Patricia Squires
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Leave to Construct
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Enbridge Gas Inc.
500 Consumers Road
North York ON
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November 14, 2024

Nancy Marconi
Registrar
Ontario Energy Board
2300 Yonge Street, Suite 2700
Toronto, ON M4P 1E4

Dear Nancy Marconi,

Re: Enbridge Gas Inc. (Enbridge Gas or the Company)
Ontario Enery Board (OEB) File No. EB-2024-0200
St. Laurent Pipeline Replacement Project
Technical Conference Undertaking Responses

Consistent with the OEB's Procedural Order No. 3, enclosed are Enbridge Gas's written responses to undertakings received during the Technical Conference held on October 30, and October 31, 2024.

In accordance with the OEB's Practice Direction on Confidential Filings, Enbridge Gas is requesting confidential treatment of the following information. Details of the specific confidential information for which confidential treatment is sought is set out in Table 1.

Table 1

Exhibit	Confidential Information Location	Brief Description	Basis for Confidentiality
JTX1.22	Pg. 1, Table 1	Station Flow The redacted information is station names and associated flow rates.	The redaction relates to the locations of Enbridge Gas critical infrastructure. Public disclosure poses both a safety and a security risk as it may allow third parties to determine gas system configurations and points of sensitivity or vulnerability that may expose Enbridge Gas to security risks.
JTX1.23	Attachment 1	System Map The redacted information is the existing system map with pipeline MOP and station locations.	The redaction relates to the locations of Enbridge Gas critical infrastructure. Public disclosure poses both a safety and a security risk as it may allow third parties to determine gas system configurations and points of sensitivity or vulnerability that may expose Enbridge Gas to security risks.
JTX1.26	pgs. 1, 2 and 3	Station Inlet Pressure and Flow The redacted information is station numbers and names.	The redactions relate to the locations of Enbridge Gas critical infrastructure. Public disclosure poses both a safety and a security risk as it may allow third parties to determine gas system configurations and points of sensitivity or vulnerability that may expose Enbridge Gas to security risks.
JTX1.26	pg. 4, Figure 1	System Map The redacted information is the existing system map with pipeline MOP, station locations and low points.	The redaction relates to the locations of Enbridge Gas critical infrastructure. Public disclosure poses both a safety and a security risk as it may allow third parties to determine gas system configurations and points of sensitivity or vulnerability that may expose Enbridge Gas to security risks.

If you have any questions, please contact the undersigned.

Sincerely,

Patricia Squires

Patricia Squires
Manager, Regulatory Applications – Leave to Construct

Cc: Zora Crnojacki (OEB Staff)
Charles Keizer (Torys)
Arlen Sternberg (Torys)
Intervenors (EB-2024-0200)

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 13

To file a spreadsheet used to trend the escalation per year (subject to redaction)

Response:

The spreadsheet used to trend the integrity dig cost escalation based on historical costs is provided in Attachment 1. A straight average of the year-over-year escalation factors produces an 11-year mean escalation rate of 18.3%. However, in order to smooth out some anomalous data points, Enbridge Gas also calculated the average annual escalation rates against two different base or anchor years that had multiple dig campaigns, providing more representative base years (2013 and 2017). The average of these two sets of escalation rates was 9.9% per year. This historical actual escalation factor is higher than the assumed escalation factor of 6% in the EI&R alternative, and therefore the escalation rate used in the EI&R alternative results in a less costly estimate.

Costs for integrity digs have escalated more rapidly than other typical pipeline construction costs for a variety of reasons. Some of the key drivers explaining why integrity dig costs escalate at higher rates are the following:

- Location: Integrity digs must be completed at the exact location that the pipe anomaly is found. Every integrity dig is unique given the circumstances and characteristics around the existing pipeline, and it is not possible to optimize a dig location if a feature or obstruction impacting construction is discovered. By contrast, a pipeline replacement project can be designed around locations with challenging construction characteristics.

- Environmental considerations: Environmental conditions conducive to the acceleration of corrosion (i.e., contaminated soils, hazardous waste, high water tables, increased AC current locations) typically cost more to remediate and to safely work in those areas. Soil sampling must be conducted and any environmental hazards must be disposed of in accordance with applicable laws and regulations. By contrast, pipeline replacement projects can alter the design route to avoid areas of high contamination or zones that accelerate corrosion.

- Scope: Integrity digs typically involve localized areas of excavation and a smaller work site as compared to a pipeline replacement project. This means that efficiencies that could otherwise be gained over linear construction are lost when the crews are constrained in a smaller area. As a result, integrity digs must be completed in the exact sequence required for the work, and crews not directly involved in each individual step for the work required are not able to be assigned elsewhere to maintain productivity (i.e., crews required for excavation will be on stand-by while the non-destructive examination (NDE) or engineering defect assessments are occurring). Additionally, if pipe anomalies are discovered near the limits of the integrity dig, the excavation must be extended to ensure the pipeline repair is completed to remediate all anomalies meeting the repair criteria outlined in the EGI Distribution Steel Pipeline Repair Standard. Please refer to Exhibit I.1-STAFF-6 for details.

- Repair method: At the outset of an integrity dig, it may not be known what repair method is required until NDE is completed. Therefore, if a replacement is required, a pipeline bypass may need to be designed in the field to maintain gas supply downstream of the integrity dig. This is especially true in situations where finding a piece of the pipeline to weld on is challenging due to features or characteristics inherent with older vintages of pipe. Until the pipeline is exposed, weldability cannot be confirmed, which can result in an extension of the integrity dig on either side of the excavation to find suitable pipe for welding.

Integrity Dig Cost Assessment

Method 1 - Year-over-year escalation

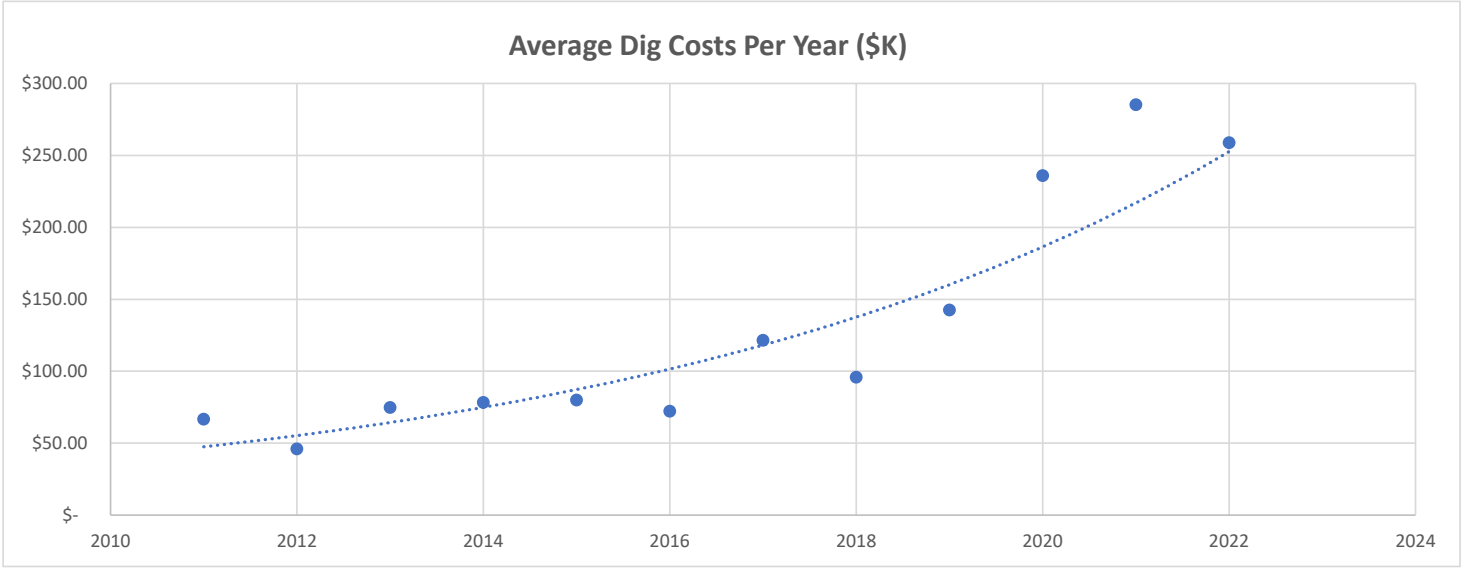
Year	Avg Cost	Data Count	Year-over-year Escalation
2011	$ 66.67	1	
2012	$ 45.96	1	-31.1%
2013	$ 74.76	6	62.7%
2014	$ 78.28	1	4.7%
2015	$ 79.92	2	2.1%
2016	$ 72.17	1	-9.7%
2017	$ 121.49	4	68.3%
2018	$ 95.82	2	-21.1%
2019	$ 142.49	3	48.7%
2020	$ 235.88	11	65.5%
2021	$ 285.25	1	20.9%
2022	$ 258.75	2	-9.3%

Mean Dig Cost Escalation Rate	18.3%

Method 2 - Anchoring based on data significance

Year	Avg Cost	Data Count	Anchor?	Compared to 2013	Compared to 2017
2011	$ 66.67	1		N/A	N/A
2012	$ 45.96	1		N/A	N/A
2013	$ 74.76	6	Anchor	N/A	N/A
2014	$ 78.28	1		4.7%	N/A
2015	$ 79.92	2		3.4%	N/A
2016	$ 72.17	1		-1.2%	N/A
2017	$ 121.49	4	Anchor	12.9%	N/A
2018	$ 95.82	2		5.1%	-21.1%
2019	$ 142.49	3		11.4%	8.3%
2020	$ 235.88	11		17.8%	24.8%
2021	$ 285.25	1		18.2%	23.8%
2022	$ 258.75	2		14.8%	16.3%

Mean Dig Cost	9.9%



ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 19

With reference to ED's request for Enbridge's calculation of the integrity dig cost changes for the 10 years prior to the pandemic, EGI to look at whether or not it has the data; to the extent that it has the data, to do the calculation; to the extent that it believes it should be qualified accordingly, to do so.

Response:

Further to this request, Enbridge Gas has updated the integrity dig cost escalation assessment provided in Exhibit JT1.1 with the following updates:

- Only integrity dig costs from 2009 to 2019 were included (10 years prior to the pandemic).
- Additional data on the dig costs from 2009 to 2019 were gathered to improve data significance in the assessment.
- The average dig cost calculation was updated to be equally weighted by the number of digs rather than the number of pipeline dig campaigns.
- An additional "Cross-fold" escalation assessment method was included, given that all years now have sufficient data points.

The revised assessment results in a historical mean escalation rate of approximately 21% for the 10 years prior to the pandemic, further demonstrating that the assumed 6% escalation rate used for integrity digs in the EI&R alternative is conservative and likely under-represents the actual costs. The revised assessment is provided in Attachment 1.

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Please see Exhibit JT1.2_Attachment 1.xlsx on the OEB's RDS.

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 19

Enbridge to file the 40-year data that the 3 percent estimate of replacement costs is based on.

Response:

The 3% estimated escalation rate used in the NPV analysis of Alternative B was derived from a statistical analysis of the Non-Residential Building Construction Price Index, as detailed in Attachment 1.

The statistical analysis employed the Tukey's fences[1] method for outlier detection, excluding data points with significant deviations from the other observations. Specifically, the 2021 and 2022 escalation rates (17.3% and 12.6%, respectively) were identified as outliers and removed from the analysis.

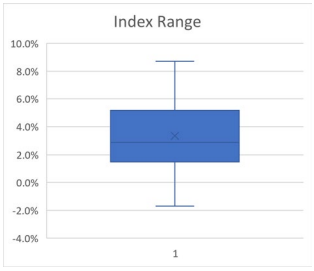
The analysis revealed an average escalation rate of 3.34%, with a 95% confidence interval ranging from 2.51% to 4.17%. This interval suggests that, based on historical data, the anticipated escalation rate is likely to fall between 2.51% and 4.17%, with 95% certainty. Moreover, modeling the distribution of the population mean showed only a 0.1% possibility that the average escalation rate would be 2% or lower.

[1] Seo S. (2006). A Review and Comparison of Methods for Detecting Outliers in Univariate Data Sets, Masters Thesis, University of Pittsburgh, Pennsylvania, page 13.

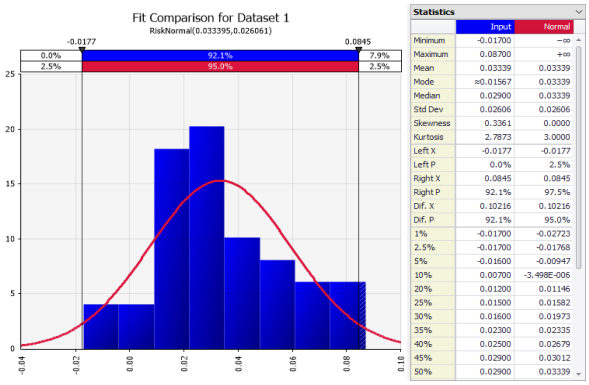
Non-Residential Building Construction Price Index Statistical Assessment

Year	Rate	Percentile	Tukey Fences Outlier
1983	5.1%	0.717	N
1984	2.6%	0.41	N
1985	4.2%	0.641	N
1986	2.9%	0.487	N
1987	3.9%	0.615	N
1988	8.5%	0.897	N
1989	6.0%	0.794	N
1990	4.6%	0.666	N
1991	-1.7%	0	N
1992	1.1%	0.128	N
1993	1.0%	0.102	N
1994	2.5%	0.358	N
1995	2.0%	0.307	N
1996	1.2%	0.179	N
1997	2.5%	0.358	N
1998	1.5%	0.23	N
1999	2.3%	0.333	N
2000	8.5%	0.897	N
2001	0.7%	0.076	N
2002	3.2%	0.538	N
2003	2.9%	0.435	N
2004	7.1%	0.871	N
2005	3.8%	0.589	N
2006	6.4%	0.82	N
2007	5.6%	0.769	N
2008	8.7%	0.948	N
2009	-1.6%	0.025	N
2010	4.7%	0.692	N
2011	5.4%	0.743	N
2012	1.4%	0.205	N
2013	-0.4%	0.051	N
2014	1.6%	0.256	N
2015	1.6%	0.256	N
2016	1.1%	0.153	N
2017	3.0%	0.512	N
2018	6.8%	0.846	N
2019	2.9%	0.435	N
2020	3.3%	0.564	N
2021	17.3%	1	Y
2022	12.6%	0.974	Y

25th Percentile	1.575%
75th Percentile	5.450%
IQR	3.875%
k	1.5
Outlier LB	-4.24%
Outlier UB	11.26%
Filtered Mean	3.34%
Filtered StdDev	2.606%



Data 95% LB	-1.77%
Data 95% UB	8.45%
Mean:	3.34%
95% CI Mean:	0.83%
MEAN LB:	2.51%
MENA UB:	4.17%



ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 25

Enbridge to confirm that the 2023 to 2032 asset management plan uses a 2 percent escalation rate for inflation.

Response:

The 2023 to 2032 Asset Management Plan[1] used a 2% escalation factor applied on an overall basis to the entire portfolio of projects.

The Asset Management Plan has thousands of investments at various stages of development. The escalation factor used in the 2023 to 2032 Asset Management Plan was an estimate used at a macro level to capture cost increases, and was not intended to be used for, and is not applicable to, evaluating the economics of a specific project within a leave to construct application, such as the St. Laurent project.

As noted in Table 6.4-1 of the 2023-2032 Asset Management Plan, future costs do not include inflationary measures. Normal inflationary measures and impacts such as rising material costs, foreign exchange and labour are expected to be covered within investment contingency. Incremental shifts in inflation caused by global supply chain shortages, pandemics or other unusual circumstances have not been considered.

A small number of programs within the Asset Management Plan with defined scope/unit rates have included an escalation factor where information was available to inform the assumption (such as for meter purchases and vehicle purchases).

Accordingly, for the St. Laurent Replacement Project leave to construct application, a specific escalation factor was used that is applicable to and reflects the representative parameters of the asset that differ in this case from those shown in the Asset Management Plan.

[1] EB-2022-0200, Exhibit 2, Tab 6, Schedule 2

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 30

To recalculate STAFF-17, attachment 4, page 2 to 3, scenario b, with a cost escalation of 2 percent

Response:

Further to this request and for illustrative purposes, Enbridge Gas has modified the escalation rates applied in both Scenario A – Full Replacement and Scenario B – Extensive Inspection and Repair with a constant 2% escalation rate across all work types. The results are provided in Attachment 1.

Enbridge Gas maintains that applying an average 2% escalation rate across all work types for this project is not an accurate or realistic representation of the actual escalation rate that can be expected over the NPV horizon, as it is inconsistent with the trends in historical data. The assumed 2% escalation rate in this hypothetical analysis is especially inaccurate for the integrity dig work types, since it significantly differs from the actual trends observed in the historical data for this type of work. The escalation rates used by Enbridge Gas and presented in the leave to construct application evidence were based on factual data derived from historical industry trends.

Please see response to Exhibit JT1.3 for more details on why the historical trends indicate that a 2% escalation rate is not appropriate for the escalation rate of general construction-related work. Please see response to Exhibit JT1.1 and Exhibit JT1.2 for more details on why a 2% escalation rate would significantly under-represent the expected escalation rate of the integrity dig work-type, and how the escalation rate used in the application already represents a conservative approach for this work-type.

Scenario Details

Project Alternative: Scenario A - Full Replacement (prepared for illustrative purposes in response to the request in JT1.5)

The scenaio cost analysis covers up to 61 years asset life starting from In-Service date: **2026**

Costs are based on 2024 dollars NPV as of: 2024

Scenario Details
This scenario involves the replacement of the SLP pipeline with: - Approximately 10.0 km of Nominal Pipe Size (NPS) 12 Extra High Pressure (XHP) Steel Coated (ST) natural gas pipeline; - Approximately 2.5 km of NPS 16 XHP ST natural gas pipeline; - Approximately 0.3 km of NPS 6 XHP ST natural gas pipeline; - Approximately 0.9 km of NPS 6 Intermediate Pressure (IP) Polyethylene (PE) natural gas pipeline; and - Approximately 3.9 km of NPS 4 IP PE natural gas pipeline.
- Discount rate is based on 2024 Enbridge WACC
~~- Cost escalation of 4% based on estimated provided by construction contractor~~

Cost/Benefit Category	Cost/Benefit Type	Scenario Tasks	Assumptions	Type	Activity	Year	Quantity	Unit Cost (2024 $)	Cost (2024 $)	Discount Rate (%)	Cost Escalation (%)	Cost in year spent ($)
Cost	Upfront	Full Replacement of the SLP	Class 3 estimate prepared by Capital Development	**Capital**	Replacement Work	**2024**	1	$ 2,515,000	$ (2,515,000)	5.75%	2.00%	$ (2,515,000)
Cost	Upfront			**Capital**	Replacement Work	**2025**	1	$ 68,699,826	$ (68,699,826)	5.75%	2.00%	$ (70,073,823)
Cost	Upfront			**Capital**	Replacement Work	**2026**	1	$ 67,110,044	$ (67,110,044)	5.75%	2.00%	$ (69,821,290)
Cost	Upfront			**Capital**	Replacement Work	**2027**	1	$ 12,996,943	$ (12,996,943)	5.75%	2.00%	$ (13,792,460)
Cost	Upfront	Interest During Construction	Based on estimates prepared by Capital Development	**Capital**	IDC	**2024**	N/A	$ 483,725	$ (483,725)	N/A	N/A	$ (483,725)
Cost	Upfront			**Capital**	IDC	**2025**	N/A	$ 1,779,300	$ (1,779,300)	N/A	N/A	$ (1,850,472)
Cost	Upfront			**Capital**	IDC	**2026**	N/A	$ 1,326,289	$ (1,326,289)	N/A	N/A	$ (1,434,514)

Scenario Details

Project Alternative: Scenario B - Extensive Inspection and Repair
(prepared for illustrative purposes in response to the request in JT1.5)

The scenaio cost analysis covers up to 61 years asset life starting from In-Service date: **2026**
Costs are based on 2024 dollars **NPV as of: 2024**

Scenario Details
- Expand Crawler Inspection and Integrity Dig activities to mitigate current corrosion risks on the St. Laurent pipeline (where required) - This includes 13 additional ILI runs through 12 additional launch points - 4.6km needs short-term inspection, 7.8km will be inspected indefinitely.
Add additional TPD barriers to mitigate TPD risk including: - Adding SLP to Vital Mains program providing on-site supervision during third-party excavtion activities - Increasing response time notifications to same day - Locating pipeline using mechanical methods - Installation of High Visibility Slabbing, where feasible
- 1.9KM targeted replacements to address imeedate Third-Party damage risks
- Accelerated ROW Patrol required until slabbing and replacements completed
- Discount rate is based on 2024 Enbridge WACC
~~- General inflation rate of 3% applied broadly for most cost categories. Integrity Dig costs increased at an escalation rate of 6% based on cost trending over the previous 10 years.~~

