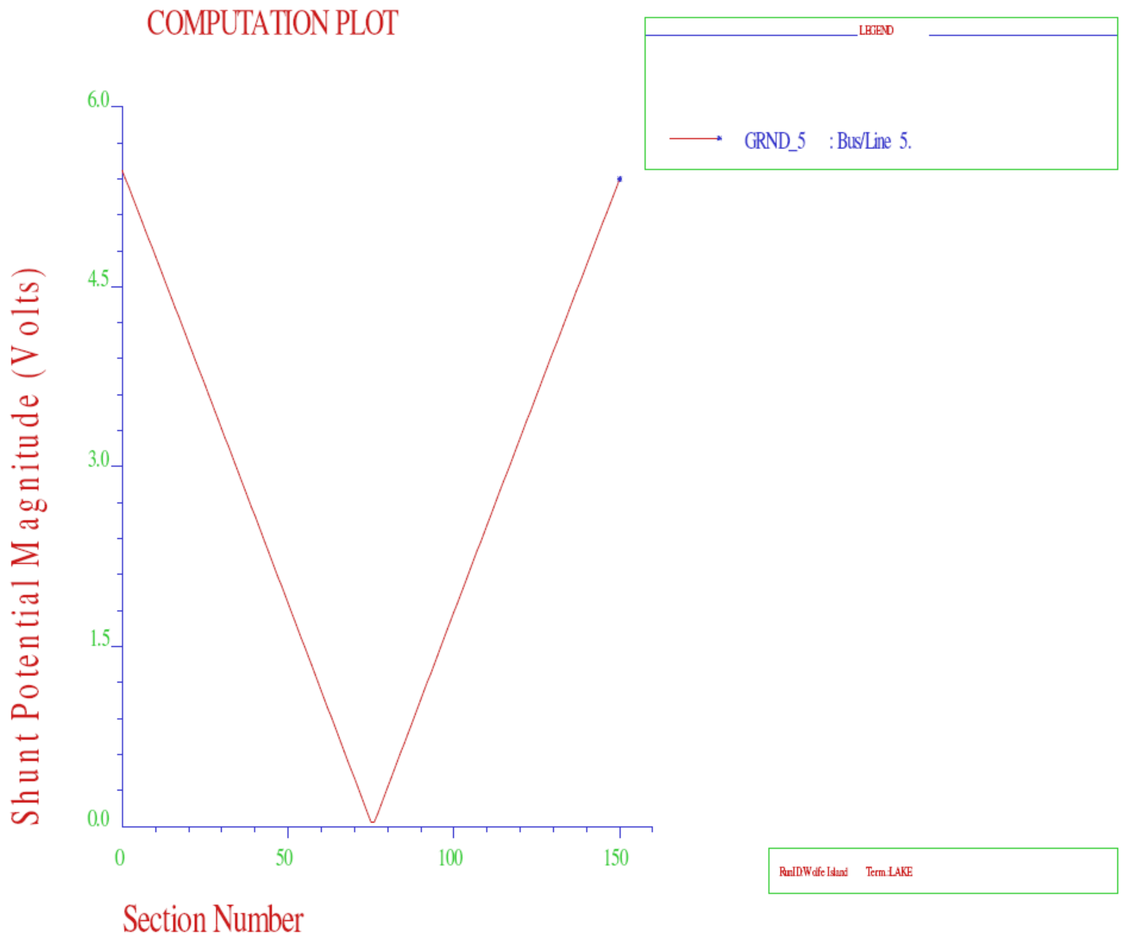

Figure 4.9: Induced Steady State Voltage for 900 mm Trunk Water Pipeline with a Maximum Parallel Length of 3,725 m

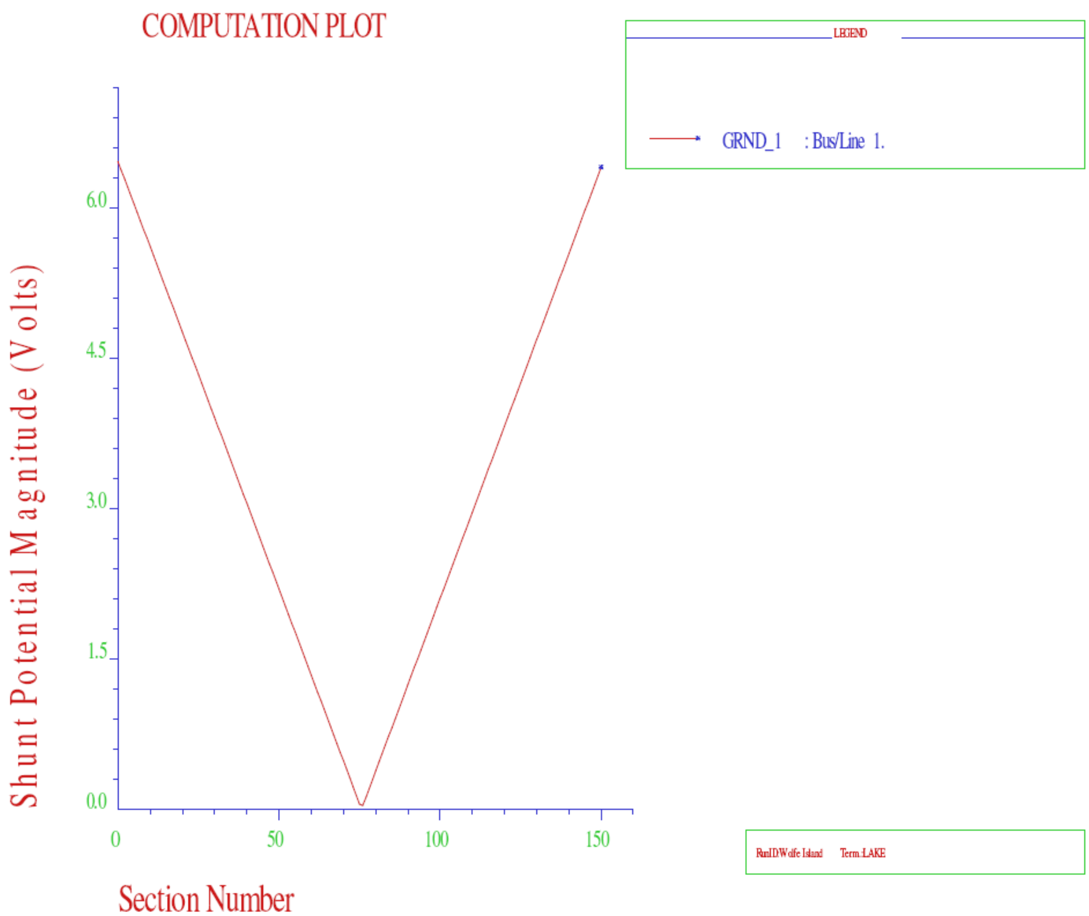

Figure 4.10: Induced Steady State Voltage for 150 mm Local Water Pipeline with a Maximum Parallel Length of 3,725 m

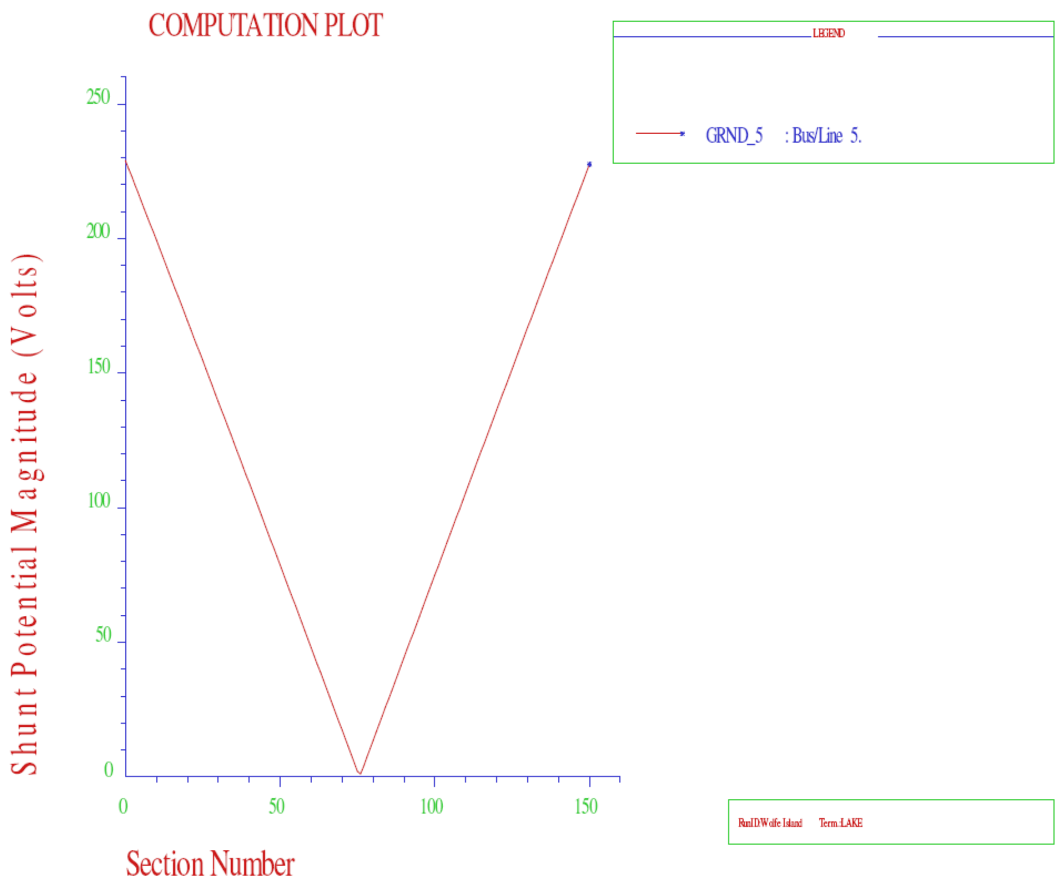

Figure 4.11: Induced Voltage on the 900 mm Trunk Water Pipeline due to a fault on the 230 kV Underground Cable with a Maximum Parallel Length of 3,725 m

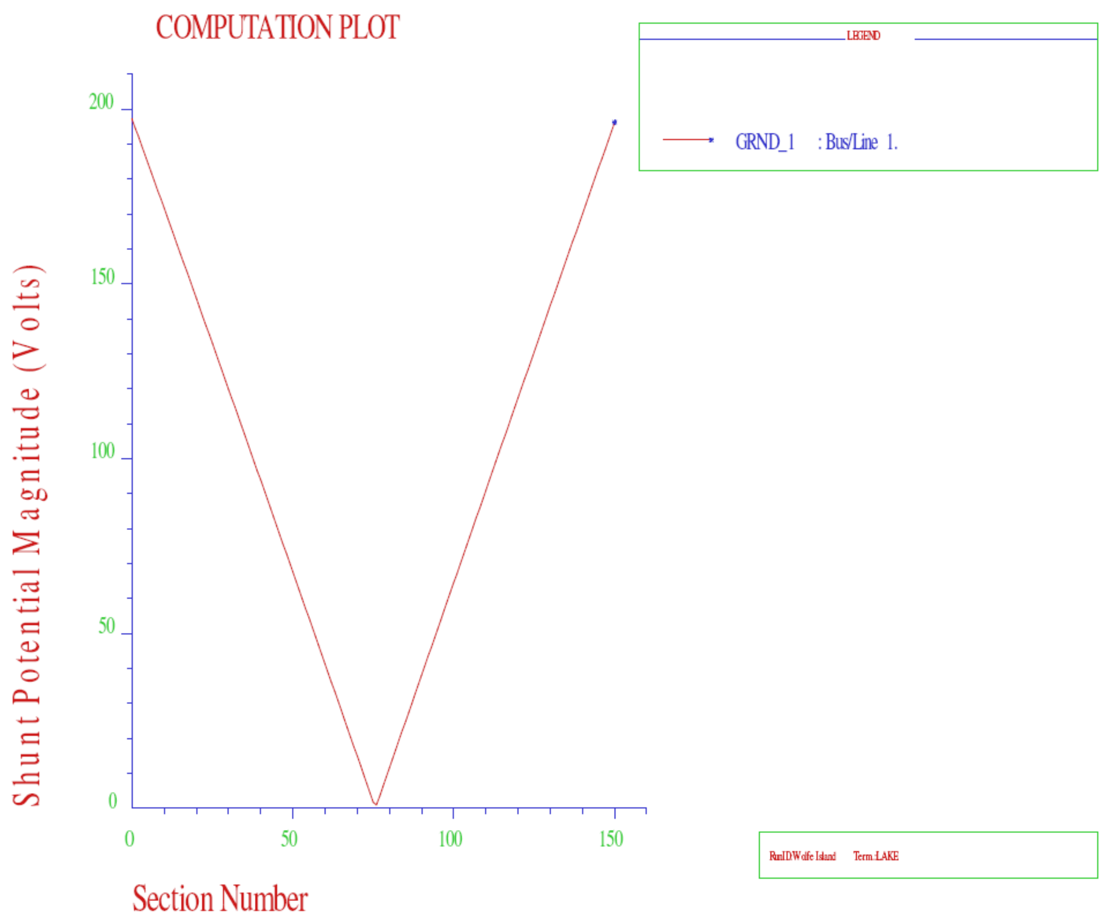

Figure 4.12: Induced Voltage on the 150 mm Local Water Pipe due to a fault on the 230 kV Underground Cable with a Maximum Parallel Length of 3,725 m