Cost/Benefit Category	Cost/Benefit Type	Scenario Tasks	Assumptions	Type	Activity	Year	Quantity	Unit Cost ($2024)	Cost ($2024)	Discount Rate (%)	Cost Escalation (%)	Cost in year spent ($)
Cost	Upfront	Inspect and mitigate remaining critical features identified from the inspected sections of the pipeline (40% of pipeline)	Integrity has identified the need for 19 additional digs based on the proposed EDIMP dig criteria and probability of sizing of the inspection tool. Based on the 2 year timeframe for Phase 2 digs in the proposed Dig Criteria, these dig would be required to be completed by 2025. Dig costs is determined based the weighted average of the 19 known dig sites and their specified accessibility through Engineering Construction review.	**Capital**	Integrity Digs + Mitigation	**2025**	19	$ 657,895	$ (12,500,000)	5.75%	2.00%	$ (12,750,000)
Cost	Upfront	Replacement @ NPS16 LRT crossing with identified corrosion issue	Estimate based on a cut out and replacements of the above grade NPS16 pipe with Corrosion that requires repair. Based on the Engineer Assessment of corrosion on this segment, mitigation must occur by 2027. Estimate provided by Capital Development (CD).	**Capital**	Replacement	**2026**	1	$ 2,741,043	$ (2,741,043)	5.75%	2.00%	$ (2,851,781)
Cost	Upfront	Inspect the uninspected portion of the pipeline with crawler inspection tool (only where required - 4.56km)	Integrity has created an inspection plan for remaining segments of SLP that will require inspection. CD has assessed the feasibility and costs of launch points in the plan.	**O&M**	Launch Site Retrofits	**2025**	12	$ 200,000	$ (2,400,000)	5.75%	2.00%	$ (2,448,000)
Cost	Upfront			**Capital**	Launch Site Retrofits	**2025**	12	$ 40,000	$ (480,000)	5.75%	2.00%	$ (489,600)
Cost	Upfront			**O&M**	Crawler Tool Inspection	**2025**	13	$ 81,500	$ (1,059,500)	5.75%	2.00%	$ (1,080,690)
Cost	Upfront	ROW Patrol for pipeline and pubic awareness campaign as temporary TPD mitigation measures	Assume daily patrol to reduce TPD risks (as per CFER TPD Fault tree model). Cost is based on 2023 actual costs related to daily patrols and additional targeted public awareness campaign.	**O&M**	Row Patrol + Public Awareness	**2025**	1	$ 140,000	$ (140,000)	5.75%	2.00%	$ (142,800)
Cost	Upfront	ROW Patrol for pipeline and pubic awareness campaign as temporary TPD mitigation measures	Assume daily patrol to reduce TPD risks (as per CFER TPD Fault tree model). Cost is based on 2023 actual costs related to daily patrols and additional targeted public awareness campaign.	**O&M**	Row Patrol + Public Awareness	**2026**	1	$ 140,000	$ (140,000)	5.75%	2.00%	$ (145,656)
Cost	Upfront	Implement additional TPD barriers to reduce the TPD threat. Install protective slabbing with high visibility marker tape on portions of the pipeline that are deemed feasible.	Based on slabbing feasibility assessment and updated costs estimates provided by CD in Feb 2024	**Capital**	Install High Visibility Slabs	**2025**	4.937	$ 2,329,350	$ (11,500,000)	5.75%	2.00%	$ (11,730,000)
Cost	Upfront	Inspect and mitigate critical features identified from the uninspected portion of the pipeline	Assumed that the uninspected portion of the pipelines will require similar post-inspection mitigation as the inspected portion. Inspected and uninspected sections have same proportions, hence, 1:1 multiplier used for uninspected sections.	**Capital**	Integrity Digs + Mitigation	**2026**	24	$ 680,420	$ (16,330,081)	5.75%	2.00%	$ (16,989,816)
Cost	Upfront	Additional Replacements required to meet risk criteria	2 segments have been identified for replacement to meet Risk targets. These segments were strategically selected to also remove any uninspected segments of vintage pipe.(1828m)	**Capital**	Replacement	**2025**	1	$ 41,500,000	$ (41,500,000)	5.75%	2.00%	$ (42,330,000)
Cost	Upfront	Uncertainty where continued inspections can result in stuck ILI tools	Assume 1 in 500 chance of the tool getting stuck and requiring a cut-out to retrieve.	**O&M**	Stuck Crawler Tool Retrieval	**2025**	13	$ 10,000	$ (130,000)	5.75%	2.00%	$ (132,600)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2029**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (209,775)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2036**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (240,966)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2043**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (276,794)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2050**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (317,949)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2057**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (365,224)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2064**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (419,528)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2071**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (481,905)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2078**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (553,558)
Cost	On-going			**O&M**	Stuck Crawler Tool Retrieval	**2085**	19	$ 10,000	$ (190,000)	5.75%	2.00%	$ (635,864)
Cost	On-going	Continued inspection of the St. Laurent pipeline system to maintain a risk/reliability that meets our thresholds	Assume a 7-year re-inspection interval (consistent with company standards) with additional construction costs to excavate and prepare launch locations.	**O&M**	Crawler Tool Inspection	**2029**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (1,709,669)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2036**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (1,963,872)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2043**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (2,255,872)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2050**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (2,591,288)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2057**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (2,976,575)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2064**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (3,419,149)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2071**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (3,927,528)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2078**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (4,511,495)
Cost	On-going			**O&M**	Crawler Tool Inspection	**2085**	19	$ 81,500	$ (1,548,500)	5.75%	2.00%	$ (5,182,290)
Cost	On-going			**O&M**	Launch Site Preparation	**2029**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (3,533,059)
Cost	On-going			**O&M**	Launch Site Preparation	**2036**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (4,058,374)
Cost	On-going			**O&M**	Launch Site Preparation	**2043**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (4,661,796)
Cost	On-going			**O&M**	Launch Site Preparation	**2050**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (5,354,938)
Cost	On-going			**O&M**	Launch Site Preparation	**2057**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (6,151,140)
Cost	On-going			**O&M**	Launch Site Preparation	**2064**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (7,065,727)
Cost	On-going			**O&M**	Launch Site Preparation	**2071**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (8,116,299)
Cost	On-going			**O&M**	Launch Site Preparation	**2078**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (9,323,077)
Cost	On-going			**O&M**	Launch Site Preparation	**2085**	16	$ 200,000	$ (3,200,000)	5.75%	2.00%	$ (10,709,284)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2030**	17	$ 683,420	$ (11,618,141)	5.75%	2.00%	$ (13,083,914)

Cost	On-going	Inspect and mitigate identified critical features identified from the ILI tool inspections	Digs in second inspection campaign estimated based on growth of ILI data. Digs in 3rd and later ILI campaign estimated based on TIMP ILI campaign trending.	**Capital**	Integrity Digs + Mitigation	**2037**	19	$ 683,420	$ (12,984,981)	5.75%	2.00%	$ (16,797,457)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2044**	21	$ 683,420	$ (14,351,821)	5.75%	2.00%	$ (21,326,051)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2051**	23	$ 683,420	$ (15,718,661)	5.75%	2.00%	$ (26,829,970)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2058**	25	$ 683,420	$ (17,085,501)	5.75%	2.00%	$ (33,499,133)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2065**	28	$ 683,420	$ (19,135,761)	5.75%	2.00%	$ (43,097,570)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2072**	31	$ 683,421	$ (21,186,052)	5.75%	2.00%	$ (54,809,809)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2079**	34	$ 683,422	$ (23,236,350)	5.75%	2.00%	$ (69,052,173)
Cost	On-going			**Capital**	Integrity Digs + Mitigation	**2086**	37	$ 683,422	$ (25,286,616)	5.75%	2.00%	$ (86,317,998)
Cost	Upfront	Interest During Construction	Assume 8 months of construction per year (construction period) and all work will be completed in the given year. 5.48% interest rate on debt.	**Capital**	IDC	**2025**	N/A	$ 1,205,235	$ (1,205,235)	N/A	N/A	$ (1,229,339)
Cost	Upfront			**Capital**	IDC	**2026**	N/A	$ 348,366	$ (348,366)	N/A	N/A	$ (362,440)
Cost	On-going			**Capital**	IDC	**2030**	N/A	$ 212,225	$ (212,225)	N/A	N/A	$ (238,999)
Cost	On-going			**Capital**	IDC	**2037**	N/A	$ 237,192	$ (237,192)	N/A	N/A	$ (306,834)
Cost	On-going			**Capital**	IDC	**2044**	N/A	$ 262,160	$ (262,160)	N/A	N/A	$ (389,556)
Cost	On-going			**Capital**	IDC	**2051**	N/A	$ 287,128	$ (287,128)	N/A	N/A	$ (490,094)
Cost	On-going			**Capital**	IDC	**2058**	N/A	$ 312,095	$ (312,095)	N/A	N/A	$ (611,917)
Cost	On-going			**Capital**	IDC	**2065**	N/A	$ 349,547	$ (349,547)	N/A	N/A	$ (787,249)
Cost	On-going			**Capital**	IDC	**2072**	N/A	$ 386,999	$ (386,999)	N/A	N/A	$ (1,001,193)
Cost	On-going			**Capital**	IDC	**2079**	N/A	$ 424,451	$ (424,451)	N/A	N/A	$ (1,261,353)
Cost	On-going			**Capital**	IDC	**2086**	N/A	$ 461,902	$ (461,902)	N/A	N/A	$ (1,576,742)

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 32

To provide the live excel spreadsheets that are underlying attachment 4, including those that were used to calculate the numbers in attachment 4.

Response:

The live spreadsheet underlying Exhibit I.2-STAFF-17, Attachment 4 is provided at Attachment 1. This spreadsheet includes all formulas used to calculate the unescalated costs [Cost (2024 $)] and the escalated costs [Cost in year spent ($)].

This page is intentionally left blank. Due to size, this Attachment has not been included.

Please see Exhibit JT1.6_Attachment 1.xlsx on the OEB's RDS.

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 34

To reproduce exhibit c, tab 1, schedule 1, page 19, table 7, the summary of npvs for alternative a and b, with various useful lives, based on a cost escalation of 2 percent, subject to time constraints

Response:

As requested and for illustrative purposes, Enbridge Gas has reproduced Exhibit C, Tab 1, Schedule 1, Page 19, Table 7 with the updated 2% escalation rate requested in Exhibit JT1.5, with the results shown below in Table 1.

Table 1
Summary of NPVs for Alternative A and B with Various Useful Lives
with Modified 2% Constant Escalation Rate

NPV ($ millions)	A – Full Replacement	B – Extensive Inspection and Repair	$ Difference (A - B)
Case A (63 years)	$(130)	$(134)	+$4
Case B (42 years)	$(130)	$(123)	-$7
Case C (31 years)	$(130)	$(113)	-$17

Enbridge Gas continues to maintain that using an average 2% escalation rate across all work types for this project is not realistic and does not accurately reflect the actual expected escalation rate over the NPV horizon for the SLP, as described in Exhibit JT1.5. A 2% escalation rate is inconsistent with the applicable historical trends. That is particularly the case, for instance, in respect of the integrity dig work-types, as further explained in JT1.5. The escalation rates used by Enbridge Gas in this application were based on factual data from historical trends.

Additionally, we note that the NPV comparison of alternatives was just one of five key evaluation criteria Enbridge Gas used to conclude that "Full Replacement" is the most effective alternative for mitigating the high risks associated with the SLP. These NPV results further reinforce Enbridge Gas's conclusions from an "Uncertainty of Plan and Outcomes" perspective. Specific uncertainty challenges with the Extensive Inspection and Repair alternative are detailed in Exhibit C, Tab 1, Schedule 1, page 19, Paragraph 35:

> "Given that this alternative will incur ongoing costs over the asset's useful life, the calculated NPV is significantly influenced by variables such as cost inflation/escalation and the discount rate (i.e., the weighted average cost of capital). The inability to precisely forecast these parameters multiple decades into the future adds further uncertainty to the NPV, making long-term financial projections more complex and less certain."

To further illustrate the broad range of potential financial outcomes and uncertainties inherent in the Extensive Inspection and Repair alternative (in contrast to the Full Replacement option), Table 2 compares NPVs for Case B (42 years) under varying escalation and discount rate assumptions for both alternatives.

Table 2
Case B NPV with Varying Escalation/Discount Parameters

Case B (42 years)	Escalation / Discount Parameters	A - Full Replacement NPV ($ millions)	B - EI&R NPV ($ millions)
Case B.1 (Original NPV Assumptions)	General Escalation = 3% Integrity Dig Escalation = 6% Full Replacement Escalation = 4% Discount Rate = 5.75%	$(134)	$(179)
Case B.2 (ED Assumptions)	General Escalation = 2% Integrity Dig Escalation = 2% Full Replacement Escalation = 2% Discount Rate = 5.75%	$(130)	$(123)
Case B.3 (Based on exact means from historical trending)	General Escalation = 3.34% Integrity Dig Escalation = 9.94% Full Replacement Escalation = 4% Discount Rate = 5.27%	$(133)	$(374)

As illustrated by the range of potential NPVs in Table 2, the Extensive Inspection and Repair alternative faces significant cost and financial uncertainty due to its sensitivity to escalation and discount rate assumptions that are challenging to reliably and precisely forecast over several decades. This uncertainty poses additional risks to ratepayers,

especially since much of the costs associated with this alternative are capital expenditures required for continued repairs and ad-hoc replacements. In contrast, the Full Replacement alternative offers significantly more predictable costs and value. By having up front capital investment, Full Replacement also reduces stranded asset risk since these costs are largely, if not fully, depreciated by the end of the pipeline's useful life.

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 37

To provide a unit cost comparison between scenario A and scenario B.

Response:

It is Enbridge Gas's understanding that this undertaking asked the Company to provide the unit cost comparison for the replacement sections in Scenario A and Scenario B.

Scenario B involves the replacement of two NPS 12 XHP ST segments. Although the length of NPS 12 pipe to be abandoned totals 1,828 m, the required replacement project involves the installation of 3,083 m NPS 12 main. The reason for this is that the proposed main cannot be installed in the same corridor as the existing main due to a lack of space from utility congestion. The proposed replacement is shown in Attachment 1.

Other pipe sizes for Scenario A and Scenario B include the installation of NPS 16 XHP ST pipe, NPS 6 XHP ST pipe and NPS 6 IP PE pipe. The costs attributed to the facilities in Scenarios A and B are summarized in Table 1 below.

Table 1: Comparison of replacement sections unit costs for Scenario A and Scenario B

	SCENARIO A			SCENARIO B		
	Proposed (km)	Cost ($)	Unit Cost ($/m)	Proposed (km)	Cost ($)	Unit Cost ($/m)
NPS 16 XHP ST	2.455	$26,757,129	$10,899	0.085	$2,741,043	$32,248
NPS 12 XHP ST	9.914	$91,178,092	$9,197	3.083	$32,616,365	$10,579
NPS 6 XHP ST	0.321	$1,344,206	$4,188	0.189	$1,380,600	$7,305
NPS 6 IP PE	0.935	$7,492,268	$8,013	1.076	$7,012,635	$6,517

It is important to note that the NPS 16 XHP ST unit cost for Scenario B is higher than Scenario A due to the additional complexities of working in this area. A number of factors increase the unit cost ,including the following (among others):

- A bypass is required. This location is a one way feed, so a dedicated bypass is necessary. Due to space constraints, limited room is available to construct bypass, making it more costly.
- The tie-in would need to cross an on ramp to Highway 417. This means the required bypass would need to be installed below grade.
- Construction would be occurring directly above the LRT.
- Construction would be occurring on St. Laurent Blvd, requiring extensive traffic control plans and limited work space, impacting productivity.
- The current pipeline configuration has angled supports, which increases the construction complexity.
- There are two watermains within 2.0 m of the gas main on the bridge crossing.
- Due to proximity of existing structures, excavation must be completed via hydrovac, increasing overall costs.
- Tie-in fittings are NPS 16, requiring external contractor support for tapping services.

The NPS 6 XHP ST unit costs are higher for Scenario B as compared to Scenario A primarily due to the shorter length of pipe required for installation. As a result, the tie-ins for this segment contribute a larger proportion of overall installation costs required, leading to a higher unit cost. In particular, the tie-in at Montreal District Station has additional construction complexities associated with it as compared to a typical district station tie-in, resulting in an even higher unit cost for installation.

The NPS 12 XHP ST unit costs are marginally higher for Scenario B as compared to Scenario A because Scenario B would be constructed entirely within a busy corridor, meaning the pipeline would be installed beneath existing hard surfaces. Although Scenario A is primarily installed beneath existing hard surfaces for the majority of the pipeline route, the unit costs benefit from smaller sections that will be installed within the boulevard (i.e., Sandridge Rd), on less busy roads requiring less traffic control measures (i.e., Brittany Rd. and Cummings Ave.) and gaining efficiencies from installing longer sections of straight pipe.

Residual Risk High
Residual Risk Medium
Residual Risk Low
Proposed Pipeline
Proposed Tie-In
Uninspectable Locations
Existing Stations

Rockcliffe Control
Sandridge Road
St. Laurent Blvd
Hemlock Road
Brittany Dr
827m Replacement on St. Laurent
Montreal Road
Cummings Avenue
McArthur Ave
Vanier Parkway
Donald Street
Ogilvie Road
1,000m Replacement on Tremblay Lateral
Highway 417
Michael Street
Hurdman Station
St Laurent Control
Industrial Ave
St. Laurent Blvd
Lancaster Road

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 45

In respect of the EI&R option, to provide a table comparing Enbridge's estimated cost per segment (crawler tool inspection cost) with the actual cost per segment in the five most recent crawls done in Enbridge's system (based on 2024 work).

Response:

Enbridge Gas completed robotic crawler inline inspection projects on four pipelines in 2024 consisting of 25 crawls (segmented inspections) in total. Each project's vendor cost consisted of a Variable Inspection Cost (VIC) which is the cost per inspection run and a Fixed Inspection Cost (FIC) which does not change as the number of runs increases. The FIC includes the mobilization & demobilization cost, dent strain analysis, new adaptor plate fabrication, Above Ground Marker (AGM) services, and expedited reporting. Please see Table 1 below providing the cost breakdown:

Table 1
2024 Robotic Crawler Inspection Costs

Pipeline	VIC per run ($ CAD)	FIC ($ CAD)	# of runs	Total cost ($ CAD)	Cost per run ($ CAD)
Wilson Ave	75,000	93,500	6	543,500	90,583
Martin Grove	75,000	100,000	6	550,000	91,667
Port Stanley and St. Thomas Phase 1	75,000	127,500	3	352,500	117,500
Sarnia South	75,000	98,050	10	848,050	84,805

Based on the above table, the average cost per run including VIC and FIC is $91,762 CAD.

By comparison, Exhibit I.2-STAFF-17, Attachment 4, Page 2 references a base cost per run of $81,500 CAD in 2024, escalated at 3% annually, which represents a conservative cost estimate.

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 53

To provide a comparison on a per Kilometre basis between 2022 (or 2018) and the present and the planned, if the pipelines were to remain in the ground as you had mentioned, in terms of the Kilometres of cathodic protection that were inadequate versus adequate, on a best-efforts basis.

Response:

Pipeline coatings are the primary defense against corrosion. Cathodic protection (CP) systems, such as rectifiers and sacrificial anodes are designed to provide secondary corrosion protection at small coating defects that are in contact with the soil. In situations where there are disbonded coatings, high resistance backfill (rocks), or other factors, shielding may occur that blocks CP current. The limitation to above ground survey techniques is that they are considered indirect methods of inspection and cannot detect these conditions, nor can they detect metal loss. Above ground surveys may indicate effective CP with no coating defects despite the fact deficiencies may exist.

The St. Laurent Pipeline is cathodically protected by impressed current with rectifiers distributed along its length.

Enbridge Gas conducts annual CP test point surveys along the pipeline as per the Company's operating standards and CSA Z662. The historic CP readings at test points on St. Laurent have met CP criteria. Note that CP readings at test points provide a general indication of CP levels of the pipeline and are located at intervals not exceeding 1.6 km.

In 2018 and 2022, various sections of the St. Laurent pipeline were surveyed using more detailed survey techniques as part of Enbridge Gas's leave to construct applications (refer to EB-2020-0293 and EB-2024-0200). These were close interval potential surveys (CIPS), alternating current voltage gradient (ACVG), direct current voltage gradient (DCVG) and depth of cover surveys. The only CIPS sections in common with both surveys was a 1.2 km section on Sandridge between Hillsdale Road and St. Laurent Blvd. When comparing those surveys, both show adequate levels of CP with a few coating defects indicated, which once again, may not be representative of the actual condition of the pipe.

The 2022 CIPS indicated approximately 1,860 m out of 7,800 m (24%) of the pipe did not meet the -0.85Vdc ‘off’ CP criterion. Recommendations were implemented to increase outputs of influencing rectifier outputs to provide the required CP current. None of the 1,860 m of pipe that did not meet the -0.85Vdc were located on Sandridge between Hillsdale Road and St. Laurent Blvd., so a comparison is not possible between this data and the 2018 survey.

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 55

To provide a table showing the average per year repair and replacement project over the last decade, and then corresponding with the future decades in STAFF-17, attachment 4, pages 2 and 3, a table showing average frequency of repair and replacement on an annual basis.

Response:

The requested table is provided below:

Decade	Total Number of Digs where repair/replacement required	Average Frequency(/yr)
2014-2023	30	3.0
2024-2033	61	6.1
2034-2043	19	1.9
2044-2053	44	4.4
2054-2063	25	2.5
2064-2073	59	5.9
2074-2083	34	3.4
2084-2093	37	3.7

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

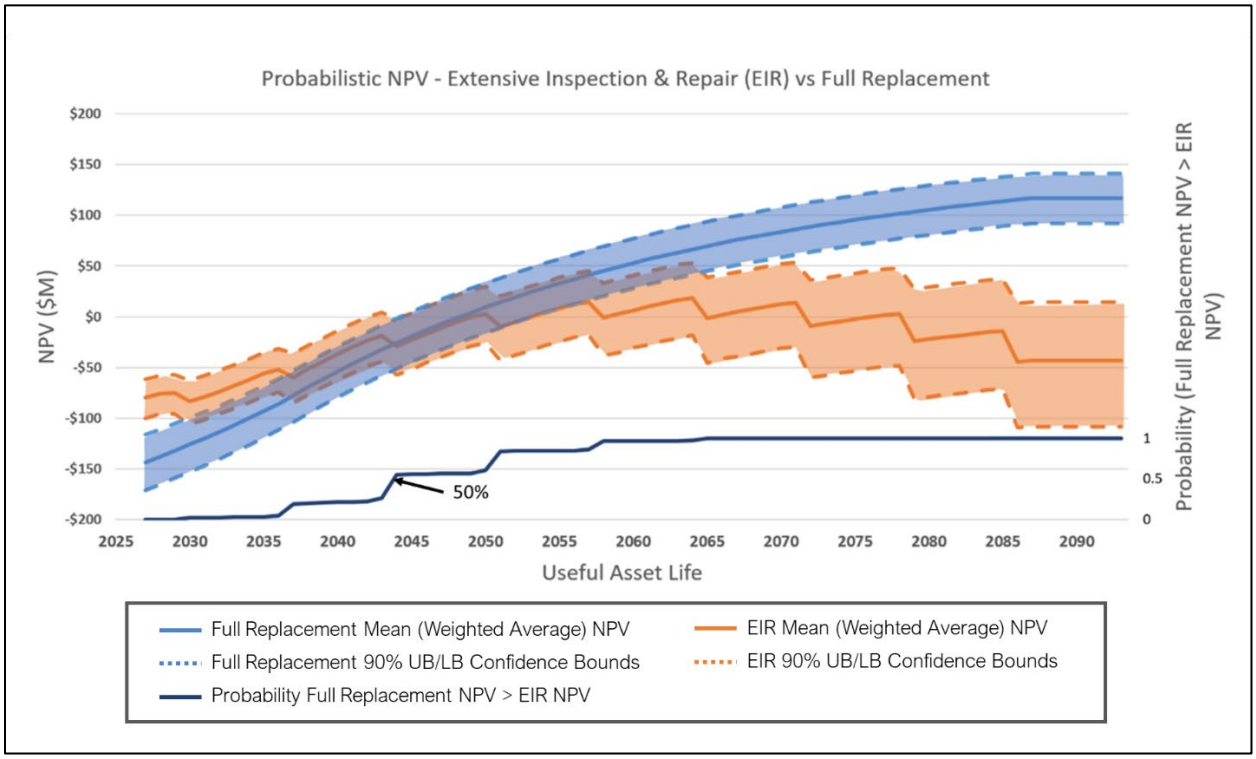
Tr: 58

To provide the latest chart version, and to include the inflection point in the undertaking response.

Response:

Enbridge Gas has re-produced the chart on Exhibit I.1-SEC-2, Attachment 2, Page 8 of 12 with the latest cost and rangeability estimates. The updated chart is provided below in Figure 1. The inflection point of the means of the NPV of the alternatives occurs in 2044. The navy-blue line at the bottom of the chart, aligned with the right y-axis, represents the probability that the NPV of the full replacement alternative (blue) surpasses that of the EI&R alternative (orange), accounting for uncertainties in the outcomes of each alternative.

Figure 1 – Probabilistic NPV for Various Useful Asset Life Horizons
(Updated November 2024)



ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 59

To provide an update of the figure based on the 2 percent escalation scenario discussed earlier in the proceeding.

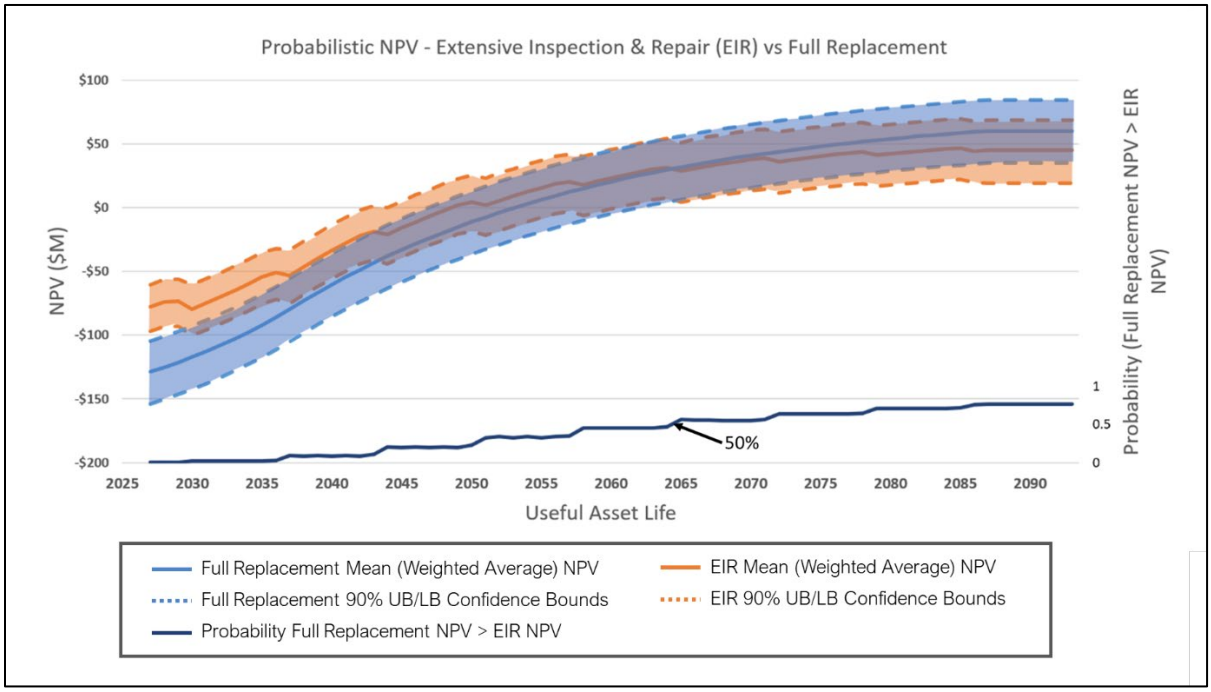
Response:

As requested and for illustrative purposes, Enbridge Gas has re-produced the chart on Exhibit I.1-SEC-2, Attachment 2, Page 8 of 12 with the latest cost and rangeability estimates and based on a constant 2% escalation assumption for all work types.