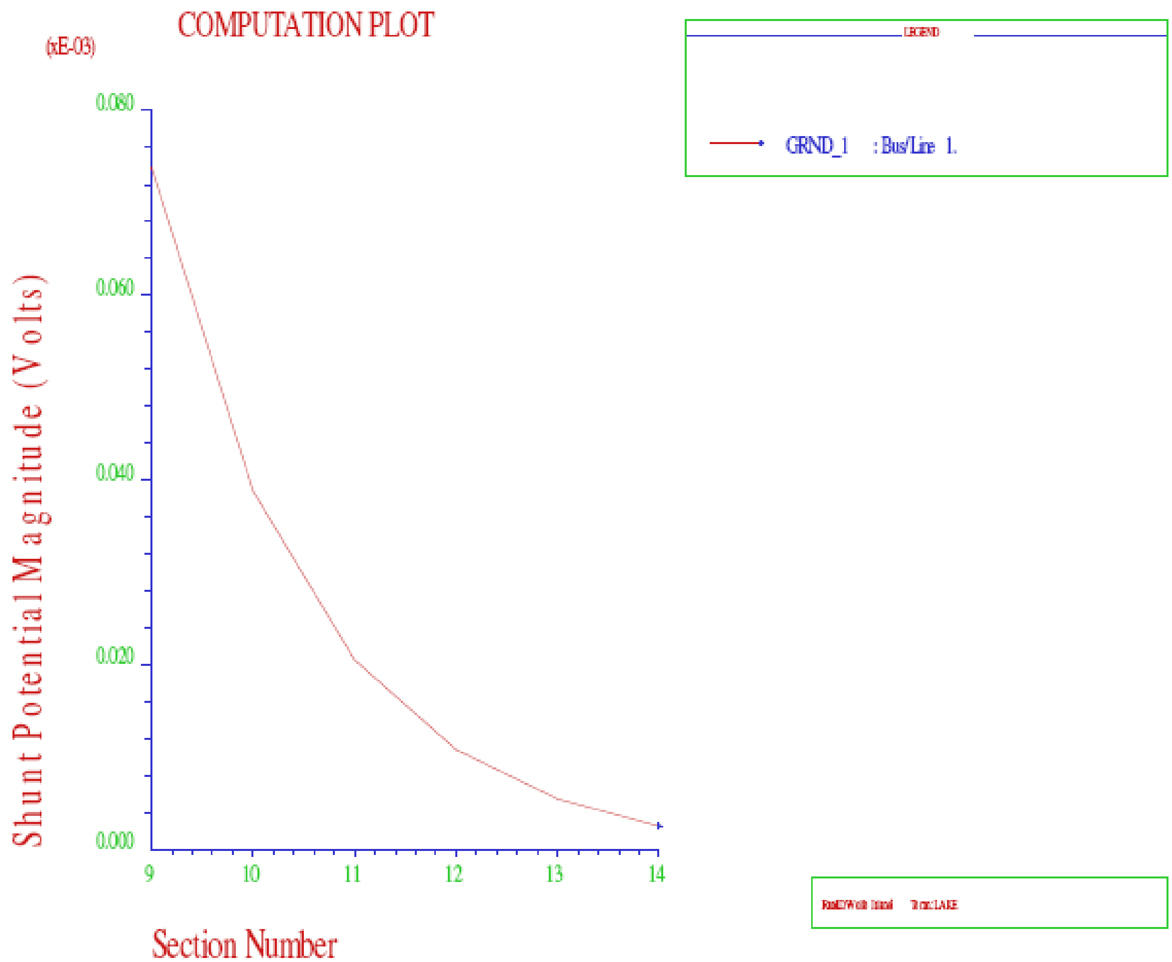

Figure 4.13: Induced Steady State Voltage for 300 mm Local Water Pipeline due to 230 kV Underground Cable

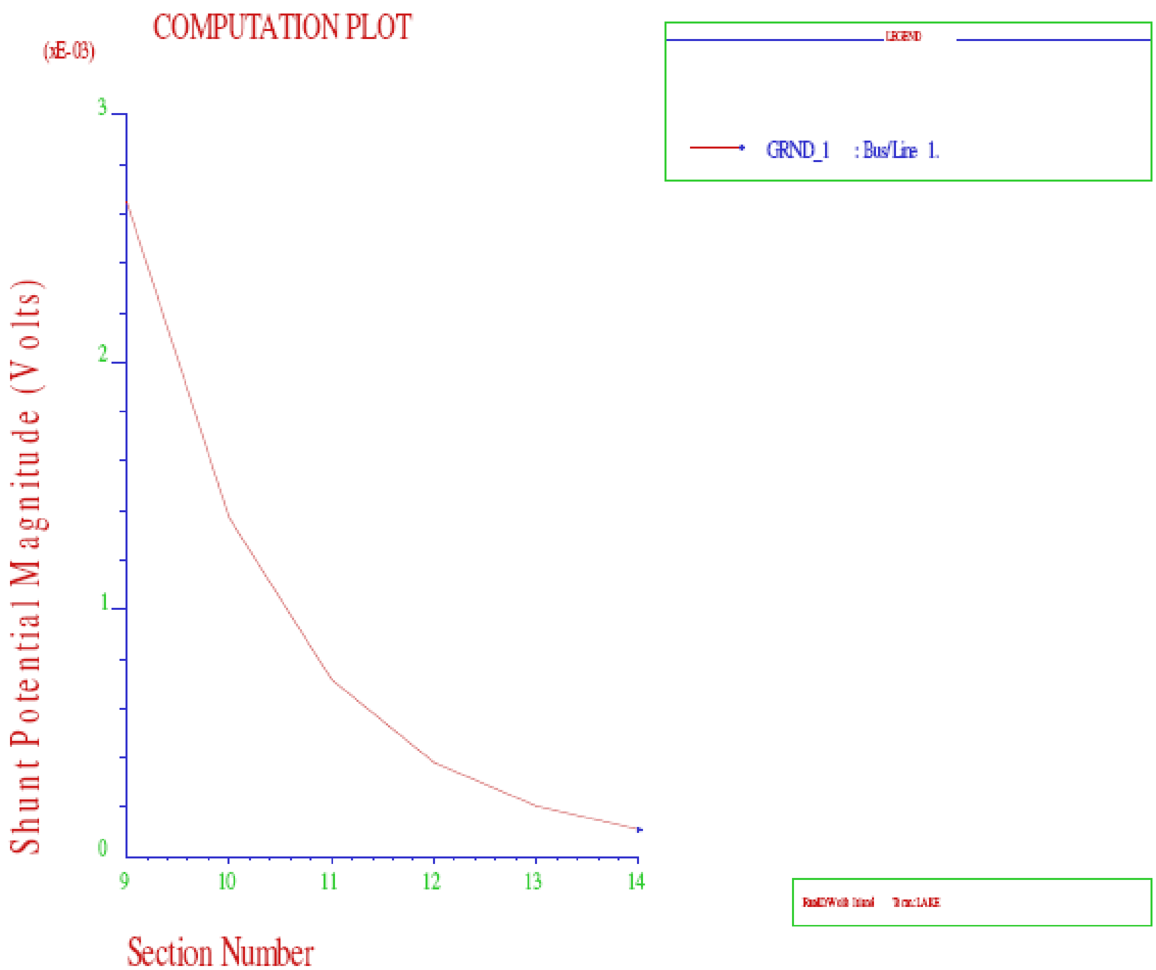

Figure 4.14: Induced Voltage on the 300 mm Local Water Pipe due to a fault on the 230 kV Underground Cable

5. CONCLUSIONS

This study was carried out to determine the induced voltages on three water pipelines in close proximity to the proposed 230 kV underground transmission cable for the Wolfe Island Wind Project. The main observations made from the analysis follow.