However, Enbridge Gas maintains that using an average 2% escalation rate across all work types is not realistic and does not accurately reflect the expected escalation rate over the NPV horizon for the SLP, as described in Exhibit JT1.5 and JT1.7. Therefore, these results are not realistic or reflective of the actual NPV projections.

The updated illustrative chart is provided below in Figure 1. The inflection point of the means of the NPV of the alternatives occurs in 2065. The navy-blue line at the bottom of the chart, aligned with the right y-axis, represents the probability that the NPV of the full replacement alternative (blue) surpasses that of the EI&R alternative (orange), accounting for uncertainties in the outcomes of each alternative.

Figure 1 – Probabilistic NPV for Various Useful Asset Life Horizons with 2% Escalation (Updated November 2024)



ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 61

On a best-efforts basis, to provide updated data in respect of disconnection rates for disconnections related to the HER+ program.

Response:

During the October 30, 2024 technical conference, Enbridge Gas witness Mr. Cody Wood made a statement, subject to check, that the HER+ participant connection status was assessed at the time of the post-retrofit audit.[1] After checking the timing of this assessment, Enbridge Gas can now clarify that HER+ applicants are initially assessed to determine if they are Enbridge Gas customers at the time when their HER+ applications are being processed. As provided in Exhibit I.1-STAFF-14 part a) the status of Enbridge Gas customers that participated in the HER+ program will continue to be assessed quarterly.

The data relied upon to establish the assumed starting rate of customer disconnection was produced in March of 2024; the customer status was determined at that time. The most recent HER+ dataset was pulled November 1, 2024. The program data indicates that of the 84,187 natural gas heated homes that installed electric heat pumps through NRCan's Canada Greener Homes Grant in Ontario, only 775 (approximately 1%) disconnected from natural gas while 83,412 (99%) maintained their natural gas connection.

[1] TC Tr. Vol. 1, p. 60, lines 1-8.

ENBRIDGE GAS INC.

Answer to Undertaking from
Environmental Defence (ED)

Undertaking:

Tr: 64

To check to see if there were written instructions or a written confirmation of instructions between Enbridge and Integral.

Response:

Enbridge Gas relayed verbal instructions to Integral Engineering in respect of doing a probabilistic analysis: to develop a probabilistic model to understand how uncertainty in heat pump adoption rates and gas customer disconnection rates could impact the modeled year in which there are zero customers remaining on the gas system. Integral Engineering verbally confirmed their understanding of what Enbridge Gas sought during the same meetings. Enbridge Gas and Integral Engineering have used this approach in the past under the Agreement for Ad-hoc work provided at Exhibit I.2-PP-44, Attachment 2. As such, no additional written instructions or confirmation of instructions was required or exists.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 77

To validate whether a casing is present or not, to the best of Enbridge's knowledge, further to what is presented here, in figure 4.

Response:

Based on the available records, drawings, and In-line Inspection (ILI) results, there is no casing at the Highway 417 ramp location where the 80+% deep metal loss anomaly was reported. The crawler tool can typically identify casings and has identified two casings at the intersection of St. Laurent Blvd. and Hemlock Rd., which aligns with Company records. The ILI results do not show any indication of metal loss around these two identified casings. This further reinforces Enbridge Gas's understanding that not all casings result in metal loss and not all metal loss is associated with casings.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 84

To confirm the responses of the witness with any appropriate qualifications.

Response:

Enbridge Gas conducts an annual cathodic protection survey program that includes casings. Casing potentials are compared with carrier pipe potentials to verify electrical isolation.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 92

To provide an estimate of the three alternatives, being the extension of the line, the potential addition of the station, or the potential upgrade of the TransAlta line, to allow a cut over to the main 470-pound feed; for those to be estimated, at least at a high level, on a best-efforts basis. If that cannot be provided, why it cannot be provided; and then, from a regulatory perspective, what Enbridge proposes as the appropriate approach that it would ask the board to consider for approval.

Response:

The initial cost estimates (excluding Interest During Construction (IDC) and Indirect Overheads) for the three alternatives are provided in Table 1. However, these cost estimates are still under development and incomplete. The only scope known at this time to be feasible with a complete cost estimate is the new 660 m segment of XHP pipe. The other cost estimates have been produced on a best-efforts basis, but are incomplete in terms of known scope and overall viability, so they will likely increase once all factors and inputs are quantified. Therefore, it is not appropriate to compare the three options as feasible alternatives at this time.

Major items that still need to be assessed for feasibility and cost include, but are not limited to:

- Land requirements for stations.
- Modifications to existing stations to accommodate changes in natural gas flows throughout the system.
- Requirement for new valves to operate system safely and reliably.
- Engineering studies to determine feasibility of pressure elevations.
- Ongoing operational/ILI costs for pipelines that would be operating above 30% SMYS as a result of the pressure elevation, including land requirements for ILI launchers and receivers.
- Retrofits required to facilitate future ILIs.
- Weldability of proposed tie-in locations .

Table 1

Item #	Description	20024463 – New 660 m	District Station at Industrial and City Yard	Pressure Elevation 470#
1	Material	$298,489	$1,171,774	$896,119
2	Labour Costs	$5,303,835	$3,318,276	$4,176,892
3	External Permitting, Land	$126,229	$73,937	$142,214
4	Outside Services	$912,836	$169,082	$310,389
5	Direct Overheads	$120,659	$36,245	$75,450
6	Contingency	$977,290	$923,903	$1,090,253
7	**Total Project Costs**	**$7,739,340**	**$5,693,217**	**$6,691,318**

At this time, Enbridge Gas is proposing the new 660 m segment of XHP pipe for the TransAlta segment, and the Company is requesting the OEB's approval for the segment in this application. If Enbridge Gas subsequently determines that an alternative option is feasible and more economic, Enbridge Gas would pursue that option. In this scenario, Enbridge Gas would advise the OEB and file any necessary update or notice of change.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 101

To provide the readings in 2021, or as far back as 2020, when Enbridge applied for the original leave to construct to replace the pipeline

Response:

Please refer to Exhibit JT2.3 Attachment 1, Appendix D for the 2022 Close Interval Potential Survey (CIPS) and DC Voltage Gradient Survey (DCVG) on the St. Laurent pipeline. Please refer to Exhibit JT1.10 for additional details on the 2018 and 2022 CIPS and DCVG surveys conducted on the St. Laurent pipeline.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 107

To provide a breakdown of the cost estimate that would be holistic to downsize the nps 16 portion to an nps 12 portion.

Response:

The Project is not designed to serve any future growth in natural gas demands, but rather to ensure that the Company can continue to meet its obligation to serve the firm contractual needs of its existing customers under peak design conditions. The capacity of the proposed pipeline is slightly less than the current due to the greater overall length of the new alignment.

As a result, based on its OEB-approved demand forecasting methodology and current contractual customer commitments, it is not appropriate to seek to downsize the proposed NPS 16 to NPS 12 as doing so would inhibit the Company's ability to meet its firm contractual obligations to natural gas customers and accordingly the solution is not feasible.

However, in an effort to be as responsive as possible and for illustrative purposes only, the Company has provided a high-level estimate of the savings that could occur from downsizing the NPS 16 section of pipeline to NPS 12 in Table 1. The estimated costs in Table 1 are based on the following assumptions:

- Material costs;
- Trenching – 3-5% savings resulting from reducing trench size to 12-inch. Table 1 assumes 5% savings;
- Similar labour and equipment costs;
- Similar welding costs (due to the urban setting of the project); and
- Identical drilling costs.

Table 1: Cost Difference if NPS 12 instead of NPS 16 illustrates the savings are minimal

	Quantity	Difference ($)	Cost ($)	Total Savings ($)
Pipe	2772	60		166,320
Fittings				
EL 45	8	729		5,832
EL 90	21	1,526		32,046
16 x 12 Reducer	3		424	1,272
3WT	1	60,766		60,766
Cap	12	(224)		(2,688)
Trenching Savings	5%		20,000,000	1,000,000
Total				1,263,548

ENBRIDGE GAS INC.

Answer to Undertaking from
Energy Probe Research Foundation (EP)

Undertaking:

Tr: 124

To advise the number of customers in the Ottawa area and the number of customers added since 2020.

Response:

Please refer to the response provided in JT2.11.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 130

To reconcile that difference of equally split in FRPO-1 with the two-thirds model through the Rockcliffe control point in the previous confidential table.

Response:

The flows at the Rockcliffe and Gatineau crossings have been outlined below in Table 1, for a 2024 47.5 HDD Winter Design Condition. The contract for supply to Gazifere, which is provided at Exhibit I.1-CAFES Ottawa-7 Attachments 1 and 2, has a Contract Demand and Maximum Daily Transportation Volume of 1,681 10^3m^3 or 84,050 m^3/hr using a 20 hour factor. As indicated in the response to Exhibit I.1-FRPO-1, the supply split is nearly equal between points of entry on design day conditions due to actual system configuration and constraints. Table 1 shows the modeled design flow between the two crossings that feed Gazifere and is based on Gazifere's customer demand at a peak. Actual daily flow will depend on the temperature profile and customer usage on any particular day.

Table 1: Design Hour Supply to Gazifere

Crossing	Modeled Design Flow (m^3/hr)
[redacted]	[redacted]
[redacted]	[redacted]

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 132

To confirm the mop at the indicated location on the map.

Response:

An updated schematic of the existing St. Laurent System and nearby system showing Maximum Operating Pressure (MOP) can be found at Attachment 1.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 135

To provide the two remaining capacity left on the line in its current conditions, for the pipelines that are undertaking jtx1.24: to provide the two remaining capacity left on the line in its current conditions, for the pipelines that are there through the eastern feed, and the minimum inlet needed at the Gatineau control station.

Response:

The remaining capacity on a pipeline is highly dependent on the location of incremental demand, and as such, can vary widely. The remaining capacity for the St. Laurent pipeline has been assessed assuming all incremental load will be added at Rockcliffe station. An incremental load of ~23,000m^3/hr can be added prior to a modelled pressure of 1379 kPa (200 PSIG) being observed.

The Eastern feed (Gatineau Crossing) is at capacity and increasing flow through the crossing would result in pressure/capacity constraints on the downstream system.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 139

To provide a design hour simulation to understand the amount of demand that could be shifted from Rockcliffe to the east to meet the peak hour demand for gazifère and provide the current numbers and the maximum potential that could be provided through the eastern feed.

Response:

For current flows through the two crossings to Gazifere, please refer to the response in Exhibit JTX1.22.

For the maximum potential that could be provided through the Eastern feed (Gatineau Crossing), based on the current configuration and limitations, please refer to the response in Exhibit JTX1.24.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 143

To take the amount that can be shifted and to net it off the 41,000 that is currently going through the Rockcliffe station and rerun the simulations for frpo-24 and -25, to see if there is any material improvement that could help reduce the cost of this project.

Response:

As outlined in the response to Exhibit JTX1.24, shifting additional flow to the Eastern crossing would result in downstream capacity/pressure constraints.

Given the impact to downstream systems that shifting additional flow to the Eastern crossing would have, modelling has focused on modifications of set pressure at stations [redacted], [redacted], and [redacted] for the potential to reduce flow at these locations. The column "Set pressure modifications" included in Tables 1 and 2 outlines the change in set pressure from the previous response in Exhibit I.2-FRPO-24 and Exhibit I.2-FRPO-25. Set pressures were modified to the extent possible, prior to downstream networks experiencing modeled pressures below the minimum system pressure (MSP).

Modification of set pressures at stations [redacted], [redacted], and [redacted] was found to have a negligible impact on project sizing/scope. However, reduction of pressure at these stations was found to be detrimental to pressures on downstream networks. At the locations outlined in Figure 1, modeled pressures were found to have the decreases outlined below; there was no change in the location of the low point. The MSP of both networks is 140 kPa.

- Low Point A: 155 kPa → 143 kPa
- Low Point B: 159 kPa → 143 kPa

The impact to system low points was consistent in both Exhibit I.2-FRPO-24 and I.2-FRPO-25 scenarios. All other stations feeding downstream networks in the vicinity of those included in Exhibit I.2-FRPO-24 and Exhibit I.2-FRPO-25 were modeled at maximum set pressure and so are not included in the map.

Table 1: Exhibit I.2-FRPO-24 Updated Table

(Proposed Design)

STN #	Stations	Winter 2023-2024		*Below Min Inlet?*	*Set Pressure Modifications (kPa)*
		Inlet Pressure (kPa)	Flow (m3/h)		
		1585	3081	No	0
		1588	60259	No	-14
		1634	500	No	0
		1644	317	No	0
		1671	6186	No	0
		1738	13610	No	0
		1586	41098	No	0
		(To be Abandoned)	0	N/A	0
		1637	16246	No	-20
		1579	3121	No	0
		1584	926	No	0

Table 2: Exhibit I.2-FRPO-25 Updated Table

(NPS 12 instead of NPS 16)

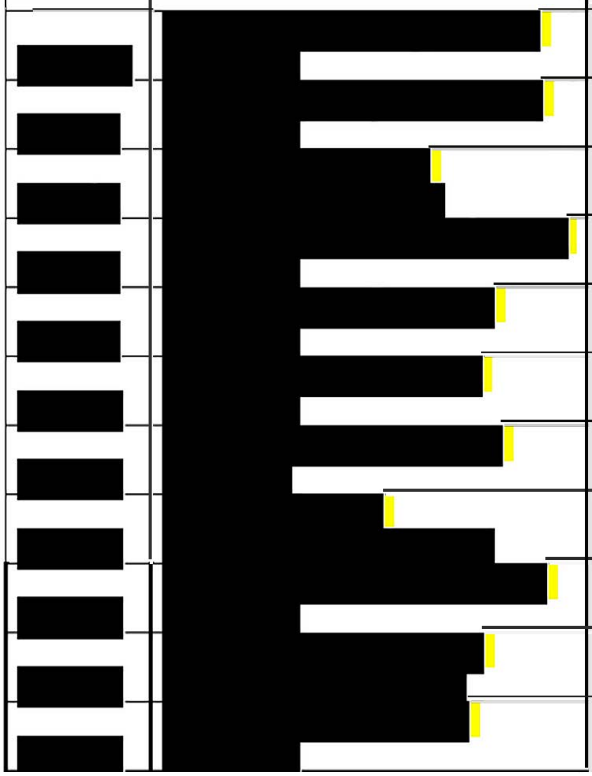
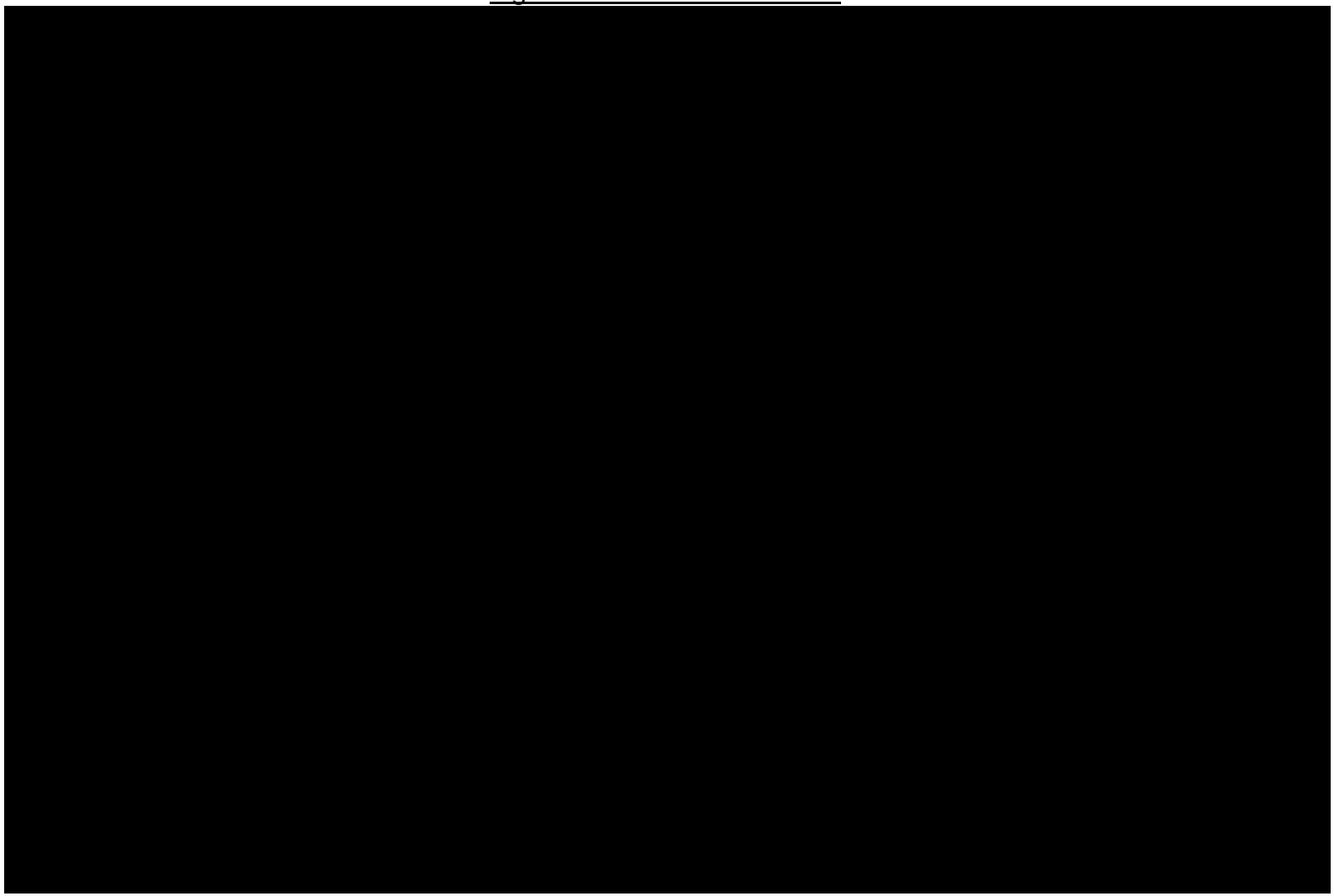
STN #	Stations	Winter 2023-2024		*Below Min Inlet?*	*Set Pressure Modifications (kPa)*
		Inlet Pressure (kPa)	Flow (m3/h)		
		1586	3081	No	0
		1234	60259	No	-14
		1309	500	No	0
		1320	317	No	0
		1339	6186	No	0
		1421	13610	No	0
		1259	37488	Yes	0
		(To be Abandoned)	0	N/A	0
		1307	16246	No	-20
		1248	3121	No	0
		1252	926	No	0

Figure 1: Low Point Locations



ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 157

To provide a map showing the 12- and 16-inch laterals.

Response:

An updated schematic of the existing St. Laurent System showing the NPS 12- and 16-inch pipe sizes can be found at Attachment 1.

Rockcliffe Control

Sandridge Road

St. Laurent Blvd

Hemlock Road

Brittany Dr

Montreal Road

Cummings Avenue

Vintage Steel NPS 16

Vintage Steel NPS 12

Vanier Parkway

McArthur Ave

Donald Street

Ogilvie Road

Highway 417

Michael Street

Hurdman Station

St Laurent Control

Industrial Ave

St. Laurent Blvd

Lancaster Road

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 157

To look at the ability to reduce the pressures at three selected stations and increase the pressure at other stations to offload them, to reduce the pressure and amount of gas that would need to flow through the St. Laurent pipeline.

Response:

Please refer to the response to Exhibit JTX1.26.

ENBRIDGE GAS INC.

Answer to Undertaking from
Federation of Rental-housing Providers of Ontario (FRPO)

Undertaking:

Tr: 164

To provide a high-level assessment of additional cost associated with putting in control valves versus other differential regulation.

Response:

The cost difference, for materials only, for control valves versus pressure regulators for this station is $500,000.

Due to design considerations including, but not limited to: noise, footprint limitations, and minimizing pressure differential requirements, control valves have already been included in the proposed design for the Rockcliffe station, and as such, these costs have already been accounted for. The differential required for the station is based upon the pressure required across the various components including control valves, metering, piping and valves at the station's maximum flow rate. The total requirement across the station, with the use of control valves, is 138 kPa (20 psi) above the delivery pressure of 1210 kPa (175 psi).

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 5

To provide inflation and escalation parameters used for the purposes of the amp.

Response:

The 2025 to 2034 Asset Management Plan[1] uses a 2% escalation factor applied on an overall basis to the entire portfolio of projects.

The Asset Management Plan has thousands of investments at various stages of development. The escalation factor used in the 2025 to 2034 Asset Management Plan is an estimate used at a macro level to capture cost increases, and is not intended to be used for, and is not applicable to, evaluating the economics of a specific project within a leave to construct application, such as the St. Laurent project.

As noted in Table 3.1-1 of the 2025 to 2034 Asset Management Plan, future costs do not include inflationary measures. Normal inflationary measures and impacts such as rising material costs, foreign exchange, and labour are expected to be covered within investment contingency. Incremental shifts in inflation caused by global supply chain shortages, pandemics, or other unusual circumstances have not been considered.

A small number of programs within the Asset Management Plan with defined scope/unit rates have included an escalation factor where information was available to inform the assumption (such as for meter purchases and vehicle purchases).

Accordingly, for the St. Laurent Replacement Project leave to construct application, a specific escalation factor was used that is applicable to and reflects the representative parameters of the asset that differ in this case from those shown in the Asset Management Plan.

[1] EB-2020-0091

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 7

To provide updated npv figures in tabular form.

Response:

Attachment 1 provides the tabular form of the updated NPV chart provided in Exhibit JT1.12, including the mean, lower bound, and upper bounds of the NPV of each alternative. Similarly, Attachment 2 provides the tabular form of the updated NPV chart provided in Exhibit JT1.13.

Probabilistic NPV for Various Useful Asest Life Horizons
(Data for Chart provided in Exhibit JT1.12)

Year	EIR Option NPV ($M)			Full Replacement Option ($M)		
	Mean	5% Percentile	95% Percentile	Mean	5% Percentile	95% Percentile
2027	-$79.72	-$100.01	-$61.53	-$143.48	-$171.61	-$116.31
2028	-$75.87	-$95.89	-$57.75	-$137.78	-$165.55	-$110.96
2029	-$75.43	-$95.76	-$57.29	-$132.01	-$159.46	-$105.50
2030	-$83.66	-$105.85	-$62.98	-$126.12	-$153.29	-$99.89
2031	-$78.94	-$101.32	-$58.29	-$120.08	-$146.99	-$94.09
2032	-$73.82	-$96.01	-$53.14	-$113.83	-$140.51	-$88.06
2033	-$68.37	-$90.75	-$47.72	-$107.34	-$133.82	-$81.76
2034	-$62.48	-$84.67	-$41.80	-$100.56	-$126.86	-$75.15
2035	-$56.20	-$78.58	-$35.55	-$93.45	-$119.60	-$68.20
2036	-$52.47	-$74.75	-$31.74	-$85.98	-$111.98	-$60.86
2037	-$59.62	-$85.04	-$36.47	-$78.09	-$103.97	-$53.10
2038	-$51.81	-$76.93	-$28.70	-$69.74	-$95.51	-$44.85
2039	-$44.30	-$69.72	-$21.16	-$61.72	-$87.38	-$36.93
2040	-$37.00	-$62.12	-$13.89	-$54.00	-$79.58	-$29.30
2041	-$29.99	-$55.41	-$6.85	-$46.58	-$72.08	-$21.95
2042	-$23.17	-$48.29	-$0.06	-$39.44	-$64.87	-$14.88
2043	-$19.16	-$44.59	$4.08	-$32.57	-$57.93	-$8.06
2044	-$28.95	-$57.47	-$2.25	-$25.95	-$51.26	-$1.49
2045	-$22.83	-$51.93	$3.23	-$19.57	-$44.83	$4.83
2046	-$16.88	-$45.40	$9.82	-$13.43	-$38.65	$10.93
2047	-$11.16	-$40.26	$14.90	-$7.51	-$32.69	$16.81
2048	-$5.60	-$34.12	$21.10	-$1.80	-$26.95	$22.49
2049	-$0.26	-$29.35	$25.80	$3.70	-$21.42	$27.96
2050	$2.83	-$25.72	$29.55	$9.00	-$16.09	$33.24
2051	-$10.22	-$43.37	$20.09	$14.12	-$10.95	$38.33
2052	-$5.33	-$37.85	$24.71	$19.06	-$5.99	$43.25
2053	-$0.71	-$33.86	$29.60	$23.82	-$1.21	$47.99
2054	$3.86	-$28.66	$33.90	$28.41	$3.40	$52.57
2055	$8.18	-$24.97	$38.49	$32.84	$7.85	$56.99

2056	$12.46	-$20.06	$42.50	$37.12	$12.14	$61.25
2057	$14.73	-$18.46	$44.96	$41.26	$16.29	$65.37
2058	-$1.18	-$38.21	$33.00	$45.24	$20.29	$69.35
2059	$2.63	-$35.39	$37.42	$49.09	$24.15	$73.19
2060	$6.32	-$30.71	$40.50	$52.81	$27.87	$76.90
2061	$9.88	-$28.14	$44.67	$56.40	$31.47	$80.48
2062	$13.33	-$23.70	$47.51	$59.87	$34.94	$83.94
2063	$16.65	-$21.37	$51.44	$63.21	$38.30	$87.28
2064	$18.42	-$18.56	$52.64	$66.45	$41.53	$90.51
2065	-$1.35	-$45.50	$38.51	$69.77	$44.89	$93.79
2066	$1.61	-$41.35	$41.28	$72.76	$47.89	$96.79
2067	$4.55	-$39.42	$43.89	$75.66	$50.79	$99.68
2068	$7.36	-$36.62	$46.69	$78.45	$53.59	$102.48
2069	$10.07	-$33.90	$49.41	$81.16	$56.30	$105.18
2070	$12.69	-$31.28	$52.03	$83.77	$58.91	$107.80
2071	$14.01	-$29.92	$53.40	$86.30	$61.44	$110.32
2072	-$9.29	-$60.20	$35.92	$88.74	$63.88	$112.77
2073	-$6.92	-$57.83	$38.28	$91.10	$66.24	$115.13
2074	-$4.63	-$55.54	$40.57	$93.38	$68.52	$117.41
2075	-$2.42	-$53.33	$42.79	$95.59	$70.73	$119.61
2076	-$0.28	-$51.19	$44.93	$97.72	$72.86	$121.74
2077	$1.79	-$49.12	$46.99	$99.78	$74.92	$123.80
2078	$2.78	-$48.19	$48.00	$101.77	$76.91	$125.80
2079	-$24.03	-$81.07	$27.34	$103.69	$78.83	$127.72
2080	-$22.16	-$79.21	$29.21	$105.55	$80.69	$129.58
2081	-$20.35	-$77.40	$31.01	$107.35	$82.49	$131.38
2082	-$18.61	-$75.66	$32.75	$109.09	$84.23	$133.11
2083	-$16.93	-$73.97	$34.44	$110.77	$85.91	$134.79
2084	-$15.30	-$72.34	$36.07	$112.39	$87.53	$136.42
2085	-$14.56	-$71.56	$36.72	$113.96	$89.10	$137.99
2086	-$44.82	-$109.48	$13.28	$115.48	$90.62	$139.50
2087	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97
2088	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97
2089	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97

2090	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97
2091	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97
2092	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97
2093	-$43.38	-$108.50	$14.67	$116.94	$92.08	$140.97

Probabilistic NPV for Various Useful Asest Life Horizons with 2% Escalation
(Data for Chart provided in Exhibit JT1.13)

Year	EIR Option NPV ($M)			Full Replacement Option ($M)		
	Mean	5% Percentile	95% Percentile	Mean	5% Percentile	95% Percentile
2027	-$77.60	-$97.13	-$60.24	-$128.84	-$154.15	-$104.40
2028	-$73.92	-$93.32	-$56.24	-$125.18	-$150.49	-$100.73
2029	-$73.48	-$93.10	-$56.14	-$121.29	-$146.60	-$96.84
2030	-$79.41	-$100.46	-$60.32	-$117.15	-$142.46	-$92.70
2031	-$74.96	-$95.94	-$55.80	-$112.74	-$138.05	-$88.30
2032	-$70.27	-$91.31	-$51.18	-$108.06	-$133.37	-$83.61
2033	-$65.23	-$86.22	-$46.08	-$103.08	-$128.39	-$78.63
2034	-$59.94	-$80.98	-$40.84	-$97.78	-$123.09	-$73.33
2035	-$54.25	-$75.24	-$35.10	-$92.15	-$117.46	-$67.70
2036	-$50.98	-$71.96	-$31.94	-$86.16	-$111.47	-$61.71
2037	-$53.29	-$75.18	-$33.26	-$79.79	-$105.10	-$55.35
2038	-$46.51	-$68.32	-$26.31	-$73.02	-$98.33	-$48.57
2039	-$40.00	-$61.88	-$19.96	-$66.54	-$91.85	-$42.10
2040	-$33.79	-$55.59	-$13.59	-$60.34	-$85.65	-$35.89
2041	-$27.81	-$49.70	-$7.78	-$54.41	-$79.72	-$29.96
2042	-$22.13	-$43.93	-$1.93	-$48.73	-$74.04	-$24.28
2043	-$18.76	-$40.61	$1.34	-$43.29	-$68.60	-$18.85
2044	-$21.05	-$43.95	$0.24	-$38.09	-$63.40	-$13.64
2045	-$16.02	-$38.72	$4.77	-$33.11	-$58.42	-$8.66
2046	-$11.26	-$34.16	$10.03	-$28.34	-$53.65	-$3.89
2047	-$6.66	-$29.35	$14.14	-$23.78	-$49.09	$0.66
2048	-$2.30	-$25.19	$19.00	-$19.42	-$44.73	$5.03
2049	$1.93	-$20.77	$22.72	-$15.24	-$40.54	$9.21
2050	$4.28	-$18.59	$25.51	-$11.24	-$36.55	$13.21
2051	$1.76	-$21.35	$23.20	-$7.41	-$32.72	$17.03
2052	$5.43	-$18.13	$27.24	-$3.75	-$29.06	$20.70
2053	$8.96	-$14.15	$30.40	-$0.24	-$25.55	$24.20
2054	$12.32	-$11.24	$34.13	$3.11	-$22.20	$27.56
2055	$15.56	-$7.55	$37.00	$6.33	-$18.98	$30.77
2056	$18.64	-$4.92	$40.45	$9.40	-$15.91	$33.85
2057	$20.33	-$2.84	$41.78	$12.34	-$12.97	$36.79
2058	$17.76	-$6.13	$40.47	$15.16	-$10.15	$39.60
2059	$20.48	-$3.59	$42.59	$17.85	-$7.46	$42.30
2060	$23.06	-$0.83	$45.77	$20.43	-$4.88	$44.88
2061	$25.55	$1.48	$47.66	$22.90	-$2.41	$47.34
2062	$27.92	$4.03	$50.63	$25.26	-$0.05	$49.71
2063	$30.20	$6.13	$52.31	$27.52	$2.21	$51.96
2064	$31.38	$7.50	$54.17	$29.68	$4.37	$54.13
2065	$28.75	$4.25	$51.08	$31.75	$6.44	$56.20
2066	$30.73	$6.38	$53.71	$33.73	$8.42	$58.18
2067	$32.70	$8.12	$55.55	$35.63	$10.33	$60.08
2068	$34.52	$9.94	$57.37	$37.44	$12.15	$61.89
2069	$36.27	$11.69	$59.12	$39.18	$13.88	$63.63
2070	$37.94	$13.36	$60.79	$40.84	$15.54	$65.29
2071	$38.78	$14.25	$61.66	$42.43	$17.13	$66.88
2072	$36.24	$11.58	$59.40	$43.96	$18.66	$68.40
2073	$37.71	$13.04	$60.87	$45.41	$20.11	$69.86
2074	$39.11	$14.45	$62.27	$46.81	$21.51	$71.25
2075	$40.46	$15.79	$63.61	$48.14	$22.84	$72.59
2076	$41.74	$17.08	$64.90	$49.42	$24.12	$73.86
2077	$42.97	$18.31	$66.13	$50.64	$25.34	$75.09
2078	$43.56	$18.87	$66.68	$51.81	$26.51	$76.26
2079	$41.20	$16.63	$64.36	$52.93	$27.63	$77.38

2080	$42.28	$17.71	$65.44	$54.00	$28.70	$78.45
2081	$43.32	$18.74	$66.47	$55.03	$29.73	$79.47
2082	$44.30	$19.73	$67.46	$56.01	$30.71	$80.45
2083	$45.25	$20.68	$68.41	$56.95	$31.65	$81.39
2084	$46.16	$21.58	$69.31	$57.84	$32.54	$82.29
2085	$46.56	$21.97	$69.75	$58.70	$33.40	$83.15
2086	$44.46	$19.85	$67.66	$59.53	$34.23	$83.97
2087	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76
2088	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76
2089	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76
2090	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76
2091	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76
2092	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76
2093	$45.17	$19.46	$68.89	$60.31	$35.01	$84.76

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 10

To file and explain the document enb-22stlau.

Response:

A copy of the document “ENB (22STLAU) CD-REP-SVY-002_D1” titled “NPS 12 St. Laurent Line 2022 CIPS+DCVG Report” can be found at Attachment 1. This report outlines the findings related to Close Interval Potential Survey (CIPS) and Direct Current Voltage Gradient (DCVG) surveys which were performed by Corrosion Service Company Limited (CSCL) in 2022. The report was issued on November 17, 2022.

CORROSION SERVICE

Enbridge Gas Inc.

Close Interval Potential Survey and DC Voltage Gradient Survey

NPS 12 St. Laurent Line

2022 CIPS+DCVG Report

CJ # 23930-21

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CORROSION SERVICE

NPS 12 St. Laurent Line
CIPS+DCVG Report

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Revisions Table

Rev. #	Description	Page
D0	Issued for Information	-
D1	Additional surveys across previously inaccessible sections added	Various

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Figures

Tables

EXECUTIVE SUMMARY

Corrosion Service Company Limited (CSCL) was retained by Enbridge Gas Inc. to conduct a close interval potential survey (CIPS) and DC voltage gradient (DCVG) survey on three sections of the NPS 12 St. Laurent pipeline:

- Section 1: From Ch. 0.0 m (45.456497, -75.674617) to Ch. 7788.4 m (45.406053, -75.630127)
- Section 2: From Ch. 0.0 m (45.406141, -75.627368) to Ch. 508.3 m (45.402145, -75.624713)
- Section 3: From Ch. 0.0 m (45.418381, -75.669210) to Ch. 2837.6 m (45.419534, -75.635635)

The CIPS and DCVG surveys were completed in two phases. Phase 1 surveys covered non-paved sections which didn't require drilling or traffic control, while Phase 2 surveys covered sections requiring drilling, traffic control where the pipeline ran below paved surfaces, and sections requiring brushing. The results for both Phase 1 and Phase 2 are presented in this report.

A summary of the indications identified during the indirect inspections Phase 1 and Phase 2 is shown in Table ES-1.

Table ES-1: Summary of Indications

Indication	Classification	Criterion	Results	Notes
CIPS	Minor	-850 mV_{CSE} Criterion ($-800\ mV_{CSE} \geq V_{OFF} > -850\ mV_{CSE}$)	555.3 m	-
		-900 mV_{CSE} Criterion ($-825\ mV_{CSE} \geq V_{OFF} > -900\ mV_{CSE}$)	914.9 m	-
	Moderate	-850 mV_{CSE} Criterion ($-750\ mV_{CSE} \geq V_{OFF} > -800\ mV_{CSE}$)	140.6 m	-
		-900 mV_{CSE} Criterion ($-750\ mV_{CSE} \geq V_{OFF} > -825\ mV_{CSE}$)	365.0 m	-
	Severe	$V_{OFF} > -750\ mV_{CSE}$	181.4 m	-
DCVG	Minor	15% ≤ %IR < 35%	127	9 "Up to" indications
	Moderate	35% ≤ %IR < 60%	27	1 "Up to" indications
	Severe	%IR ≥ 60%	7	2 "Up to" indication
DCI	Minor (No CIPS Ind.)	$\Delta V_{Rect\text{-}ON} > 30$ mV	0.0 m	-
	Minor	0 mV < $\Delta V_{Rect\text{-}ON}$ < 30 mV	0.0 m	-
	Moderate	30 mV ≤ $\Delta V_{Rect\text{-}ON}$ < 60 mV	0.0 m	-

Table ES-1: Summary of Indications

Indication	Classification	Criterion	Results	Notes
DCI	**Severe**	$\Delta V_{Rect\text{-}ON} \geq 60$ mV	0.0 m	-

Based on the results of the indirect inspection, the following actions are recommended:

- It is recommended to increase the current output of the Enbridge rectifiers providing cathodic protection to the NPS 12 St. Laurent pipeline, especially M-469494, M-469476, M-2967250, M-469588 and M-3905290. If increasing the output of the protecting rectifiers is not feasible, consider the installation of additional cathodic systems.
- Indications were prioritized using NACE Standard SP0502-2010 and the Enbridge External Corrosion Direct Assessment Standard as guidelines, and locations recommended for direct examination are provided in Table ES-2. If additional direct examination locations are required, Table ES-3 lists additional locations to be considered.

Table ES-2: Recommended Direct Examination Locations

Section	DE#	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 1	1	45.440396, -75.646552	3526.8	2.10	Severe DCVG (82.6%IR) Severe CIPS (-682 mV_{CSE})	Immediate action required Reduced confidence. At section with possible thick asphalt
	2	45.432576, -75.642164	4463.6	1.35	Moderate DCVG (42.3%IR) Moderate CIPS (-788 mVCSE)	Scheduled action required
	3	45.430336, -75.640887	4731.6	0.92	Minor DCVG (25.7%IR) Severe CIPS (-724 mV_{CSE})	Scheduled action required
	4	45.430255, -75.640838	4741.4	1.20	Minor DCVG (28.7%IR) Severe CIPS (-719 mV_{CSE})	Scheduled action required

Table ES-3: Additional Direct Examination Locations

Section	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 1	45.454541, -75.654406	1802.3	1.10	Minor DCVG (21.1%IR)	Suitable for monitoring Recommended in Phase 1
	45.445410, -75.649170	2904.8	1.22	Minor DCVG (31.5%IR) Moderate CIPS (-817 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.444684, -75.648774	2990.8	1.06	Minor DCVG (25.6%IR) Moderate CIPS (-824 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.444550, -75.648676	3009.3	1.06	Minor DCVG (30.9%IR) Minor CIPS (-834 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.443780, -75.648251	3102.9	0.91	Minor DCVG (29.0%IR) Moderate CIPS (-818 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.443295, -75.647976	3160.2	1.35	Moderate DCVG (38.1%IR) Minor CIPS (-852 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.424536, -75.637605	5426.2	1.21	Minor DCVG (29.4%IR) Minor CIPS (-833 mV_{CSE})	Suitable for monitoring
	45.421024, -75.635733	5853.1	1.82	Minor DCVG (18.3%IR) Severe CIPS (-538 mV_{CSE})	Scheduled action required
	45.415665, -75.633066	6552.1	2.12	Minor DCVG (33.8%IR) Severe CIPS (-678 mV_{CSE})	Scheduled action required
	45.412861, -75.631172	6900.2	1.28	Moderate DCVG (37.3%IR) Minor CIPS (-827 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.412011, -75.630709	7001.1	1.70	Severe DCVG (65.8%IR)	Scheduled action required

Table ES-3: Additional Direct Examination Locations

Section	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 2	45.405824, -75.627004	46.2	1.96	Severe DCVG (Up to 74.1%IR)	Scheduled action required
Section 3	45.418173, -75.669014	28.8	1.25	Minor DCVG (19.9%IR) Minor CIPS (-848 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.417504, -75.668039	152.1	1.06	Minor DCVG (24.5%IR) Moderate CIPS (-784 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.417622, -75.659092	871.0	2.64	Minor DCVG (24.5%IR) Severe CIPS (-719 mV_{CSE})	Scheduled action required
	45.418515, -75.651120	1566.1	4.64	Severe DCVG (73.1%IR)	Scheduled action required Reduced confidence. Located in Area with Thick Asphalt
	45.418616, -75.648793	1785.7	1.56	Minor DCVG (23.8%IR)	Suitable for monitoring Recommended in Phase 1

1 General

Corrosion Service Company Limited (CSCL) was retained by Enbridge Gas Inc. to conduct a close interval potential survey (CIPS) and DC voltage gradient (DCVG) survey on three sections of the NPS 12 St. Laurent pipeline:

- Section 1: From Ch. 0.0 m (45.456497, -75.674617) to Ch. 7788.4 m (45.406053, -75.630127)
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- Section 3: From Ch. 0.0 m (45.418381, -75.669210) to Ch. 2837.6 m (45.419534, -75.635635)

The CIPS and DCVG surveys were completed in two phases. Phase 1 surveys covered non-paved sections which didn't require drilling or traffic control, while Phase 2 surveys covered sections requiring drilling, traffic control where the pipeline ran below paved surfaces, and sections requiring brushing. The results for both Phase 1 and Phase 2 are presented in this report.

2 Technical Approach

The work is based on the standard practices detailed in NACE Standard SP0207-2007, which is intended to provide guidelines for performing CIPS and DCVG in typical pipeline situations.

All locations and features are referenced by chainages "as measured" on site (i.e., survey chainages). Note that the site chainages have not been aligned against and do not correspond exactly with the alignment chainages. The site chainages were typically measured using a wire dispenser counter and checked using sub-meter GPS coordinates. In case of erroneous records from the wire dispenser counter, the site chainages were calculated using the sub-meter GPS coordinates[1].

[1] As per the Department of Defense (DOD) World Geodetic System 1984 (i.e. WGS84), which was defined as a standard by the National Imagery and Mapping Agency (NIMA) technical report 8350.2

3 Pipeline Data Review

3.1 General

The objectives of the pipeline data review step were to outline the selected survey tools and confirm their reliability.

3.2 Survey Measurements

The indirect inspections were conducted using the following testing methods:

- Influence Testing – to evaluate if the lines are "clean" during the CIPS, meaning that all influencing rectifiers were identified and interrupted simultaneously and that any dynamic stray current activity (i.e., telluric currents) would be compensated in the final results.
- Close Interval Potential Survey (CIPS) – to assess the protection level of the lines and the subsequent risk of corrosion, to identify areas subject to DC interference and to evaluate the general coating condition.
- Direct Current Voltage Gradient (DCVG) Survey – to detect, locate and classify coating holidays.
- Depth of Cover Survey – to record the vertical distance between the pipeline and ground level.

The complete survey procedures for these testing methods are detailed in Appendix A and Appendix B.

3.3 Survey Reliability Assessment

The segment under evaluation is generally accessible along its entire route, including paved roads as they may be surveyed by drilling through the asphalt to ensure contact with the soil. Some areas such as water courses or dense bush may be found to be inaccessible during the CIPS+DCVG survey.

All areas excluded from the CIPS+DCVG survey are listed in Table 4-3.

Reliability in the data recorded during a DCVG survey is expected to be reduced for pipe depths greater than 5 m. Depths of this magnitude are typically observed at trenchless crossings such as horizontal directional drilled crossings. Due to this reduced reliability, the DCVG survey tool will be excluded for sections of pipeline found to be greater than 5 m deep.

Some field applied coatings such as shrink sleeves and polyethylene tape have a poor record in terms of adhesion to the pipe, resulting in risks of electrical shielding. When a line shows a risk of electrical shielding, the reliability of the survey is recommended to be evaluated in conjunction with a direct examination of the pipeline by examining the field coating condition. Should

disbonded field coating be found, the reliability of the survey will be diminished. The protection level of the pipe under the disbonded coating cannot be measured, and so a degree of uncertainty would exist with regards to the protection level of the pipe underneath said coating. The field coating of the St. Laurent Line was unknown at the time of the survey so the risk of electrical shielding is unknown.

4 Survey Results

4.1 Influence Testing

Influence testing was performed prior to the CIPS+DCVG survey to help identify influencing rectifiers and to indicate the presence of additional uninterrupted rectifiers.

In cases where the influence testing suggested there might be additional residual IR drop from rectifiers that could not be located, the influence testing data was used to inform the choice of a modified criterion to assess the cathodic protection potentials as described in Section 4.3.1.1.

4.1.1 Current Interruption

Rectifiers affecting the subject pipeline were based on the information obtained from Enbridge Gas as well as CSCL's internal rectifier database.

Enbridge Gas rectifiers were interrupted through remote monitoring devices.

The parameters, locations and interruption dates for all interrupted current sources are shown in Appendix C.

4.1.2 Waveform Spectrum Testing

To confirm that all of the identified influencing rectifiers were synchronously interrupted and if the lines were "clean" of additional IR drop from influencing rectifiers, the pipe-to-soil potential during the OFF cycle was recorded at test points on each pipeline and analyzed for any trace of rectifier activity.

The test is based on the fact that a single-phase rectifier does not generate a perfect DC current (i.e., like a battery), but it introduces a significant 120 Hz ripple.

If the pipe-to-soil potential is recorded or displayed on an oscilloscope, the magnitude of various frequencies, including 120 Hz, can be determined. When the recording is done during the OFF cycle, and no 120 Hz ripple is found, it suggests that no single-phase influencing rectifiers are active during the recording. Similarly, a three-phase rectifier has a 180 Hz ripple, however sometimes the signature of a three-phase rectifier cannot be accurately detected as it coincides with the most dominant harmonic within any induced voltage from 60 Hz powerline systems.

Waveforms were recorded during the OFF cycles and frequency analyses were conducted using commercially available software, based on a Fourier series mathematical model, to calculate the amplitude of various frequency components in order to identify signatures of influencing single-phase or three-phase rectifiers left ON or out of synchronization.

To facilitate analysis of the 120 Hz frequency component observed on the pipeline, sections of the pipeline displaying similar 120 Hz levels were grouped together. A higher 120 Hz level was interpreted as a higher likelihood that soil IR drop remained due to influence from unidentified rectifier(s) during the OFF cycle. Consecutive test points displaying 120 Hz influence less than 10

mV were grouped and classified as low rectifier influence, 10 mV to 100 mV were grouped and classified as moderate rectifier influence, and greater than 100 mV were grouped and classified as high rectifier influence.

A frequency analysis considered representative of the 120 Hz frequency component along with a summary of the results for each grouped area is shown in Table 4-1.