In both the steady state and ground fault scenarios south of Bath Road, the induced voltage for the 44 kV line is greater than that for the 230 kV line due to proximity and line construction. The induced voltage due to ground faults for the pipelines south of Bath Road is much greater than the induced voltage for the pipeline north of Bath Road, as the latter is parallel to the transmission line for a much shorter distance.

Based on the assumptions outlined in section 3.2 and the calculations made, the induced voltages on all pipelines under steady state conditions were found to be well within the limits established by the Canadian Standards Association. Similarly, the touch voltages under fault conditions are well below the limits established by the Ontario Electrical Safety Code. Therefore, no further mitigative measures are required with respect to the 230 kV underground cable.

The induced voltage calculations carried out for both steady state and fault conditions on the 230 kV underground cable were based on the assumptions stated in section 3.2. Sensitivities to changes in soil resistivity and distances in which the pipelines run parallel to the 230 kV underground cable indicate that the induced voltages will be within safe limits for all likely values of soil resistivity and parallel distances.

6. REFERENCES

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IESO, Transmission Assessments and Performance Department, “System Impact Assessment Report, Wolfe Island Wind Generation Station (WGS), Connection Assessment & Approval Process,” Document ID IESO_REP_0344, Issue 1.0, June 30, 2007.

Canadian Standards Association, “Principles and Practices of Electrical Coordination between Pipelines and Electric Supply Lines,” CAN/CSA-C22.3 No. 6-M91, 2003.

Ontario Electrical Safety Code, Table 52: “Tolerable Touch and Step Voltages”, 23rd Edition, p.306, 2002.

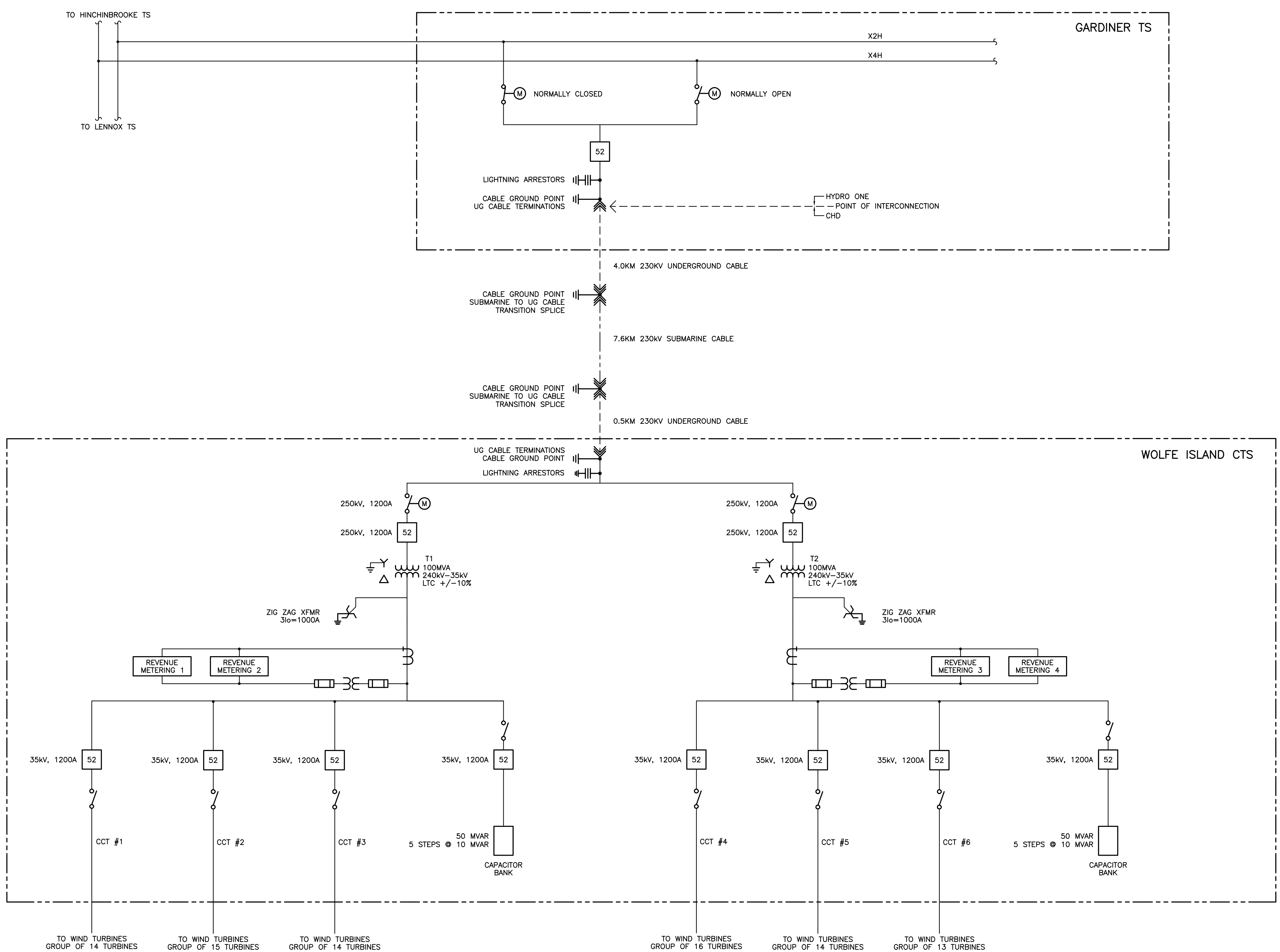
Nexans, Technical data and Drawings for the cable systems, grounding scheme, and link box.

Utilities Kingston, Pipeline Details and Area Maps.

Canadian Renewable Energy Corporation, Wolfe Island Wind Project Routing – Overall Plan, SLD, etc.