Table 4-1: OFF Cycle Waveforms. Frequency Spectrum

Section	Chainage (m)	Representative Frequency Components (mV)				Notes
		DC	60 Hz	120 Hz	180 Hz	
Section 1	0.0 to 1202.0	1194.7	434.6	16.4	367.7	Moderate influence from unknown single-phase rectifier(s)
	1202.0 to 2285.2	872.0	136.9	9.0	127.9	Low influence from single-phase rectifiers
	2285.2 to 4198.0	879.0	702.7	15.0	763.4	Moderate influence from unknown single-phase rectifier(s)
	4198.0 to 7785.5	924.8	438.4	6.1	16.9	Low influence from unknown single-phase rectifier(s)
Section 2	0.0 to 508.3	1228.9	33.4	13.6	48.2	Moderate influence from unknown single-phase rectifier(s)
Section 3	0.0 to 2084.2	919.4	142.8	12.3	47.7	Moderate influence from unknown single-phase rectifier(s)
	2084.2 to 2837.6	1087.2	1072.4	8.1	439.6	Low influence from unknown single-phase rectifier(s)

A moderate to high 120 Hz component is suggestive of influence on the pipeline from one or more single-phase rectifiers during the OFF cycle. A low 120 Hz component is suggestive of minimal residual DC current from single-phase rectifiers influencing the pipeline during the OFF cycle.

There are two limitations in the identification of additional uninterrupted rectifiers using the spectrum analysis: first, the test can result in a false negative, so the results do not guarantee an absence of additional rectifier influence; and second, the magnitude of the measured influence provides some indication of the magnitude of the soil IR drop, but the two are not necessarily correlated. Nevertheless, this testing provides some confidence that the field technicians have performed their due diligence in searching for rectifiers, which results in a good compromise between time spent in the field and ensuring the CIPS provides an accurate assessment of the cathodic protection potentials.

4.1.3 Telluric Activity and Compensation

Data loggers were installed at test points to record any telluric activity and stary current effects from the Ottawa Light Rail Transit (LRT) system during the CIPS+DCVG survey.

A summary of the compensated sections for the subject pipeline is outlined in Table 4-2.

Table 4-2: Telluric Activity and Compensation

Section	Telluric Compensation Performed	Chainage (m)
Section 1	No	0.0 to 1202.0
	Yes	1202.0 to 3861.0
	No	3862.4 to 4110.5
	Yes	4112.1 to 5178.9
	No	5181.9 to 5853.1
	Yes	5896.3 to 6297.6
	No	6298.9 to 6318.9
	Yes	6318.9 to 7015.3
	No	7016.5 to 7044.2
	Yes	7052.1 to 7104.2
	No	7105.0 to 7297.7
	Yes	7297.7 to 7665.1
	No	7665.9 to 7678.9
	Yes	7678.9 to 7756.5
	No	7756.5 to 7785.5
Section 2	Yes	0.0 to 508.3
Section 3	Yes	0.0 to 873.1
	No	949.4 to 1117.6
	Yes	1394.8 to 1414.2
	No	1416.5 to 1745.9
	Yes	1745.9 to 2837.6

4.2 CIPS+DCVG Survey

The CIPS and DCVG inspection tools were merged into an integrated CIPS+DCVG survey where possible, in order to increase accuracy and to improve indication alignment. Locations requiring separate CIPS and DCVG surveys were surveyed independently and the data were aligned using sub-meter GPS coordinates.

Pipe-to-soil potentials and 3 m gradients were recorded every three meters. When in the vicinity of DCVG indications, pipe-to-soil potentials and lateral 3 m gradients were recorded every meter to improve the resolution of the observed indications. A combination of lateral and longitudinal DCVG surveys were used during the survey based on the survey conditions.

The sections that were excluded from the CIPS+DCVG survey are listed in Table 4-3.

Table 4-3: Survey Exceptions

Section	Excluded Survey Chainage (m)	Indirect Inspection Tool	Notes
Section 1	5185.8 to 5193.6	CIPS+DCVG	Metal Plate
	5617.0 to 5637.0	DCVG	Rectifier Issue - Interruption Stopped
	5853.1 to 5896.3	CIPS+DCVG	Aboveground Section
	5944.8 to 5997.9	CIPS+DCVG	Highway 417 (Paved)
	5997.9 to 6001.9	DCVG	Depths Greater than 5 m
	6073.4 to 6083.9	CIPS+DCVG	Highway 417 Ramp Off (Paved)
	6087.8 to 6138.6	CIPS+DCVG	Highway 417 Ramp Off (Paved)
	6557.6 to 6602.5	CIPS+DCVG	Railway
	7320.7 to 7326.4	DCVG	Depths Greater than 5 m
	7326.4 to 7378.4	DCVG	Offset Greater than 5 m
	7552.1 to 7557.1	CIPS+DCVG	River
Section 2	22.0 to 42.7	CIPS+DCVG	Concrete Section and Thick Asphalt
Section 3	468.8 to 499.2	DCVG	Depths Greater Than 5 m
	499.2 to 637.0	CIPS+DCVG	Rideau River
	637.0 to 687.0	DCVG	Depths Greater Than 5 m
	873.1 to 949.4	CIPS+DCVG	Highway 417 Ramp Off
	1033.9 to 1102.3	CIPS+DCVG	Highway 19 (Paved)
	1117.6 to 1394.8	CIPS+DCVG	Highway 417 Ramp Off and TransCanada Highway
	1456.0 to 1493.6	DCVG	Depths Greater Than 5 m
	1493.6 to 1511.6	CIPS+DCVG	Excluded Section due to Equipment Malfunction
	1511.6 to 1542.7	DCVG	Depths Greater Than 5 m

Table 4-3: Survey Exceptions

Section	Excluded Survey Chainage (m)	Indirect Inspection Tool	Notes
Section 3	1571.2 to 1688.2	CIPS+DCVG	OC Transpo Facility
	1902.7 to 1910.3	CIPS+DCVG	Sidewalk (Paved)
	2719.4 to 2755.6	CIPS+DCVG	Highway 417 Ramp
	2792.4 to 2803.6	CIPS+DCVG	Highway 417 Ramp

A representative survey profile is plotted in Figure 4-1 and the complete survey results are shown in Appendix D.

The ON and OFF pipe-to-soil potentials (in orange and blue) and the CIPS identification criterion (yellow) are shown with respect to the primary (i.e., left-hand) vertical axis on the top chart. The lateral voltage gradients (in green) or longitudinal voltage gradients (in purple) are shown with respect to the secondary (i.e., right-hand) vertical axis on the top chart.

The depth of cover (in red) is shown on the bottom chart.

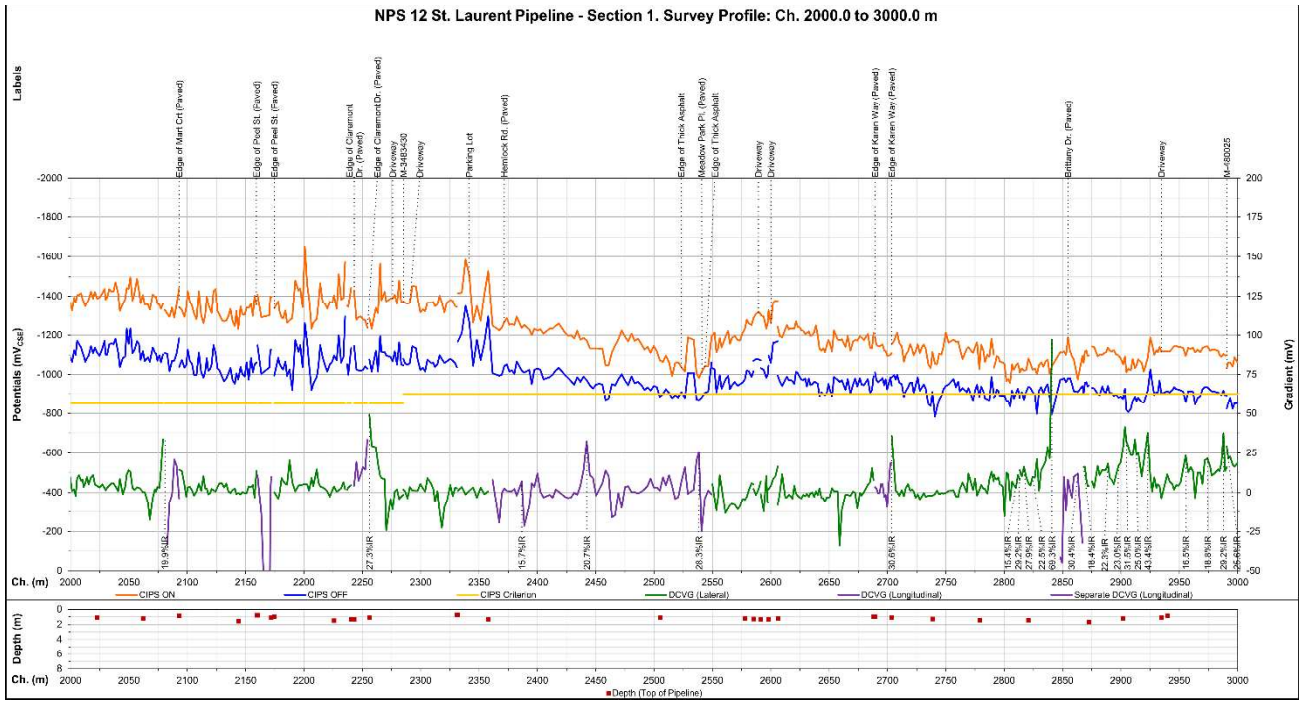

Figure 4-1: NPS 12 St. Laurent Pipeline – Section 1. Ch. 2000.0 m – 3000.0 m. Survey Data

Cross gradients are locations with a positive gradient measured on one side of the pipe in conjunction with a negative gradient on the other side of the pipe and can typically indicate a holiday located on another pipeline or structure. However, this gradient can mask a smaller indication on the line under investigation. As such, these locations were marked on the graph by the text "Cross Gradient" for reference.

Similarly, when a positive gradient of significantly larger magnitude is measured on one side of the pipe in conjunction with a negative gradient of a smaller magnitude on the other side of the pipe, the presence of a holiday in conjunction with a portion of current crossing the pipe is the expected cause. Such locations were marked on the graphs by the text, "Up to %IR", where the %IR value was calculated using the higher observed gradient (i.e. a holiday that may be as large as the listed %IR or smaller).

4.3 Identification and Classification of Indications

4.3.1 Identification Criteria

The following criteria were developed to identify indications.

4.3.1.1 Close Interval Potential Survey

In the absence of additional IR drop in the recorded OFF potentials, CIPS data is primarily assessed using a -850 mV_{CSE} criterion.

However, the identification criterion for CIPS indications was conservatively modified from -850 mV_{CSE} for locations where additional IR drop may be present as indicated by the moderate rectifier influence observed during the waveform spectrum testing as detailed in Section 4.1.2.

Any location displaying an OFF potential more electropositive than the criterion (as detailed in Table 4-4) is defined as an indication under this assessment.

Table 4-4: CIPS Identification Criterion

Section	Survey Chainage (m)	CIPS Identification Criterion (mV_{CSE})	Notes
Section 1	0.0 to 1202.0	-900	Moderate influence from unknown single-phase rectifier(s)
	1202.0 to 2285.2	-850	Low influence from single-phase rectifiers
	2285.2 to 4198.0	-900	Moderate influence from unknown single-phase rectifier(s)
	4198.0 to 7785.5	-850	Low influence from unknown single-phase rectifier(s)
Section 2	0.0 to 508.3	-900	Moderate influence from unknown single-phase rectifier(s)
Section 3	0.0 to 2084.2	-900	Moderate influence from unknown single-phase rectifier(s)

Table 4-4: CIPS Identification Criterion

Section	Survey Chainage (m)	CIPS Identification Criterion (mV_{CSE})	Notes
Section 3	2084.2 to 2837.6	-850	Low influence from unknown single-phase rectifier(s)

4.3.1.2 DC Voltage Gradient Survey

Any location displaying a severity index (i.e., %IR) higher than 15%, consistent with the characteristic shape of the lateral gradient at a holiday (i.e., increasing, reaching a maximum value, and then decreasing) is defined as an indication under this assessment. The calculation of the severity index from the integrated CIPS+DCVG survey data is based on the method detailed in Paper #06193[2] presented at the NACE 2006 Conference.

Cross gradients, as detailed in Section 4.2, are indicative of current flowing across the subject pipeline and were not classified as DCVG indications under this assessment.

4.3.1.3 DC Interference

Two identification criteria are used to identify DC interference indications under this assessment.

Any location displaying an electropositive shift in excess of 30 mV at an OFF potential equal to or more electronegative than the chosen CIPS criterion is defined as an indication.

Additionally, any electropositive shift at an OFF potential more electropositive than the chosen CIPS criterion, when the interfering rectifier is turned ON is defined as an indication.

4.3.2 Classification Criteria

The following criteria were developed to classify DCVG indications in conformance with Paragraph 4.3.2 of the NACE Standard SP0502-2010.

4.3.2.1 Protection Level (CIPS Indication)

4.3.2.1.1 -850 mV_{CSE} Criterion

- Minor: -800 $mV_{CSE} \geq V_{OFF} >$ -850 mV_{CSE}
- Moderate: -750 $mV_{CSE} \geq V_{OFF} >$ -800 mV_{CSE}
- Severe: $V_{OFF} >$ -750 mV_{CSE}

4.3.2.1.2 -900 mV_{CSE} Criterion

- Minor: -825 $mV_{CSE} \geq V_{OFF} >$ -900 mV_{CSE}
- Moderate: -750 $mV_{CSE} \geq V_{OFF} >$ -825 mV_{CSE}
- Severe: $V_{OFF} >$ -750 mV_{CSE}

[2] Segall S.M., Gummow R.A., Reid R.G. Use of an Integrated CIPS/DCVG Survey in the ECDA Process, NACE Corrosion 2006, Paper No. 193, San Diego.

4.3.2.2 Coating Damage (DCVG Indication)

- Minor: 15% ≤ %IR < 35%
- Moderate: 35% ≤ %IR < 60%
- Severe: %IR ≥ 60%

4.3.2.3 DC Interference with No CIPS Indication (DCI Indication)

- Minor: $\Delta V_{Rect\text{-}ON}$ > 30 mV
- Moderate: N/A
- Severe: N/A

4.3.2.4 DC Interference with CIPS Indications (DCI Indication)

- Minor: 0 mV < $\Delta V_{Rect\text{-}ON}$ < 30 mV
- Moderate: 30 mV ≤ $\Delta V_{Rect\text{-}ON}$ < 60 mV
- Severe: $\Delta V_{Rect\text{-}ON}$ ≥ 60 mV

4.3.3 Summary and Classifications of Indications

A summary of the indications identified during the indirect inspections is shown in Table 4-5.

Table 4-5: Summary of Indications

Indication	Classification	Criterion	Results	Notes
CIPS	Minor	-850 mV_{CSE} Criterion (-800 mV_{CSE} ≥ V_{OFF} > -850 mV_{CSE})	555.3 m	-
		-900 mV_{CSE} Criterion (-825 mV_{CSE} ≥ V_{OFF} > -900 mV_{CSE})	914.9 m	-
	Moderate	-850 mV_{CSE} Criterion (-750 mV_{CSE} ≥ V_{OFF} > -800 mV_{CSE})	140.6 m	-
		-900 mV_{CSE} Criterion (-750 mV_{CSE} ≥ V_{OFF} > -825 mV_{CSE})	365.0 m	-
	Severe	V_{OFF} > -750 mV_{CSE}	181.4 m	-
DCVG	Minor	15% ≤ %IR < 35%	127	9 "Up to" indications
	Moderate	35% ≤ %IR < 60%	27	1 "Up to" indications
	Severe	%IR ≥ 60%	7	2 "Up to" indication
DCI	Minor (No CIPS Ind.)	$\Delta V_{Rect\text{-}ON}$ > 30 mV	0.0 m	-
	Minor	0 mV < $\Delta V_{Rect\text{-}ON}$ < 30 mV	0.0 m	-
	Moderate	30 mV ≤ $\Delta V_{Rect\text{-}ON}$ < 60 mV	0.0 m	-
	Severe	$\Delta V_{Rect\text{-}ON}$ ≥ 60 mV	0.0 m	-

The full list of indications identified during the indirect inspections are listed in Appendix E.

4.4 Discussion of Results

The three sections of the St. Laurent line ranged from poorly protect to well protected with a total of 1.86 km of subcriterion potentials. A total of 161 DCVG indications were identified with several being identified in areas with subcriterion potentials, suggesting a risk of active corrosion.

4.4.1 Stray Current

The survey done on the NPS 12 St. Laurent displayed significant fluctuations due to stray current influence from the Ottawa Light Rail Transit (LRT). Section 3, and particularly the area between Rideau River (Ch. 637.0 m) and the off ramp at Highway 417 (Ch. 2792.4 m), was the area most significantly impacted by the high level of stray current. The CIPS on this area was compensated using telluric compensation, however, given the speed of the stray current, the resulting survey profile along this section after compensation, still displays some larger variations in measured potentials from the LRT system. Since the potentials recorded along Section 3 were mostly above criterion, additional survey reads eliminating the stray current completely was not required.

A sample of the stray current influence on Section 3 is shown in Figure 4-2, taken from the datalogger installed at the test post at Trembley Rd. and Avenue O.

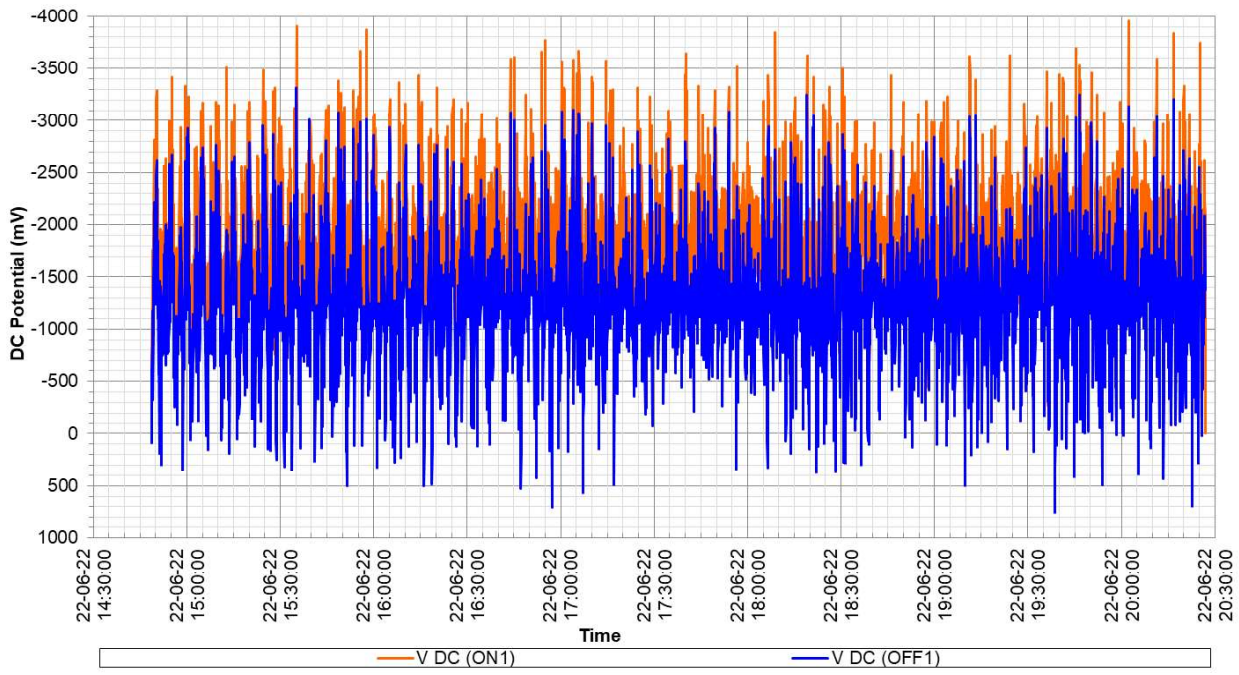

Figure 4-2: Stray Current due to LRT – Test Post at Trembley Rd. and Avenue O

4.4.2 Drilled sections

The survey done on the St. Laurent Line was in an urban area where the pipeline terrain was a mixture of green space and paved surfaces. Paved sections were surveyed when possible during Phase 1 by using cracks with adequate ground contact to the soil. The remaining paved roads were surveyed with a longitudinal survey during Phase 2, using 6 inch deep holes drilled at 3m spacing.

Four paved survey areas were noted as having asphalt that may have been deeper than the 6 inch drilled holes. The contact resistance for these sections was found to be higher for these areas, resulting in less stable CIPS and DCVG measurements. As such, the reliability in the identification and sizing of indication in these sections is expected to be reduced. Table 4-6 summarizes the sections identified with tick asphalt. DCVG indications were still selected in these areas where large DCVG spikes were observed in conjunction with a depression in CIPS potentials.

Table 4-6: Possible Thick Asphalt Areas

Section	From		To	
	Chainage (m)	GPS	Chainage (m)	GPS
Section 1	3160.2	45.443292, -75.648007	3260.2	45.442544, -75.647557
	3386.9	45.441494, -75.646973	3995.7	45.436481, 75.644370
Section 3	58.3	45.417924, 75.668885	69.6	45.417801, -75.668850
	1557.0	45.418438, -75.651170	1571.2	45.418535, -75.651091

4.4.3 CIPS and DCVG Survey Exclusions

On September 15th, an unknown rectifier(s) stopped interruption temporarily during the survey on Section 1, from Ch. 5617.0 to Ch. 5637 m. The CIPS+DCVG survey along this section is being excluded from the survey as there is no shift which would allow to size a possible coating defect on the line at this section. Table 4-3 shows the datalogger installed at test station M-471398, where the failure on interruption can be seen at approximately 3:55 UTC time.

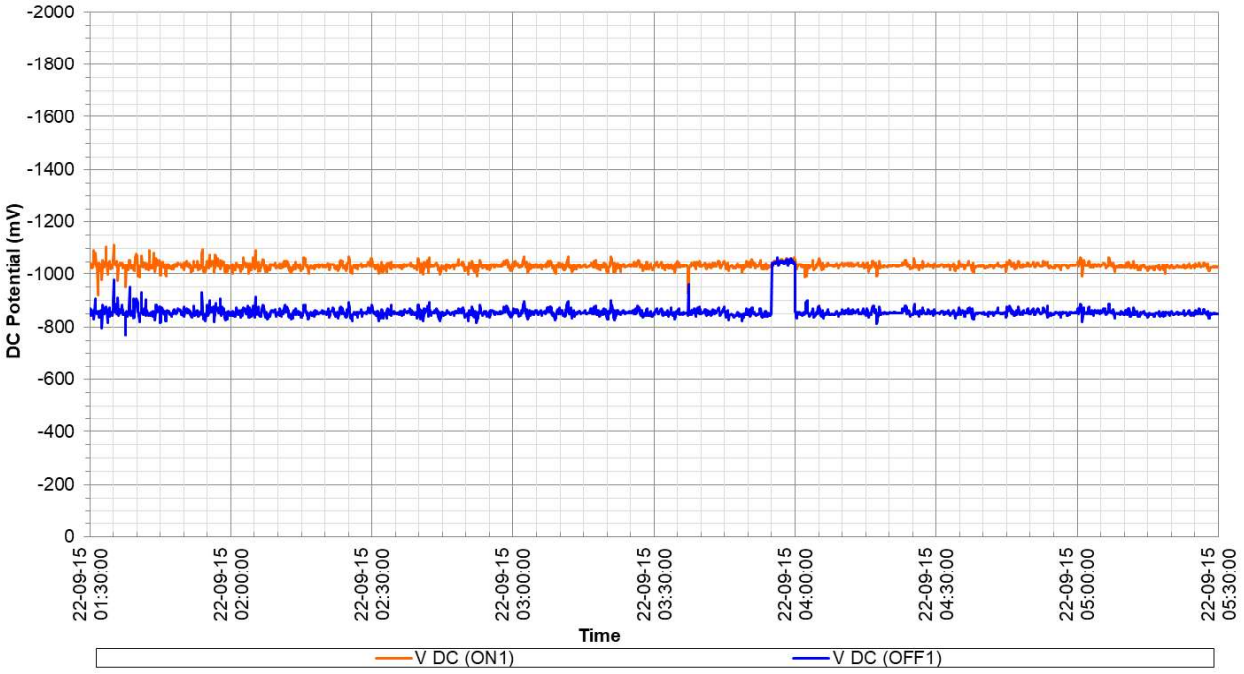

Figure 4-3: Rectifier Interruption Failure – Datalogger at M-471398

During the survey on Section 3, from Ch. 1493.6 m to Ch. 1511.6 m, a possible equipment malfunction was identified, displaying lower potentials which resulted on a CIPS exclusion. The adjacent upstream and downstream areas displayed potentials above criterion, suggesting that the expected potentials at this excluded section would also be above criterion. Additionally, this area showed depths greater than 5 m, where DCVG has a poor ability to identify coating defects.