CDEGS Software Package:
http://www.sestech.com/Products/SoftPackages/CDEGS.htm

ELECTRICAL INTERCONNECTION SINGLE LINE DIAGRAM



STAMP

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
G	07	06	28	REVISE INTERCONNECT	JRP	JRP	JRK
F	07	04	04	ISSUED FOR INTERCONNECT REVISION	JRP	JRP	JRK
E	06	12	11	ISSUED FOR REVISION	JRP	AJD	JRK
D	06	04	25	ISSUED FOR REVIEW	JRP	AJD	JRK
C	06	04	16	ISSUED FOR REVISION	JRP	AJD	JRK
B	06	02	10	ISSUED FOR 230KV CABLE RFO'S	DRR	DRR	JRK
A	05	08	–	ISSUED FOR RFP #2	JRP	DRR	JRK

Canadian Renewable Energy Corporation
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CADD FILE: WI 6510

CANADIAN RENEWABLE ENERGY CORP.

PROJECT NAME: WOLFE ISLAND WIND PROJECT

TITLE: ELECTRICAL INTERCONNECTION SINGLE LINE DIAGRAM

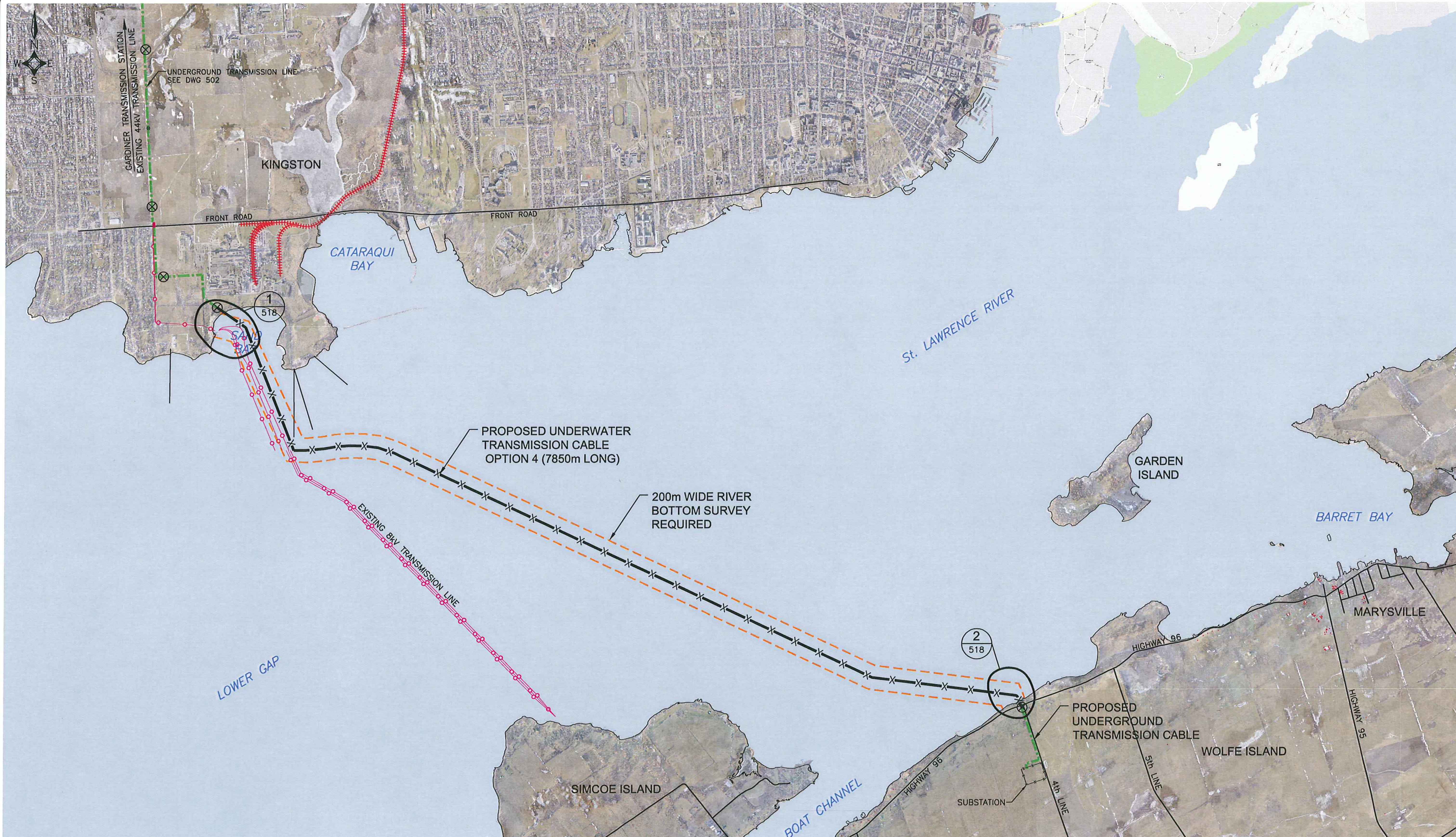
PROJECT:

SCALE: NTS

DRAWING: 6510

REV.: G

230 kV UNDERGROUND TRANSMISSION LINE ROUTING



NOTES

1. ALL DIMENSIONS IN METERS UNLESS NOTED OTHERWISE.
2. ALL COORDINATES ARE NAD 83 ZONE 18.

LEGEND

- RAILWAY
- EXISTING TRANSMISSION LINE
- PROPOSED SUBMARINE TRANSMISSION LINE
- PROPOSED TRENCHED TRANSMISSION LINE
- PROPOSED BORED TRANSMISSION LINE
- PROPOSED CABLE SPLICE LOCATION

PREVIOUSLY RELEASED AS DRAWING 103

SCALE 1:30 000

0 300 600 900 1200 1500

METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
K	07	07	09	REVISED CABLE APPEARANCE	CCC	AD	CCC
J	07	05	31	REVISED TRANSMISSION LINE ROUTE	CCC	AD	CCC
H	07	05	08	REVISED AIR PHOTOS	CCC	AD	CCC

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CALGARY, ALBERTA

CANADIAN HYDRO DEVELOPERS, INC

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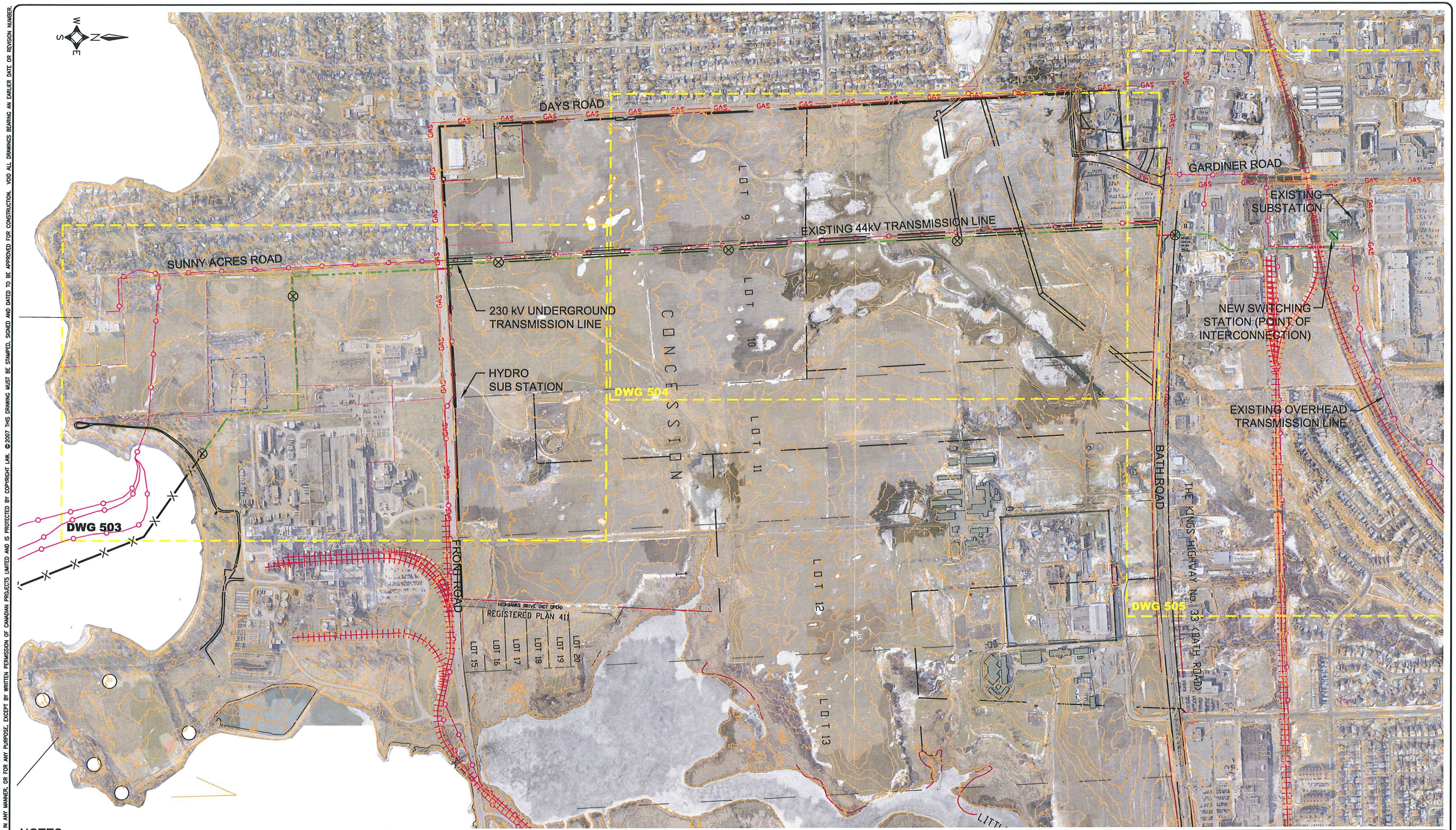
WOLFE ISLAND WIND PROJECT
230 kV U/G TRANSMISSION LINE
UNDERWATER CORRIDOR
PLAN

PROJECT NUMBER 1032-004
CADD NUMBER 4.3.004
DRAWING NUMBER 501



NOTES

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. BASE MAPPING FROM LiDAR PHOTO, FLOWN JANUARY 2006.
3. LOCATION OF EXISTING TRANSMISSION LINES TO BE FIELD CONFIRMED.

LEGEND

- RAILWAY
- EXISTING TRANSMISSION LINE
- PROPOSED SUBMARINE TRANSMISSION LINE
- PROPOSED TRENCHED TRANSMISSION LINE
- PROPOSED BORED TRANSMISSION LINE
- PROPOSED CABLE SPLICE LOCATION
- BELL COMMUNICATIONS
- SEWER
- UNION GAS
- WATER MAIN
- RIGHT OF WAY
- PROPERTY LINE
- CLOSED LAND FILL

PREVIOUSLY RELEASED AS DRAWING 111

SCALE 1:10 000

0 100 200 300 400 500

METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
M	07	07	09	REVISED ROAD NAMES	CCC	AD	CCC
L	07	05	30	REVISED CABLE ROUTE AND ROW	CCC	AD	CCC
K	07	05	15	ADDED HAZARDOUS WASTE PITS	CCC	AD	CCC

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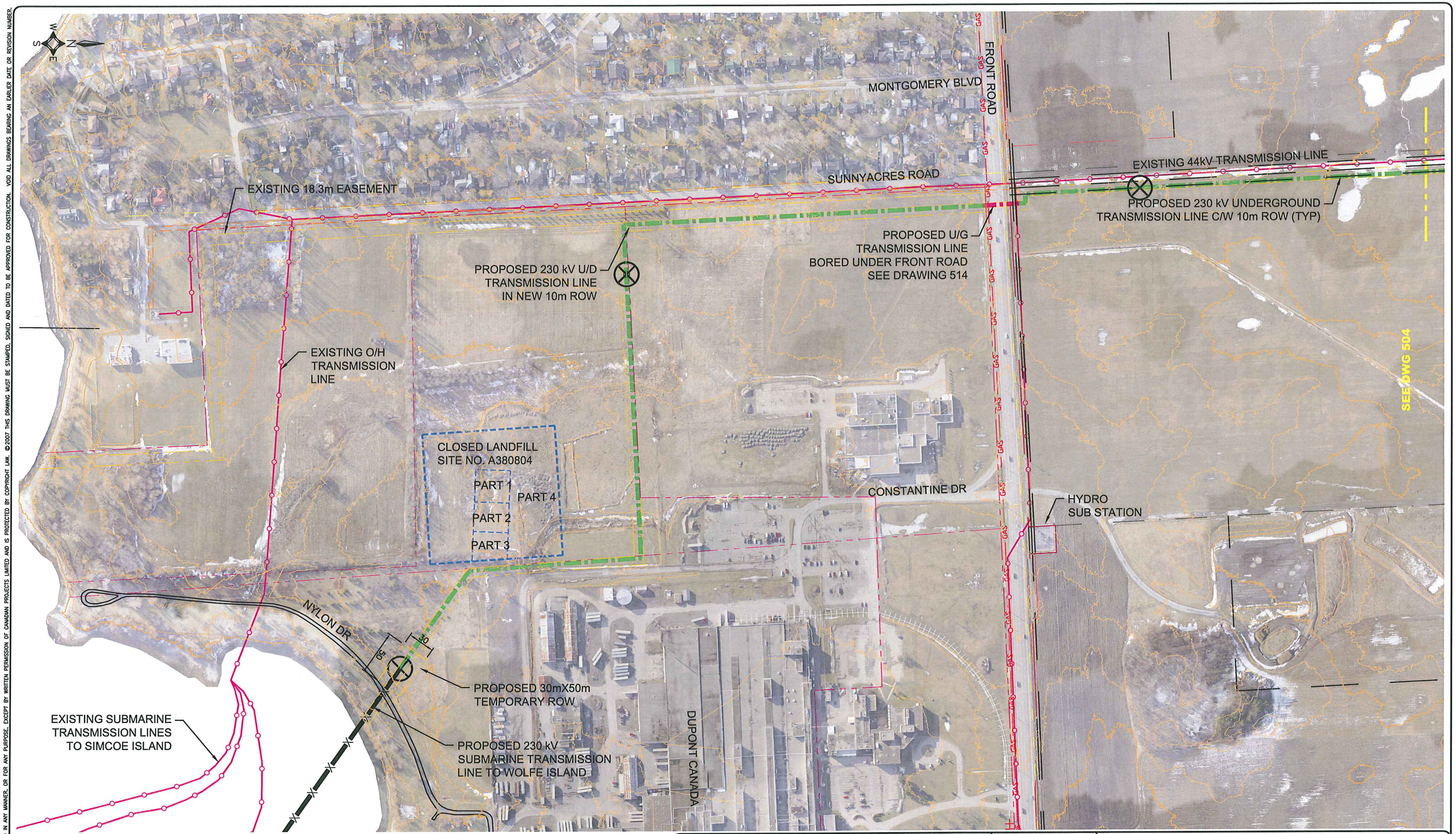
WOLFE ISLAND WIND PROJECT
230 kV U/G TRANSMISSION LINE
ROUTING
OVERALL PLAN - MAINLAND