4.4.4 DCVG Survey

Low shift between the ON and OFF was found during the survey recorded on Section 3, from Ch. 949.4 m and Ch. 1117.6 m. Five possible minor DCVG indications were identified along this area, at Ch. 949.4 m, Ch. 956.2 m, Ch. 959.6 m, 1026.1 m, and 1117.6 m respectively. These indications were classified as "Up to" to take into account possible increased DCVG sizing due to the low shift.

4.5 Recommendations

Based on the results of the CIPS+DCVG survey, the following actions are recommended:

- It is recommended to increase the current output of the Enbridge rectifiers providing cathodic protection to the NPS 12 St. Laurent pipeline, especially M-469494, M-469476, M-2967250, M-469588 and M-3905290. If increasing the output of the protecting rectifiers is not feasible, consider the installation of additional cathodic systems.

- Indications were prioritized using NACE Standard SP0502-2010 and the Enbridge External Corrosion Direct Assessment Standard as guidelines, and locations for consideration for direct examination are provided in Section 5.

5 Direct Examinations

5.1 General

This section covers the following activities:

- Prioritization of indications
- Selection of sites recommended for direct examination

5.2 Prioritization of Indications

Although this report is not part of an ECDA, the prioritization of indications for the St. Laurent Line was determined in conformance with Paragraph 5.2 of NACE Standard SP0502-2010 and Enbridge External Corrosion Direct Assessment Standard in order to select direct examination locations for consideration.

According to these guidelines, the indications identified on the NPS 12 St. Laurent Line are prioritized as shown in Appendix F.

5.3 Direct Examination Locations

A summary of the prioritized indications on the NPS 12 St. Laurent Line is shown in Table 5-1.

Table 5-1: Indications Prioritization

Section	Number of Indications			
	Immediate Action Required	Scheduled Action Required	Suitable for Monitoring	No Action Required
1	1	12	105	0
2	0	1	8	0
3	0	3	31	0

Using the Enbridge External Corrosion Direct Assessment Standard as guidelines, a minimum of two direct examinations are required on the NPS 12 St. Laurent Line. Two additional direct examinations are suggested for a first time assessments.

To facilitate the selection of direct examination locations for the NPS 12 St. Laurent Line, the indications considered most suitable for direct examination have been listed in Table 5-2. If additional direct examination locations are required, Table 5-3 lists additional locations to be considered.

It should be noted that one Immediate Action Required indication has been selected, however as previously mentioned, its confidence level is low as it was identified in a section with thick asphalt, increasing the contact resistance with the soil. An additional Scheduled Action Required was also

provided as an additional direct examination location but its confidence level is also low as it was also located in an area with thick asphalt.

Table 5-2: Recommended Direct Examination Locations

Section	DE#	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 1	1	45.440396, -75.646552	3526.8	2.10	Severe DCVG (82.6%IR) Severe CIPS (-682 mV_{CSE})	Immediate action required Reduced confidence. At section with possible thick asphalt
	2	45.432576, -75.642164	4463.6	1.35	Moderate DCVG (42.3%IR) Moderate CIPS (-788 mVCSE)	Scheduled action required
	3	45.430336, -75.640887	4731.6	0.92	Minor DCVG (25.7%IR) Severe CIPS (-724 mV_{CSE})	Scheduled action required
	4	45.430255, -75.640838	4741.4	1.20	Minor DCVG (28.7%IR) Severe CIPS (-719 mV_{CSE})	Scheduled action required

Table 5-3: Additional Direct Examination Locations

Section	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 1	45.454541, -75.654406	1802.3	1.10	Minor DCVG (21.1%IR)	Suitable for monitoring Recommended in Phase 1
	45.445410, -75.649170	2904.8	1.22	Minor DCVG (31.5%IR) Moderate CIPS (-817 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.444684, -75.648774	2990.8	1.06	Minor DCVG (25.6%IR) Moderate CIPS (-824 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.444550, -75.648676	3009.3	1.06	Minor DCVG (30.9%IR) Minor CIPS (-834 mV_{CSE})	Suitable for monitoring Recommended in Phase 1

Table 5-3: Additional Direct Examination Locations

Section	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 1	45.443780, -75.648251	3102.9	0.91	Minor DCVG (29.0%IR) Moderate CIPS (-818 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.443295, -75.647976	3160.2	1.35	Moderate DCVG (38.1%IR) Minor CIPS (-852 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.424536, -75.637605	5426.2	1.21	Minor DCVG (29.4%IR) Minor CIPS (-833 mV_{CSE})	Suitable for monitoring
	45.421024, -75.635733	5853.1	1.82	Minor DCVG (18.3%IR) Severe CIPS (-538 mV_{CSE})	Scheduled action required
	45.415665, -75.633066	6552.1	2.12	Minor DCVG (33.8%IR) Severe CIPS (-678 mV_{CSE})	Scheduled action required Identified during post-Phase 2 Survey
	45.412861, -75.631172	6900.2	1.28	Moderate DCVG (37.3%IR) Minor CIPS (-827 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.412011, -75.630709	7001.1	1.70	Severe DCVG (65.8%IR)	Scheduled action required
Section 2	45.405824, -75.627004	46.2	1.96	Severe DCVG (Up to 74.1%IR)	Scheduled action required
Section 3	45.418173, -75.669014	28.8	1.25	Minor DCVG (19.9%IR) Minor CIPS (-848 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.417504, -75.668039	152.1	1.06	Minor DCVG (24.5%IR) Moderate CIPS (-784 mV_{CSE})	Suitable for monitoring Recommended in Phase 1
	45.417622, -75.659092	871.0	2.64	Minor DCVG (24.5%IR) Severe CIPS (-719 mV_{CSE})	Scheduled action required

Table 5-4: Additional Direct Examination Locations

Section	GPS Coordinate	Chainage	Depth (Top of Pipe)	Indications	Notes
Section 3	45.418515, -75.651120	1566.1	4.64	Severe DCVG (73.1%IR)	Scheduled action required Reduced confidence. Located in Area with Thick Asphalt
	45.418616, -75.648793	1785.7	1.56	Minor DCVG (23.8%IR)	Suitable for monitoring Recommended in Phase 1

APPENDIX A

Project Specifications

A.1 Survey Information

Table A-1: Survey Information

Pipeline Name	NPS 12 St. Laurent Pipe		
Section	Section 1	Section 2	Section 3
Start of Survey Section	Ch. 0.0 m (45.456500, -75.674402)	Ch. 0.0 m (45.406188, -75.627407)	Ch. 0.0 m (45.418347, -75.668945)
End of Survey Section	Ch. 7840.0 m (45.406043, -75.630126)	Ch. 539.0 m (45.401887, -75.624586)	Ch. 2862.0 m (45.419536, -75.635574)

A.2 Survey Specifications

Table A-2: Survey Specifications

Test/Survey	Relevant Section in Survey Procedures Appendix B	Notes
Influence Testing	B.2	– Enbridge rectifiers will be interrupted through RMU. – Interrupt foreign rectifiers (TCE, TNPI) in case there is significant influence.
Waveform Spectrum Testing	B.3	–
Integrated CIPS+DCVG Survey	B.4	– Phase 1: An integrated CIPS+DCVG survey is to be performed along sections where it is feasible do it: green areas, not paved areas, offsets < 5 m. – Phase 2: An integrated CIPS+DCVG survey is to be performed along sections excluded during Phase 1 where drilling and/or traffic control is required
Independent CIPS Survey	B.5	– Phase 1: Perform independent CIPS surveys along sections where offset is feasible, but this offset is greater than 5 m
Modified DCVG Survey (Line Proximity to Gradient Interference)	B.7.1	– A separate DCVG survey may be required on Section 1 due to groundbed gradients in the vicinity of Enbridge Gas rectifiers M-469494 (081), M-469476 (052) and M-469475 (036)

A.2.1 Additional Project Requirements

- DCVG Survey
  - Lateral surveys
    - Consider carrying a longer lateral cable which allows to increase or decrease the lateral survey as needed (more or less than the 3 m lateral spacing). Ensure the lateral spacing changes are commented in the HEX. Offset surveys should still be less than 5 m to have valid DCVG reads.

- Longitudinal surveys
  - Longitudinal DCVG survey can be used along those sections where the survey is performed over the pipeline but there is not enough space for a lateral gradient.
  - Longitudinal DCVG survey should be avoided during offset surveys.

- Section 3:
  - Confirm the pipeline's path at the Tremblay Rd. and Belfast Rd. intersection.

- The table below shows the test locations identified during the preassessment and their possible description. Other possible test points can be identified during the survey.

Test Point	Description
M-481317	Unknown
M-3483530	Unknown
M-3483430	Steel riser (gas meter
M-480025	Steel riser (gas meter
M-471410	Steel riser
M-83370	Flush mount
M-471411	Steel riser
M-471403	Unknown
M-483334	Unknown
M-471398	Steel Riser
M-471402	Test Post
M-471395	Test Post
M-471396	Test Post
M-471409	Test Post
M-471404	Steel riser
M-471406	Test Post
M-4047502	Test Post
M-3617531	Unknown
M-3483427	Steel riser
M-471407	Test Post

APPENDIX B

Survey Procedures

B.1 General

Corrosion Service uses several different testing methods and survey techniques to evaluate pipeline integrity, including:

- **Influence Testing:** Measures ON/OFF potential shifts along a pipeline to determine the limits of influence of CP current sources.
- **Waveform Spectrum Testing:** Pipe-to-soil potential harmonics are calculated from waveform data to identify whether any influencing rectifiers remain uninterrupted or unsynchronized.
- **Close Interval Potential Survey (CIPS):** Measures the structure-to-electrolyte potentials to assess the cathodic protection level along the subject line.
- **Direct Current Voltage Gradient (DCVG) Survey:** Measures the soil voltage gradients to assess coating condition and locate holidays along the subject line. Allows for sizing of coating holidays.
- **AC Current Attenuation (ACCA) Survey:** Measures an alternating current imposed on the subject pipeline to assess the coating condition of a section of pipeline in comparison to the other sections along the subject line.
- **AC Voltage Gradient (ACVG) Survey:** Measures the soil voltage gradients from an imposed alternating current to assess coating condition and locate holidays along the subject line.
- **Test Point Measurements:** Measurements at test points including AC and DC potentials, isolating flange continuity testing, bond currents, and coupon potentials.
- **Casing Isolation Testing:** Measures casing potentials to detect pipe-to-casing shorts or coupling.
- **Soil Resistivity Measurements:** Measures soil resistivity to assess soil corrosivity and the risk of AC corrosion.

Selection of appropriate survey procedures depends on the cathodic protection system in place and the configuration of the subject line. The specific surveys to be performed on the subject line can be found in Appendix A.

B.2 Influence Testing

Influence testing is performed to determine the limits of influence of any given current source on the subject pipeline.

B.2.1 Procedure

For each rectifier that may influence the line under assessment, measure the influence on the potentials at the nearest test point by temporarily turning the rectifier OFF. Install interrupters at rectifiers which produce more than a minimal influence, typically 5 mV. If there are more than a critical number of rectifiers, consult the CSCL project manager regarding the possibility of turning OFF rectifiers with minimal influence (typically 5 to 10 mV). Record the "as found" rectifier

parameters (voltage, current, taps), GPS coordinate, interrupter installation date/time, and daily interruption start time.

- Interrupted rectifiers should remain ON except during the active survey period.
- Some pipeline segments may be long enough that a rectifier will only influence a portion of the segment. If there are more rectifiers than interrupters available, it may be possible to move interrupters as the survey progresses.

Any sacrificial anodes installed on the pipeline at test stations should also be interrupted for the duration of the survey, unless otherwise stated in Appendix A.

B.3 Waveform Spectrum Testing

Waveform spectrum testing is used to identify the presence of rectifiers which have not been interrupted and are influencing pipe potentials.

B.3.1 Procedure

After the necessary interrupters have been installed, conduct a waveform analysis at each test station along the segment to be surveyed using a portable oscilloscope. Determine whether any remaining influencing rectifiers requiring interruption can be identified based on the harmonics generated by the rectifiers (i.e., 120 Hz for single-phase and possible 180 Hz for three-phase rectifiers).

- Record a 200ms (short) waveform with spectrum analysis at each test station. Waveforms should consist of 32 fames.
  - A 120 Hz component greater than 10 mV suggests remaining influence from uninterrupted single-phase rectifier(s)
  - A 180 Hz component greater than the 60 Hz component may suggest remaining influence from uninterrupted 3-phase rectifier(s). Additional engineering support may be required.
- Record a 10s (long) waveform at each test station to confirm rectifiers are synchronously interrupted. Waveforms should consist of 3 fames.
- Interface with the CSCL project manager and with the proper area technician to identify and interrupt possible sources of influence.

B.4 Integrated CIPS+DCVG Survey

CIPS and DCVG surveys will typically be integrated into one survey for perfect alignment of the data.

The survey measurement interval and lateral gradient spacing are detailed in Appendix A.

Some locations may require a modified separate DCVG survey when the encountered conditions described in Section B.7 do not allow for an integrated CIPS+DCVG survey to be performed.

B.4.1 Daily Setup

Daily setup is required at the beginning of each day and must be repeated if continuing to a new survey section.

Step 1: Install GPS synchronized stationary data loggers at test points upstream and downstream of the area to be surveyed, if not already present. If data loggers were installed overnight, download the data to the field laptop and check that all the interrupters have started interrupting at their scheduled time, if applicable. Record the stationary data logger number, time, location, ON/OFF potentials and AC voltage. Confirm these values by taking similar readings with a multimeter and record them in the field book. These points will act as your start and end points for the survey section. The suggested maximum distance between loggers is 3 km (subject to test point availability). Install intermediate data loggers as needed.

- If an interrupter did not start at its scheduled time, the interrupter must be fixed or replaced before continuing the survey.
- Stationary dataloggers should be set up to record at 1 second intervals with a continuous wave capture recorded every 30 minutes for 30 seconds.
  - For a 3ON:1OFF cycle, a 600ms measurement delay should be used
  - For a 1.5ON:0.5OFF cycle, a 300ms measurement delay should be used

Step 2: Using a portable oscilloscope, confirm that the 120Hz influence has remained consistent since the initial influence testing and that CP interruption conditions have not changed at the upstream and downstream test points by recording long and short waveforms as described in Section B.3.1.

Step 3: Install the signal transmitter at a suitable test point in proximity to the area being surveyed. The transmitter should not be installed at the same location as a stationary data logger or the survey logger, if possible.

- If the transmitter must be installed at the same test point as a stationary data logger, the transmitter should be connected to a separate lead from the data/survey logger and/or the transmission frequency must be selected such that it does not affect the potentials being recorded.

B.4.2 Survey Procedure

Step 1: Connect the survey logger to the wire dispenser and to the two reference electrodes, as per the manufacturer's instructions.

Step 2: Connect the trailing wire from the dispenser to the pipe connection where the survey is beginning. Ensure that the ON/OFF potential shift (i.e., the rectifier current) is strong enough to allow conducting an integrated CIPS+DCVG survey. Compare the survey logger potentials with the stationary data logger potentials to validate the correct operation of the two units.

- Ensure the trailing wire remains taut to allow for accurate recording of chainage.

Step 3: Conduct an interrupted survey at the interval specified in Appendix A. Begin at the start point, recording chainage, ON/OFF pipe-to-soil potential, GPS time, GPS coordinates and lateral ON/OFF DC voltage gradients in the survey logger. Should the start point of the survey section be in an area displaying a significant lateral gradient, start the survey before the test point (unless the subject line terminates, runs aboveground, or enters a restricted-entry station/area) at a point where the gradient is no longer visible.

- Record any wire breaks, wire spool changes or wire pulls resulting in an abrupt change in chainage.
- When the pipeline is at the edge of a multi-pipeline right of way, the lateral gradient should be recorded on the side away from the other pipelines where possible.
- An offset survey may be performed by laterally offsetting the survey from the pipeline when obstacles above the pipeline do not allow for measurement to be taken directly above the pipeline route. The applicability of offset surveys will be dependent on data quality.

Step 4: Every 40 m (or as defined in Appendix A), mark the pipeline route on the ground using alphanumeric identifiers (e.g., A1, B1, etc.), record sub-meter GPS coordinates, and measure pipe depth.

Sub-meter GPS coordinates and pipe depths should also be recorded at any other relevant features such as:

- Survey start/end points
- Any pipeline appurtenance (bends, line markers, risers, power/fuel gas taps)
- Edges of roadways
- Edges of impassible features
- Cable trenches
- Casing vents
- Changes in topography

To match the sub-meter GPS coordinates with the survey logger record, the same descriptor shall be entered on both instruments.

- Sub-meter GPS coordinates representing the pipeline must be taken directly over the pipeline. Also record sub-meter GPS coordinates for test posts themselves (if offset from the line) and for the corresponding location as measured along the line (i.e., drop a perpendicular line from the test post and record the coordinates of the point where it intersects the line).

Step 5: Possible coating damage will appear as an increase followed by a decrease in the lateral DC gradient measured by the survey logger, with the maximum gradient at the epicenter of the holiday. When the gradient reaches a maximum, take a sub-meter GPS reading and enter an appropriate descriptor. Record an additional voltage gradient reading on the other side of the line and add an appropriate descriptor.

- If obstacles prevent a lateral measurement at 3 m spacing, the lateral spacing can be changed for one or more measurements between 1 m and 5 m, with the new lateral spacing clearly

commented in the survey logger. If a larger offset is needed, contact the CSCL project manager.
- More frequent other side readings should be taken at areas of extended elevated gradients to classify the current direction

Step 6: If the lateral gradient indicated current flowing towards the pipeline, repeat the measurement on the other side of the line. Enter an appropriate descriptor and continue the survey on the second side of the line. Periodically take readings on the original side to confirm the continued presence of the negative gradient.

Step 7: When reaching a test point, supplementary readings must be taken as outlined in Section B.11. If the structure lead is found to be a suitable connection point, the trailing wire should be severed and reconnected to the new test point and an appropriate descriptor should be entered.

Step 8: Continue surveying until the end point of the survey section. Should the end point of the survey section be in an area displaying a significant lateral gradient, continue the survey past the test point (unless the subject line terminates, runs above-ground or enters a restricted-entry station/area) until the gradient is no longer visible.

- When possible, survey sections should end at a test point on the subject line.

B.4.3 End of Day

Step 1: Collect the used trailing wire to be disposed of.

Step 2: Remove the stationary data loggers and signal transmitter. Download the data contained on the stationary data loggers and relocate the units to the upstream and downstream test points of the area to be surveyed the next day.

Step 3: Using a portable oscilloscope, confirm if the 120Hz influence has not changed throughout the day and that CP interruption conditions have not changed at the upstream and downstream test points by recording long and short waveforms as described in Section B.3.1.

B.4.4 Completion of Survey

Step 1: Confirm with the CSCL project manager that no resurveys are required. If any are required, send the data for validation before continuing with Step 2.

Step 2: Remove the interrupters from influencing rectifiers. Record the interrupter removal date, interrupter removal time, and "as left" rectifier parameters (voltage, current, taps).

- Check the "as left" values against the "as found" values and make sure they are reasonably similar.
- All rectifiers must be returned to their "as found" operating condition or be reported to the proper area technician.

B.5 Independent CIPS Survey

B.5.1 Daily Setup

As described in Section B.4.1.

B.5.2 Survey Procedure

Step 1: Connect the survey logger to the wire dispenser and to the reference electrode as per the manufacturer's instructions.

Step 2: Connect the trailing wire from the dispenser to the pipe connection at the beginning of the survey. Compare the survey logger potentials with the stationary data logger potentials to validate the correct operation of the two units.

- Ensure the trailing wire remains taut to allow for accurate recording of chainage.

Step 3: Conduct an interrupted survey at the interval specified in Appendix A. Begin at the start point, recording chainage, ON/OFF pipe-to-soil potential, GPS time and GPS coordinates.

- Record any wire breaks, wire spool changes or wire pulls resulting in an abrupt change in chainage.
- An offset survey may be performed by laterally offsetting the survey from the pipeline when obstacles above the pipeline do not allow for measurement to be taken directly above the pipeline route. The applicability of offset surveys will be dependent on data quality.

Step 4: Every 40 m (or as defined in Appendix A), mark the pipeline route on the ground using alphanumeric identifiers (e.g., A1, B1, etc.), record sub-meter GPS coordinates, and measure pipe depth.

Sub-meter GPS coordinates and pipe depths should also be recorded at any other relevant features such as:

- Survey start/end points
- Any pipeline appurtenance (bends, line markers, risers, power/fuel gas taps)
- Edges of roadways
- Edges of impassible features
- Cable trenches
- Casing vents
- Changes in topography

To match the sub-meter GPS coordinates with the survey logger record, the same descriptor shall be entered on both instruments.

- Sub-meter GPS coordinates representing the pipeline must be taken directly over the pipeline. Also record sub-meter GPS coordinates for test posts themselves (if offset from the line) and

for the corresponding location as measured along the line (i.e., drop a perpendicular line from the test post and record the coordinates of the point where it intersects the line).

Step 5: When reaching a test point, supplementary readings must be taken as outlined in Section B.11. If the structure lead is found to be a suitable connection point, the trailing wire should be severed and reconnected to the new test point and an appropriate descriptor should be entered.

Step 6: Continue surveying until the end point of the survey section.

- When possible, survey sections should end at a test point on the subject line.

B.5.3 End of Day

As described in Section B.4.3.

B.5.4 Completion of Survey

As described in Section B.4.4 or continue to Section B.6 if additional DCVG surveys are required.

B.6 Independent DCVG Survey

Independent DCVG surveys will typically be performed with a connection to the pipeline in order to measure modified pipeline potentials for use in sizing coating damage. The potentials collected during this type of survey are for defect sizing only and are not representative of cathodic protection levels.

Some locations may require modifications to the DCVG survey when the encountered conditions described in Section B.7 do not allow for an adequate DCVG survey to be performed.

B.6.1 Daily Setup

Step 1: Turn OFF any influencing rectifier with a groundbed in close proximity to the subject line.

Step 2: The potential shift (i.e., $V_{OFF\text{-}VON}$) along the survey section should be at least 100 mV. This may be achieved with a temporary rectifier and groundbed, by bonding across an isolating flange, or by increasing the output of remote influencing rectifiers. If installing a test rectifier, the temporary groundbed should be connected to a test point that is a minimum of 1 km away from the section to be surveyed so that the groundbed gradient does not affect the readings. If making any changes to bonds or rectifier output, record the "as found" and modified conditions.

Step 3: Continue daily setup as described in Section B.4.1.

B.6.2 Survey Procedure

Step 1: Connect the survey logger to the wire dispenser and to the two reference electrodes as per the manufacturer's instructions.

Step 2: Connect the trailing wire from the dispenser to the pipe connection where the survey is beginning. Ensure that the ON/OFF potential shift (i.e., the rectifier current) is strong enough to allow conducting an integrated CIPS+DCVG survey. Compare the survey logger potentials with the stationary data logger potentials to validate the correct operation of the two units.

- If the ON/OFF potential shift (i.e., $V_{OFF-VON}$) drops below 100 mV, additional action as described in Section B.6.1 may be required to increase the potential shift.
- Ensure the trailing wire remains taut to allow for accurate recording of chainage.

Step 3: Conduct an interrupted survey at the interval specified in Appendix A. Begin at the start point, recording chainage, ON/OFF pipe-to-soil potential, GPS time, GPS coordinates and lateral ON/OFF DC voltage gradients in the survey logger. Should the start point of the survey section be in an area displaying a significant lateral gradient, start the survey before the test point (unless the subject line terminates, runs aboveground, or enters a restricted-entry station/area) at a point where the gradient is no longer visible.