PROJECT NUMBER 1032-004

CADD NUMBER 4.3.007

DRAWING NUMBER 502



NOTES

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. BASE MAPPING FROM LiDAR PHOTO, FLOWN JANUARY 2006.
3. LOCATION OF EXISTING TRANSMISSION LINES TO BE FIELD CONFIRMED.

LEGEND

- RAILWAY
- EXISTING TRANSMISSION LINE
- PROPOSED SUBMARINE TRANSMISSION LINE
- PROPOSED TRENCHED TRANSMISSION LINE
- PROPOSED BORED TRANSMISSION LINE
- ⊗ PROPOSED CABLE SPLICE LOCATION
- BELL COMMUNICATIONS
- SEWER
- UNION GAS
- WATER MAIN
- RIGHT OF WAY
- PROPERTY LINE
- CLOSED LANDFILL

PREVIOUSLY RELEASED AS DRAWING 112

SCALE 1:4000

0 40 80 120 160 200

METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
L	07	07	09	ADDED TEMPORARY ROW AT LANDFALL	CCC	AD	CCC
K	07	06	19	ADDED CLOSED LANDFILL	CCC	AD	CCC
J	07	05	29	REVISED CABLE ROUTE AND ROW	CCC	AD	CCC

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WOLFE ISLAND WIND PROJECT
230 kV U/G TRANSMISSION LINE
ROUTING
PLAN 1 OF 3

PROJECT NUMBER 1032-004
CADD NUMBER 4.3.007
DRAWING NUMBER 503

NOTES

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. BASE MAPPING FROM LiDAR PHOTO, FLOWN JANUARY 2006.
3. LOCATION OF EXISTING TRANSMISSION LINES TO BE FIELD CONFIRMED.

LEGEND

- RAILWAY
- EXISTING TRANSMISSION LINE
- PROPOSED SUBMARINE TRANSMISSION LINE
- PROPOSED TRENCHED TRANSMISSION LINE
- PROPOSED BORED TRANSMISSION LINE
- ⊗ PROPOSED CABLE SPLICE LOCATION
- BELL COMMUNICATIONS
- SEWER
- GAS — GAS UNION GAS
- WATER MAIN
- RIGHT OF WAY
- PROPERTY LINE

PREVIOUSLY RELEASED AS DRAWING 113

SCALE 1:4000

0 40 80 120 160 200
METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
H	07	07	09	REVISED CABLE IDENTIFICATION	CCC	AD	CCC
G	07	05	29	REVISED CABLE ROUTING AND ROW	CCC	AD	CCC
F	07	05	04	ADDED UTILITIES	CCC	AD	CCC

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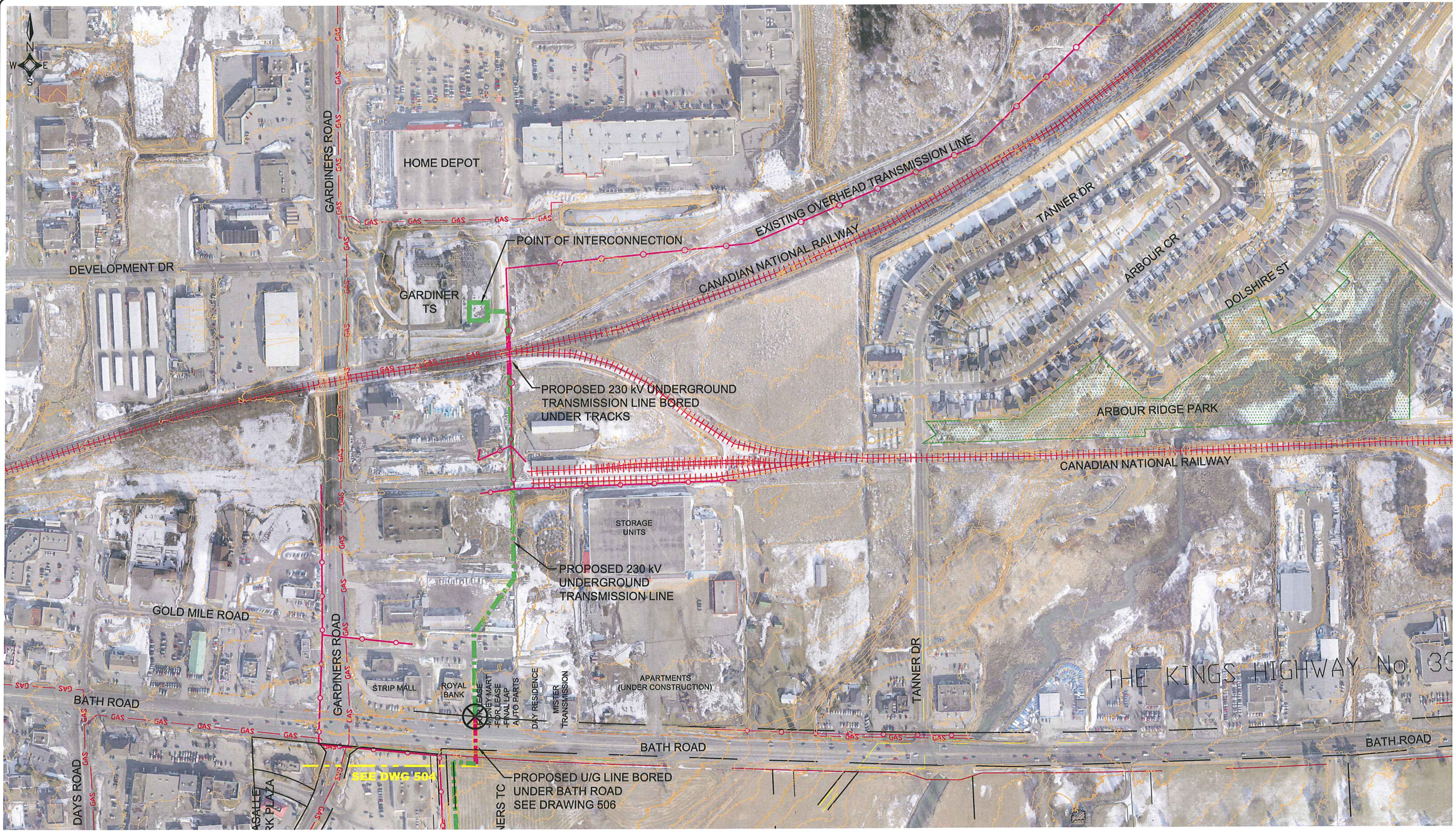
WOLFE ISLAND WIND PROJECT
230 kV U/G TRANSMISSION LINE
ROUTING
PLAN 2 OF 3

PROJECT NUMBER 1032-004
CADD NUMBER 4.3.007
DRAWING NUMBER 504



NOTES

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. BASE MAPPING FROM LiDAR PHOTO, FLOWN JANUARY 2006.
3. LOCATION OF EXISTING TRANSMISSION LINES TO BE FIELD CONFIRMED.

LEGEND

- RAILWAY
- EXISTING TRANSMISSION LINE
- PROPOSED SUBMARINE TRANSMISSION LINE
- PROPOSED TRENCHED TRANSMISSION LINE
- PROPOSED BORED TRANSMISSION LINE
- PROPOSED CABLE SPLICE LOCATION
- BELL COMMUNICATIONS
- SEWER
- UNION GAS
- WATER MAIN
- RIGHT OF WAY
- PROPERTY LINE

PREVIOUSLY RELEASED AS DRAWING 115

SCALE 1:4000

0 40 80 120 160 200

METRES

REV	Y	M	D	REVISION DESCRIPTION	DES	DRN	CHK
J	07	07	09	REVISED OVERHEAD TRANSMISSION LINE	CCC	AD	CCC
H	07	05	29	REVISED CABLE ROUTING AND ROW	CCC	AD	CCC
G	07	05	04	ADDED UTILITIES	CCC	AD	CCC

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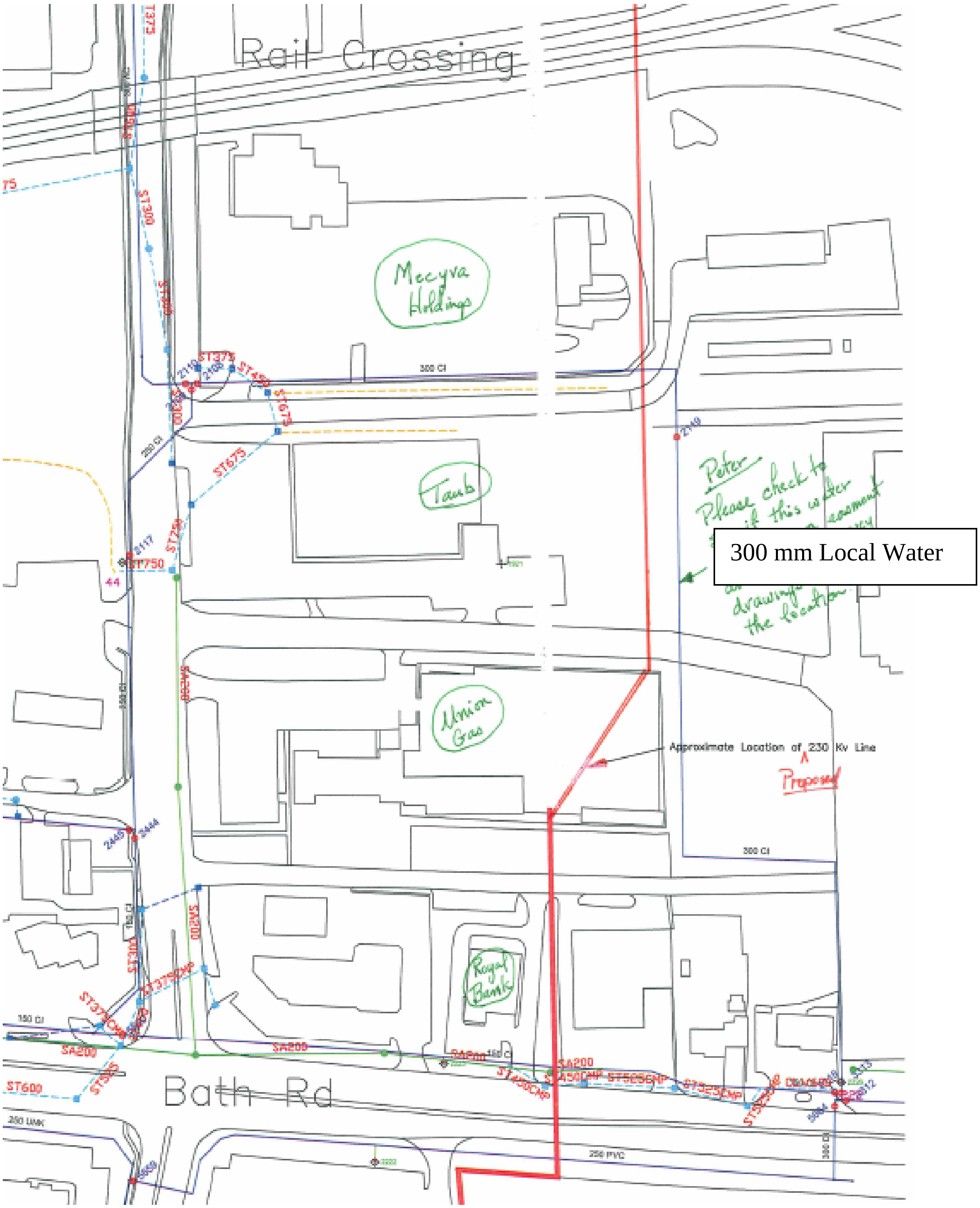
WOLFE ISLAND WIND PROJECT
230 kV U/G TRANSMISSION LINE
ROUTING
PLAN 3 OF 3

PROJECT NUMBER: 1032-004
CADD NUMBER: 4.3.007
DRAWING NUMBER: 505

300 mm LOCAL WATER PIPE LOCATION



Location of the 300 mm Local Water pipeline between Bath Road and the Rail Crossing