- Record any wire breaks, wire spool changes or wire pulls resulting in an abrupt change in chainage.
- When the pipeline is at the edge of a multi-pipeline right of way, the lateral gradient should be recorded on the side away from the other pipelines where possible.
- An offset survey may be performed by laterally offsetting the survey from the pipeline when obstacles above the pipeline do not allow for measurement to be taken directly above the pipeline route. The applicability of offset surveys will be dependent on data quality.

Step 4: Every 40 m (or as defined in Appendix A), mark the pipeline route on the ground using alphanumeric identifiers (e.g., A1, B1, etc.), record sub-meter GPS coordinates, and measure pipe depth.

Sub-meter GPS coordinates and pipe depths should also be recorded at any other relevant features such as:

- Survey start/end points
- Any pipeline appurtenance (bends, line markers, risers, power/fuel gas taps)
- Edges of roadways
- Edges of impassible features
- Cable trenches
- Casing vents
- Changes in topography

To match the sub-meter GPS coordinates with the survey logger record, the same descriptor shall be entered on both instruments.

- Sub-meter GPS coordinates representing the pipeline must be taken directly over the pipeline. Also record sub-meter GPS coordinates for test posts themselves (if offset from the line) and for the corresponding location as measured along the line (i.e., drop a perpendicular line from the test post and record the coordinates of the point where it intersects the line).

- When performed in conjunction with an independent CIPS survey, GPS points with matching identifiers should be recorded at the same locations as performed during the independent CIPS survey for an accurate alignment of the two sets of data.

Step 5: Possible coating damage will appear as an increase followed by a decrease in the lateral DC gradient measured by the survey logger, with the maximum gradient at the epicenter of the holiday. When the gradient reaches a maximum, take a sub-meter GPS reading and enter an appropriate descriptor. Record an additional voltage gradient reading on the other side of the line and add an appropriate descriptor.

- If obstacles prevent a lateral measurement at 3 m spacing, the lateral spacing can be changed for one or more measurements between 1 m and 5 m, with the new lateral spacing clearly commented in the survey logger. If a larger offset is needed, contact the CSCL project manager.

Step 6: If the lateral gradient indicated current flowing towards the pipeline, repeat the measurement on the other side of the line. Enter an appropriate descriptor and continue the survey on the second side of the line. Periodically take readings on the original side to confirm the continued presence of the negative gradient.

Step 7: When reaching a test point, supplementary readings must be taken as outlined in Section B.11. If the structure lead is found to be a suitable connection point, the trailing wire should be severed and reconnected to the new test point and an appropriate descriptor should be entered.

Step 8: Continue surveying until the end point of the survey section. Should the end point of the survey section be in an area displaying a significant lateral gradient, continue the survey past the test point (unless the subject line terminates, runs above-ground or enters a restricted-entry station/area) until the gradient is no longer visible.

B.6.3 End of Day

As described in Section B.4.3.

- Revert all bonding or rectifier modifications and/or remove the test rectifier and temporary groundbed. Record the conditions prior to reverting, and "as left" values.

B.6.4 Completion of Survey

As described in Section B.4.4.

B.7 Modified DCVG Survey

The typical DCVG survey procedure requires modification in some scenarios in order to minimize measurement errors. Note that changes to the CP system must not be made until all required CIPS surveys has been completed on the entire line.

B.7.1 Line Proximity to Gradient Interference

When a DCVG survey is performed in the vicinity of sources of gradient distortion, measures must be taken to temporarily remove the source of distortion. Sources of distortion can include:

- Rectifier groundbeds (remote or distributed)
- Sacrificial anodes
- Coupons
- Electrical grounding
- AC mitigation

Step 1: Turn OFF or disconnect the source of the gradient distortion.

Step 2: Survey the pipe section as per the corresponding survey procedure.

Step 3: Return all modifications to the "as found" operating conditions.

B.7.2 Induced AC Voltage on Trailing Wire

If there is significant induced AC from high-voltage transmission lines on the pipeline or if there are high-voltage transmission lines parallel to the survey section, then it is possible that an induced voltage on the survey wire will interfere with the measurement of the lateral gradient. In these areas, the appropriate DCVG survey procedure should be followed with the modifications outlined below:

- Connect the trailing wire to the pipe connection but conduct the survey with the wire dispenser disconnected from the survey logger.
- Upon arriving at a recorded reference point or identifying a holiday, reconnect the survey logger to the wire dispenser and record a pipe-to-soil potential, complete with reference point descriptor. Disconnect the survey logger from the wire dispenser once the reading has been taken.

B.7.3 Without Pipe Connection

If a connection cannot or should not be made between the chainer and the pipe, perhaps due to safety concerns or station access difficulties, the appropriate DCVG survey procedure should be followed with the modifications outlined below:

- Conduct the survey with the trailing wire fastened to the start point, but without connection to the pipe.
- ON/OFF pipe-to-soil potentials will not be recorded in the survey logger.
- After taking a sub-meter GPS reading and entering an appropriate descriptor at locations showing possible coating damage, record an additional voltage gradient reading on the other side of the line and add an appropriate descriptor. If the voltage gradient taken on the other side is of the same polarity as the original gradient reading, or is of opposite polarity but significantly smaller magnitude, perform the following steps.

Step 1: On the side where the gradient of greater magnitude was measured, the chainer should be disconnected from the survey logger, and both the pipe and lateral half cell operators should offset laterally by 3 m, maintaining a 3 m separation between them. Take a voltage gradient reading with the survey logger and enter an appropriate descriptor containing the offset distance.

Step 2: Repeat Step 1, offsetting by an additional 3 m each time until a voltage gradient less than 1 mV has been measured twice in a row.

Step 3: Return to the pipe and continue the survey as normal.

B.8 Longitudinal DCVG Survey

A longitudinal DCVG survey may be requested to supplement a lateral DCVG survey. If site conditions dictate, and with permission from the project manager, a longitudinal survey may be conducted in lieu of a lateral DCVG survey. To conduct a longitudinal DCVG survey, the appropriate DCVG survey procedure should be followed with the modifications outlined below:

- The DC voltage gradient is measured longitudinally at a distance of 3 meters in front of the survey logger operator.
- To improve indication alignment accuracy, the chainer should be kept with the trailing surveyor.
- Possible coating damage will appear as an increase in voltage gradient magnitude followed by a reversal in polarity and subsequent decrease in magnitude. The epicenter of the holiday corresponds the peak negative gradient observed on the survey logger when surveyed in the configuration described above.
- Additional lateral gradients shall be measured at indications on both sides of the pipeline when an indication is identified.

B.9 AC Current Attenuation (ACCA) Survey

An ACCA survey may be used as a primary or supplementary assessment tool for determining coating quality of a pipeline or pipeline or pipeline segment.

B.9.1 Procedure

Step 1: At the test post closest to the area to be surveyed, set up a temporary groundbed. The groundbed must be installed perpendicular to the pipe and positioned a minimum of 50 m from the subject pipe with a pin spacing of 3 m. Alternatively, a completely disconnected permanent rectifier groundbed or sacrificial anode can be used as a groundbed. Record the type and location of groundbed. If applicable, also record the number of pins used.

- The transmitter is capable of outputting hazardous voltages. Ensure that the transmitter is OFF while handling the terminals and connection leads and take appropriate precautions to prevent contact with the exposed conductors/ground rods.

Step 2: Connect the positive lead of the signal transmitter to the pipe connection (e.g., lead, riser, etc.) and the negative lead to the groundbed.

Step 3: Following the manufacturer's instructions, set up the transmitter. Record the output voltage, current, and location of the transmitter.

- Maximizing the output signal will permit the survey to be carried out over a longer segment of pipeline.
- To maximize the current output of the transmitter, it may be necessary to relocate or modify the groundbed. So long as the groundbed remains perpendicular to the pipe and maintains a minimum distance of 50 m, the specific arrangement can be modified by the survey team.

Step 4: Begin the survey at the start point. Use the pipe locator to observe the current and depth of cover with the locator directly above the pipe. Record the measurements twice, ensuring the variation between results is not substantial.

- If the measurements taken are fluctuating significantly in value, it is possible there is a distortion in the electromagnetic field caused by a bend, tee or other feature. Choose a new location to take the reading or move the signal transmitter.
- If there are large variations in the current measurement, but the depth of cover measurement remains consistent, there is likely coating damage nearby.

Step 5: Continue taking the readings recorded in Step 4 at 10 m intervals (or as defined in Appendix A).

Step 6: End the survey at the end point.

- When performing an ACCA survey on a section that cannot be accessed safely (i.e., high volume roads, large rivers, etc.), at least five readings are required upstream and downstream of the edge of the inaccessible area. Intermediate readings in the inaccessible area may be taken if it is safe to do so.

B.10 AC Voltage Gradient (ACVG) Survey

ACVG surveys may be requested in addition to, or in lieu of, a standard DCVG survey. This survey should only be performed when requested by the project scope.

B.10.1 Procedure

Step 1: Setup the signal transmitter as described in Section B.9.1.

Step 2: Connect the ACVG survey tool to the connection leads, as per the manufacturer's instructions.

Step 3: Conduct the survey every 1 m (or as defined in Appendix A) beginning at the start point, recording the current/decibel reading and sufficient submeter GPS reference points with appropriate

descriptors to locate possible holidays. When available, note the direction of the arrows indicating holiday location.

Step 4: If the survey is being performed with a probe placed laterally to the pipe, possible coating damage will appear as an increase in current magnitude/decibel reading, with the maximum value at the epicenter of the holiday. If the survey is being performed with a probe placed longitudinally to the pipe, possible coating damage will appear as an increase in current magnitude/decibel reading, followed by a reversal in current polarity, followed by a subsequent decrease in current magnitude/decibel reading. The epicenter of the holiday will be located where the current magnitude/decibel reading is zero. If there are current direction arrows, they should point consistently towards the possible coating damage. If there is no coating damage in the vicinity, the current direction arrows (if applicable) may flicker forward and backwards. At possible coating damage, conduct perpendicular readings for confirmation and record sub-meter GPS coordinates with an appropriate descriptor.

Step 5: Continue surveying until the end point of the survey section.

B.11 Test Point Measurements

When arriving at a test point (e.g., riser, test post, etc.) along the subject line, the following readings must be taken with respect to each lead or connection point:

- Induced AC Voltage: With the multimeter, measure the AC voltage on the subject line with respect to a portable $Cu/CuSO_4$ reference electrode. When possible, long term AC recordings should also be performed to characterise the AC voltage over the course of 24 hours.
- Long Lead (LL) Potential: With the trailing wire connected to the previous test point, a pipe-to-soil potential will be taken at the newly reached test point.
- Short Lead (SL) Potential: With the positive terminal of the survey logger connected to the newly reached test point, a pipe-to-soil potential will be taken at the newly reached test point.
- IR Drop: With the trailing wire connected to the previous test point and the negative terminal of the survey logger connected to the newly reached test point pipe connection, a voltage (IR) drop reading between the two test points will be taken at the newly reached test point.
- Above-Grade Isolating Flanges: At isolating flanges, take short lead potentials on both sides of the flange to check for effective isolation.
- Below-Grade Isolating Flanges: At suspected locations of below-grade isolating flanges, identify the location where the pipe locator signal current suddenly drops off. If practical, also measure the resistance between the closest upstream and downstream test points.
- Bond Currents: When a bond is present (i.e., bonded leads, flanges, etc.) a bond current should be taken.

- Nearby Foreign Structures: When a foreign structure is identified in the immediate vicinity (<5m) of the pipeline (station fence, pipe supports, grounding rods, etc.), take short lead and IR reading with respect to the structure.

B.11.1 DC Coupon Measurements

When a DC coupon is present at a test point, the following measurements must be taken with respect to the coupon:

- ON/OFF potentials to portable CSE with the coupon connected to the pipe.
- Disconnect potentials to portable CSE with the coupon disconnected from the pipe.
- ON/OFF potentials to each installed permanent reference electrode (typically zinc) with the coupon connected to the pipe.
- Disconnect potentials to each installed permanent reference electrode with the coupon disconnected from the pipe.
- Calibration voltage between the portable CSE and each permanent reference electrode.
- Calibration voltage between the portable CSE and each permanent reference electrode with the coupon disconnected.
- Zero resistance coupon current between pipe and the coupon.

To best correlate the coupon data with any corresponding survey data, all coupon measurements, with the exception of the coupon current, should be taken at the time of the survey at that location using a datalogger.

For the best results, each reading above should be recorded for 3-5 seconds and two times before moving to the next reading.

When a coupon monitoring port is installed at a coupon location, all coupon readings with respect to the portable CSE should be recorded with the portable CSE placed within the monitoring port.

B.11.2 AC Coupon Measurements

When an AC coupon is present at a test point, the following measurements must be taken:

- Record the resistance of the resistor between the AC coupon and the pipe
- AC voltage across the resistor
- Zero resistance DC coupon current between pipe and the coupon

AC voltages across the resistor should be recorded over a period of 16-24 hours using a datalogger.

B.11.3 Casing Isolation Testing

When a survey contains a section or sections of pipe enclosed in a casing, potentials must be taken to confirm the electrical isolation of the casing and pipe. They may be identified in the field by the presence of a casing vent at one or both ends of the casing, test station labels, or

unidentifiable test leads with depressed potentials. Surveying and testing of cased crossings is conducted as follows:

Step 1: When arriving at a cased crossing, survey up to the casing vent or test station if no casing vent is present.

Step 2: Record SL potentials of both the pipeline and the casing. Additionally, record the IR between the pipe and casing.

Step 3: Move to the casing vent or test station at the other end of the casing and repeat the reading described in Step 2.

Step 4: Continue the survey process previously being followed with the trailing wire reconnected to the subject pipe.

B.11.4 Pictures

Overview, upstream and downstream pictures should be taken at every test point. At test posts, additional close-up views are required clearly showing the terminal configuration.

Upstream and downstream pictures should be taken 5-10 m back from the appurtenance to capture both the appurtenance and its surroundings.

Additional pictures should be taken of other appurtenances or features of note during the survey, such as valves, casing vents, isolating flanges and topography/terrain that cannot be surveyed.

In congested areas such as stations, panoramic pictures may be used to better document the area.

B.12 Soil Resistivity Measurements

When required, the Wenner four-pin method will be used to obtain soil resistivity measurements at all test points along the subject line to assess the risk of AC corrosion and estimate soil corrosivity.

B.12.1 Procedure

Step 1: Locate a section of native soil which is approximately 5 m away from the subject line and other buried metallic structures. If there are special conditions such as the pipeline running in a ditch beside the road, simulate these conditions if possible.

Step 2: Perform testing at pin spacings of 5, 10 and 15 feet with the pins setup perpendicular to the pipeline if possible. If required, pour water around the pins to facilitate readings in dry soil conditions. Record the location, pin spacing, and measured values.

APPENDIX C

Current Interruption

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C.1 Remote Current Interruption

The current sources that were remotely interrupted as listed in Table C-1. The DC voltage outputs in volts (V) are listed in rows with a white background and the DC current outputs in amperes (A) are listed in rows with a grey background.

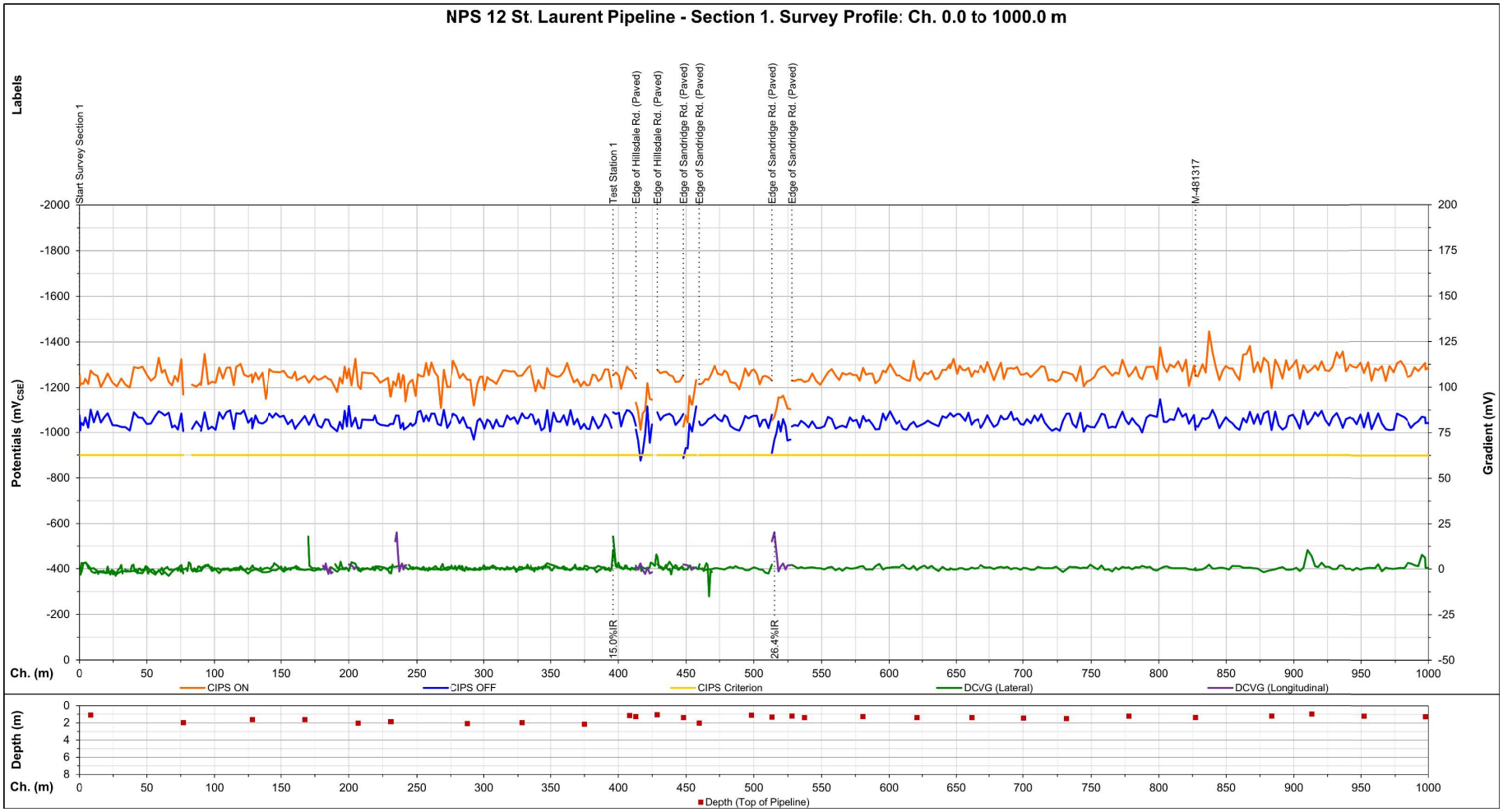
Table C-1: Remote Current Interruption (Elecsys)

Owner	Rectifier	GPS Coordinate		June 2022		September 2022		October 2022	
		Latitude	Longitude	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Voltage (V)	Current (A)
Enbridge Gas	M-469494	45.455300	-75.654800	14.45	10.70	14.93	8.08	15.14	7.54
Enbridge Gas	M-469473	45.444100	-75.637900	30.12	8.11	30.80	6.70	30.62	5.57
Enbridge Gas	M-469476	45.438993	-75.645360	17.97	7.79	18.02	8.29	18.11	7.68
Enbridge Gas	M-2967250	45.424163	-75.642649	22.74	3.17	22.85	2.48	23.25	2.10
Enbridge Gas	M-3905290	45.416740	-75.645190	38.19	1.91	38.19	1.91	38.51	1.33
Enbridge Gas	M-469475	45.411833	-75.630972	10.02	10.58	10.13	10.18	10.25	9.70
Enbridge Gas	M-469464	45.402382	-75.638809	20.25	5.88	20.71	5.57	21.05	3.79
Enbridge Gas	M-469585	45.389400	-75.616700	28.50	7.90	27.71	7.24	28.30	6.38
Enbridge Gas	M-7555042	45.372983	-75.596202	6.57	0.66	6.27	0.81	6.58	0.58
Enbridge Gas	M-469474	45.382800	-75.600400	8.11	5.92	7.89	5.81	8.01	5.70
Enbridge Gas	M-469588	45.419534	-75.675663	14.24	10.96	13.92	10.52	14.22	10.38

APPENDIX D

Survey Graphs

D.1 Section 1



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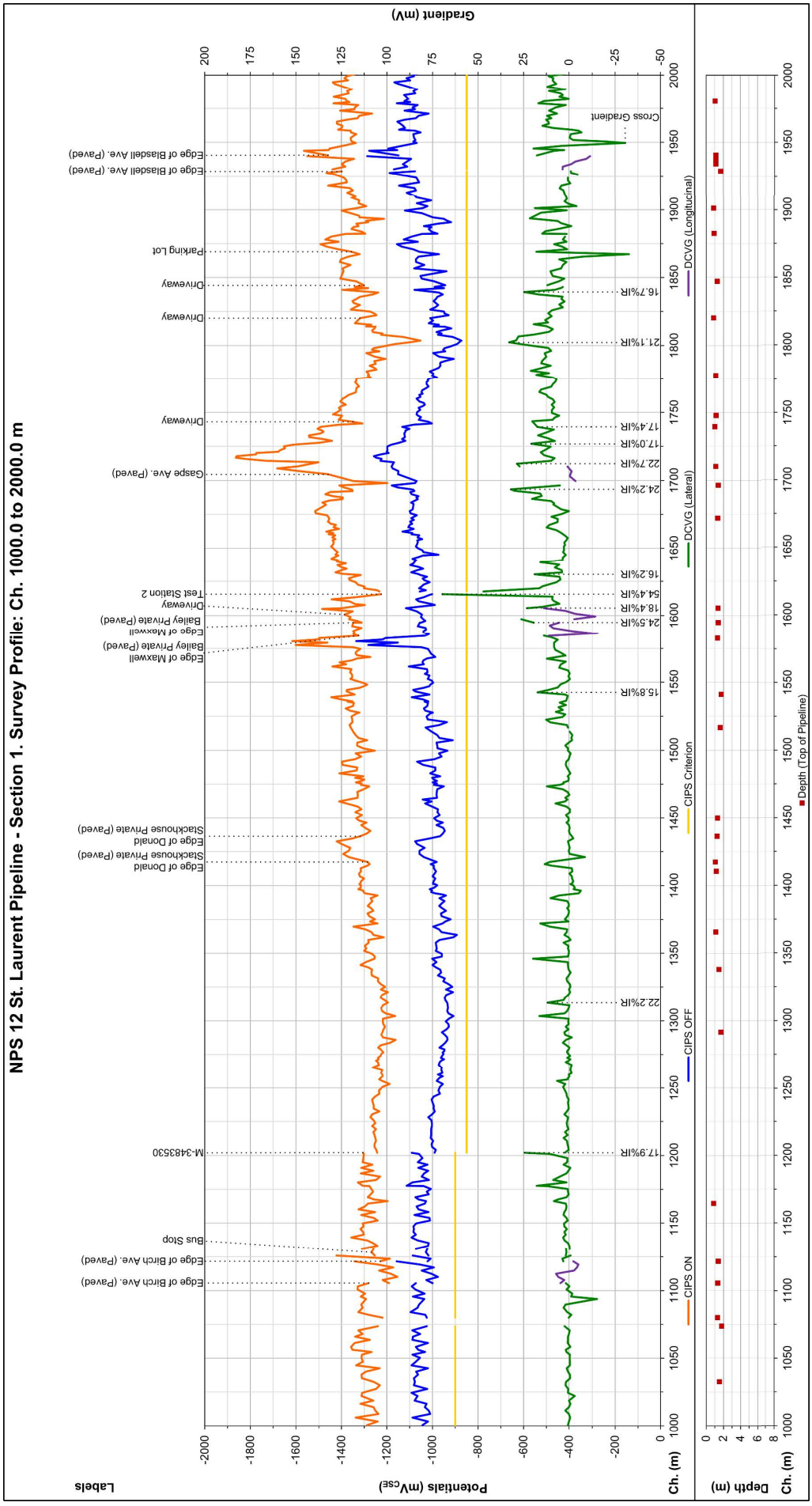
NPS 12 St. Laurent Line
CIPS+DCVG Report



Information Classification: INTERNAL USE	CSCL Doc ID: ENB (22ST-LAU) CD-REP-SVY-002	CSCL Rev: D1	Client Doc ID: N/A	Client Rev: N/A
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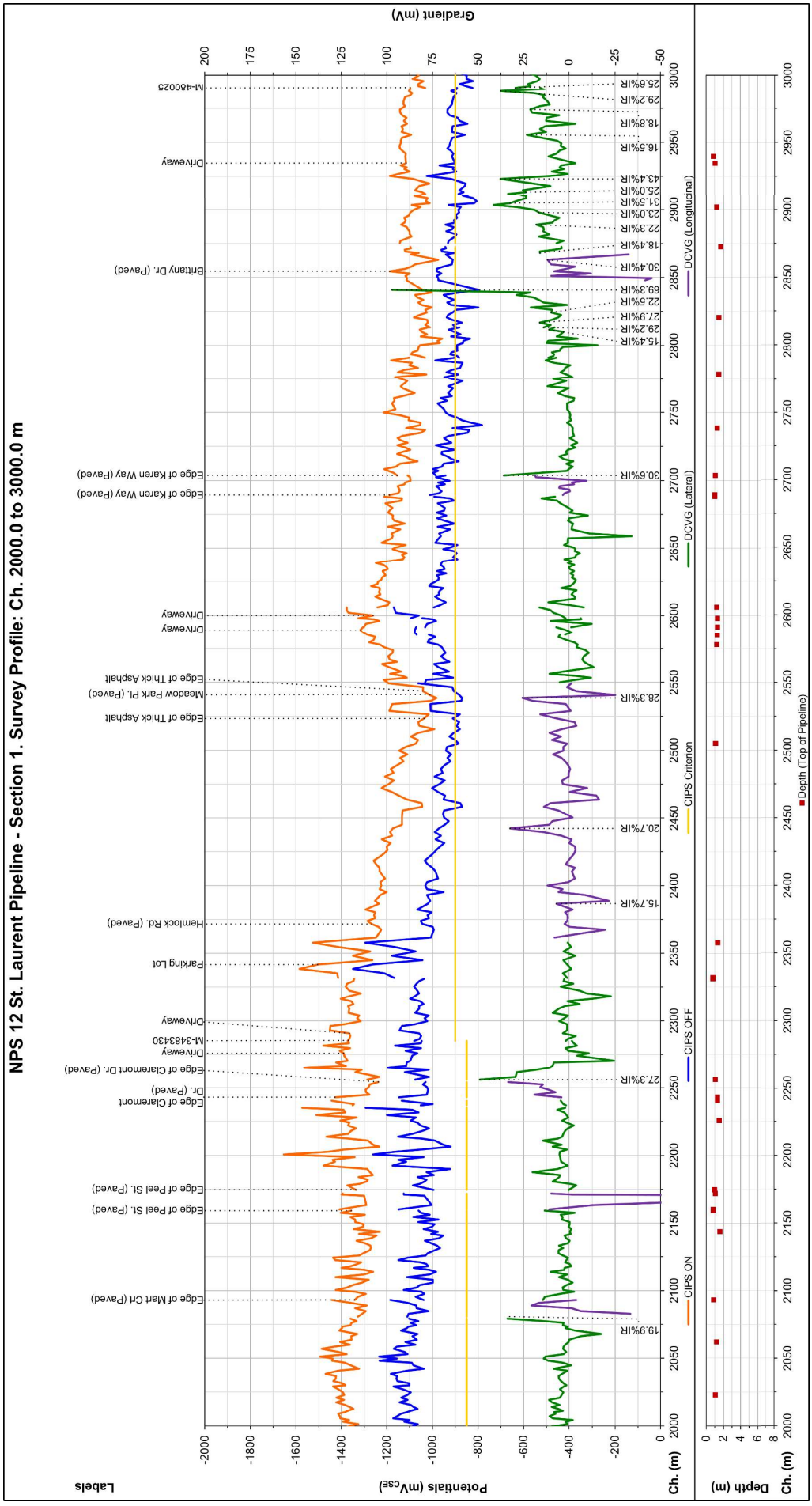

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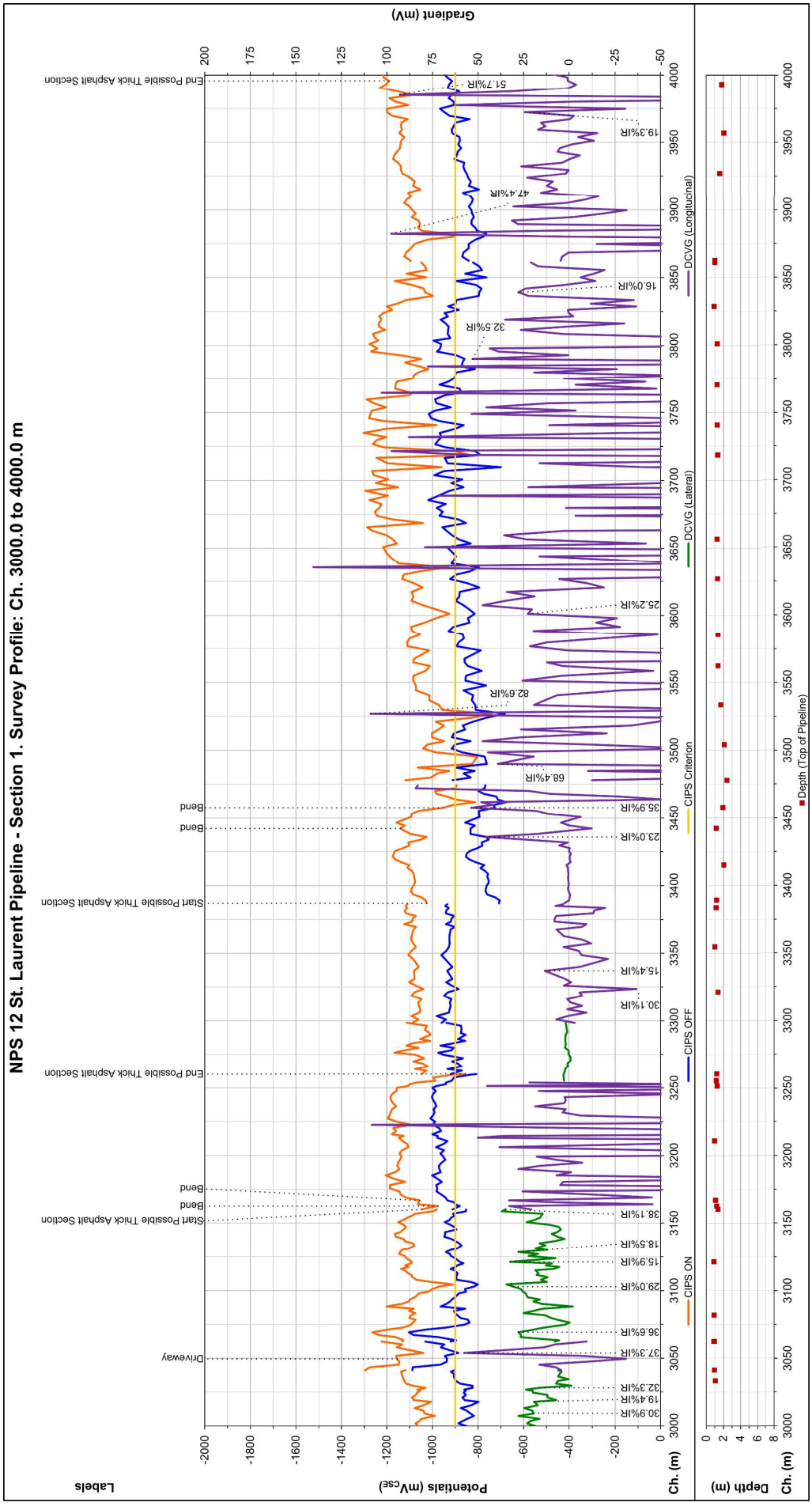

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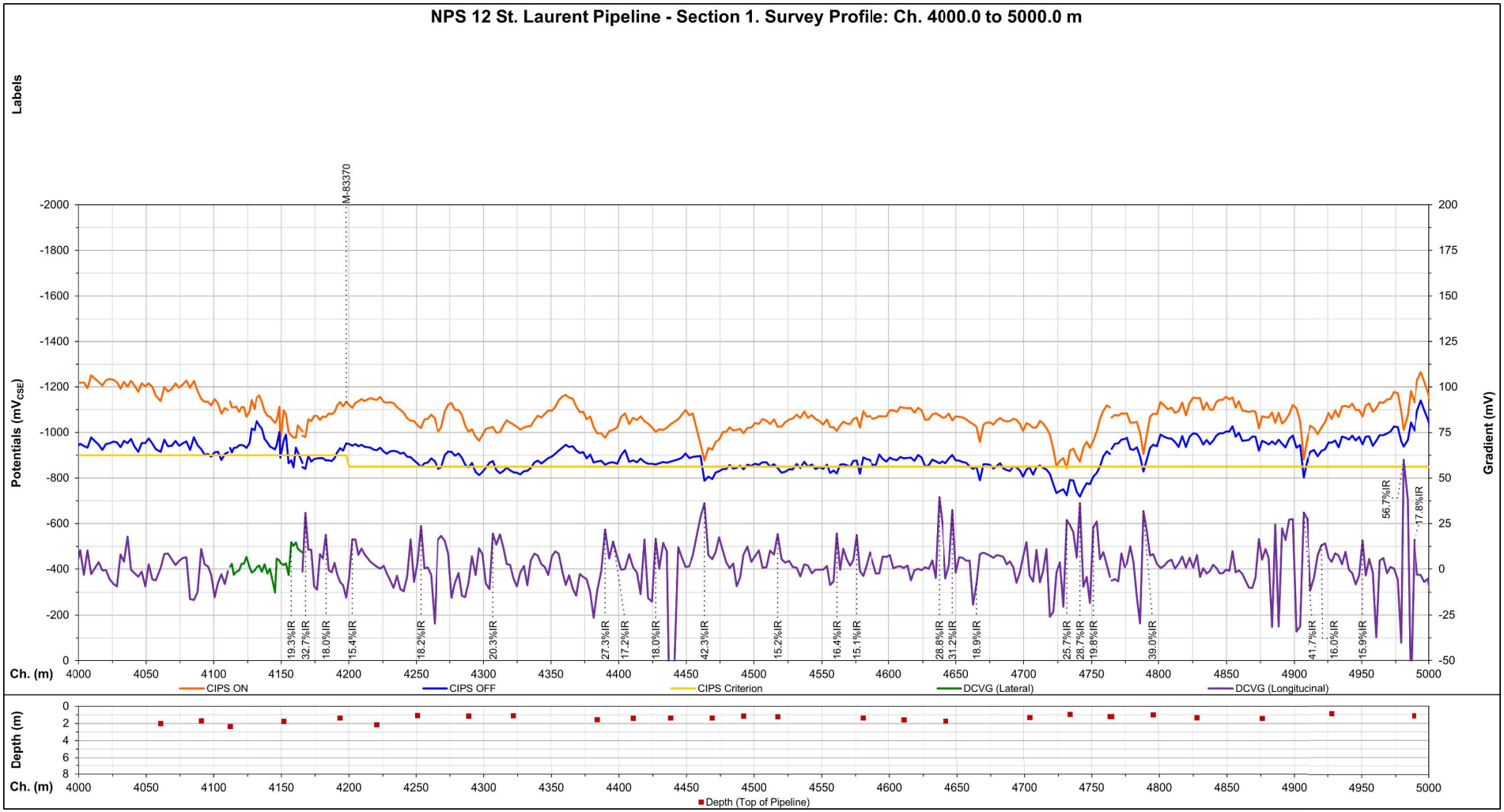
NPS 12 St. Laurent Pipeline - Section 1. Survey Profile: Ch. 4000.0 to 5000.0 m
Labels
M-83370
Potentials (mV$_{CSE}$)
Gradient (mV)
Ch. (m)
CIPS ON
CIPS OFF
CIPS Criterion
DCVG (Lateral)
DCVG (Longitucinal)
19.3%IR
32.7%IR
18.0%IR
15.4%IR
18.2%IR
20.3%IR
27.3%IR
17.2%IR
18.0%IR
42.3%IR
15.2%IR
16.4%IR
15.1%IR
28.8%IR
31.2%IR
18.9%IR
25.7%IR
28.7%IR
19.8%IR
39.0%IR
41.7%IR
16.0%IR
15.9%IR
56.7%IR
17.8%IR
Depth (m)
Depth (Top of Pipeline)

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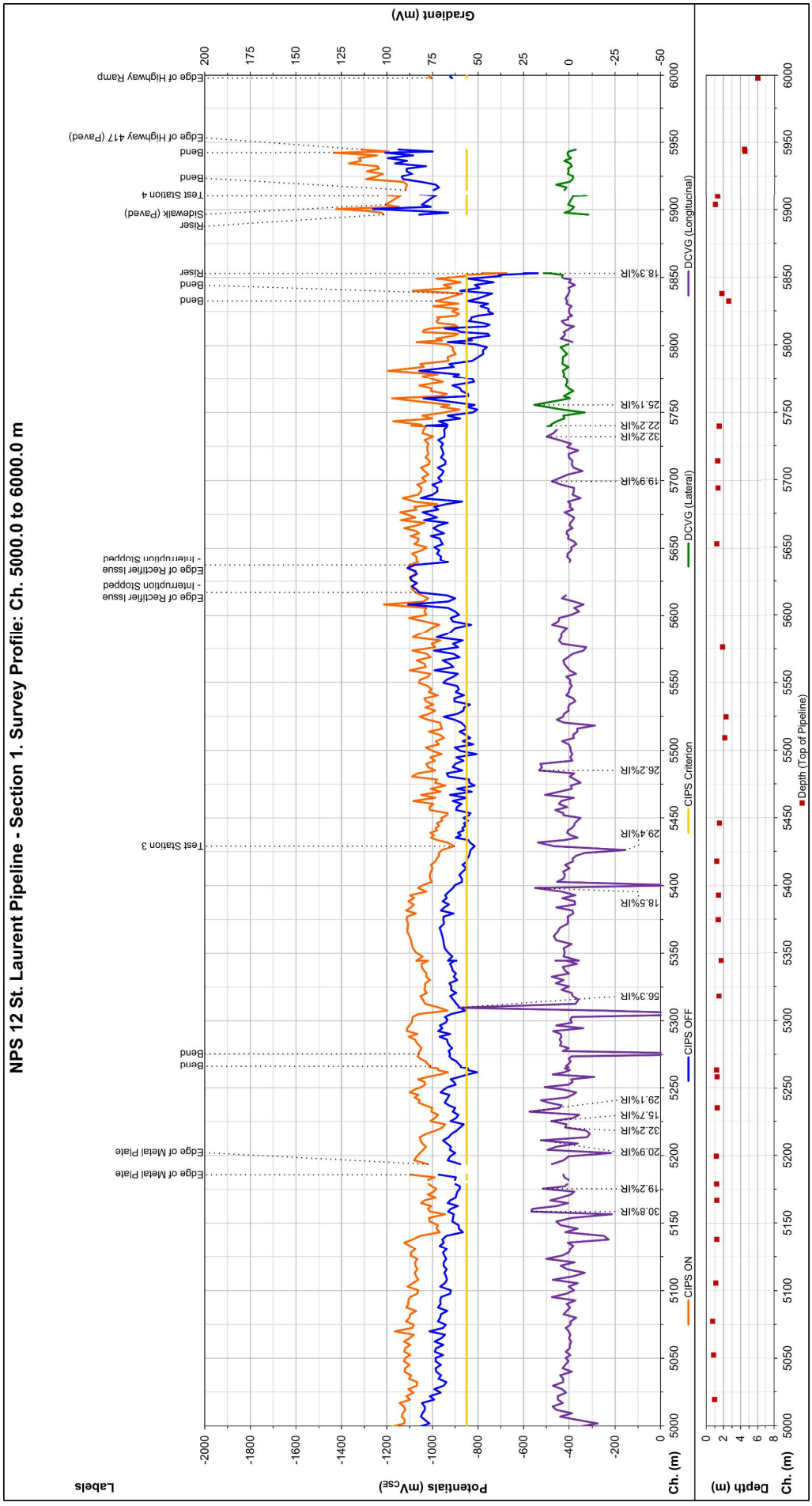
NPS 12 St. Laurent Line
CIPS+DCVG Report



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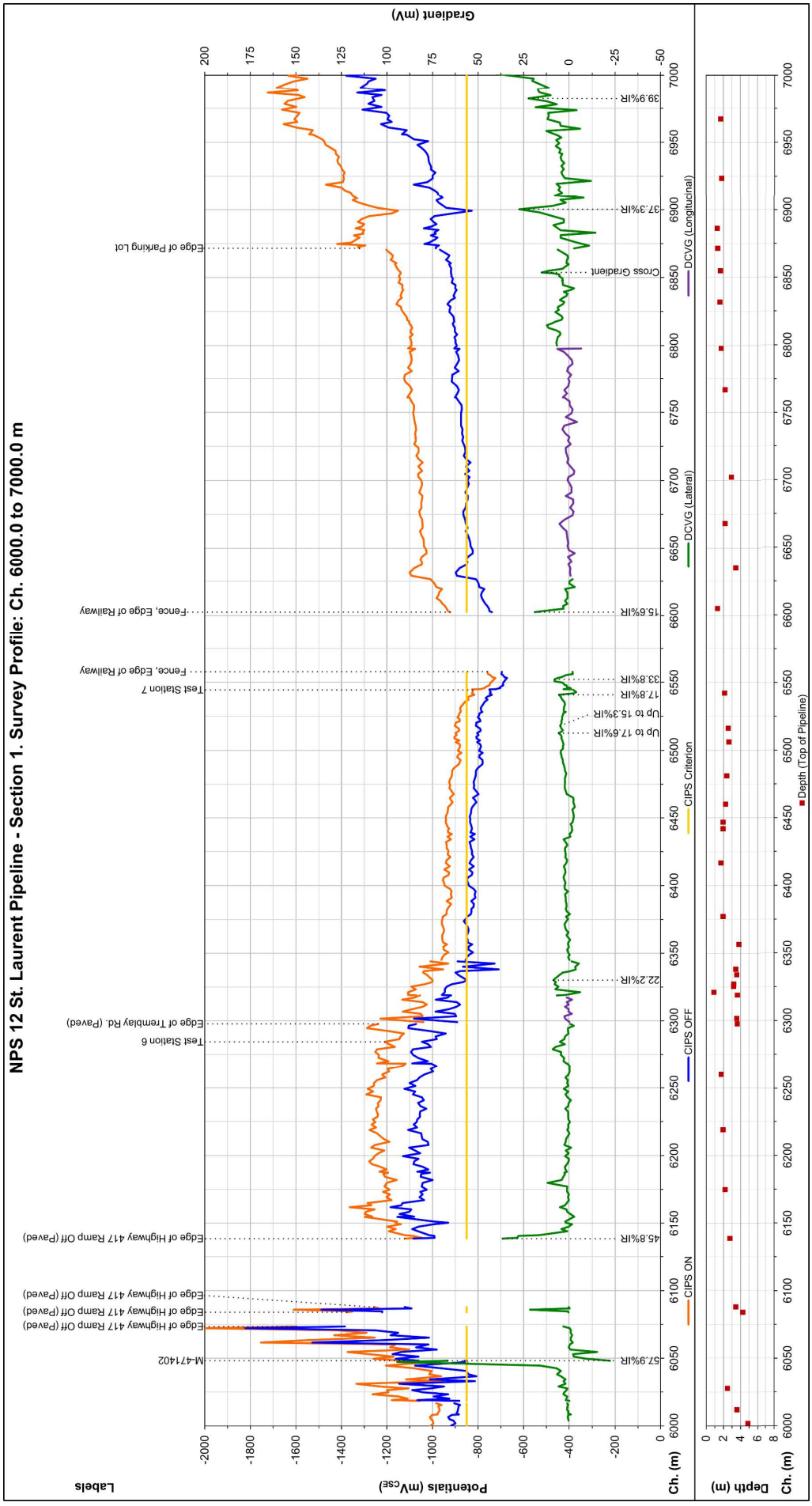

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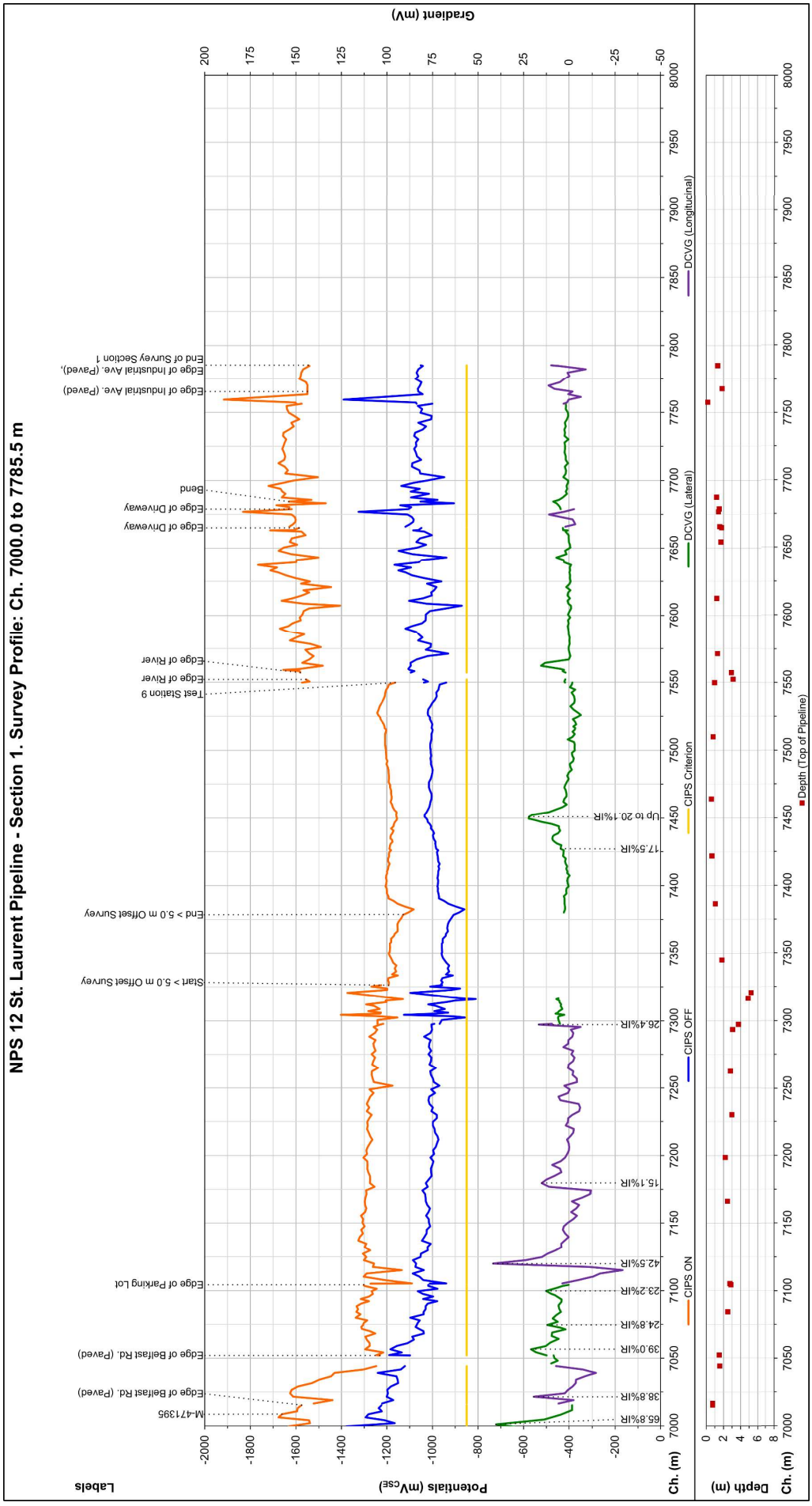

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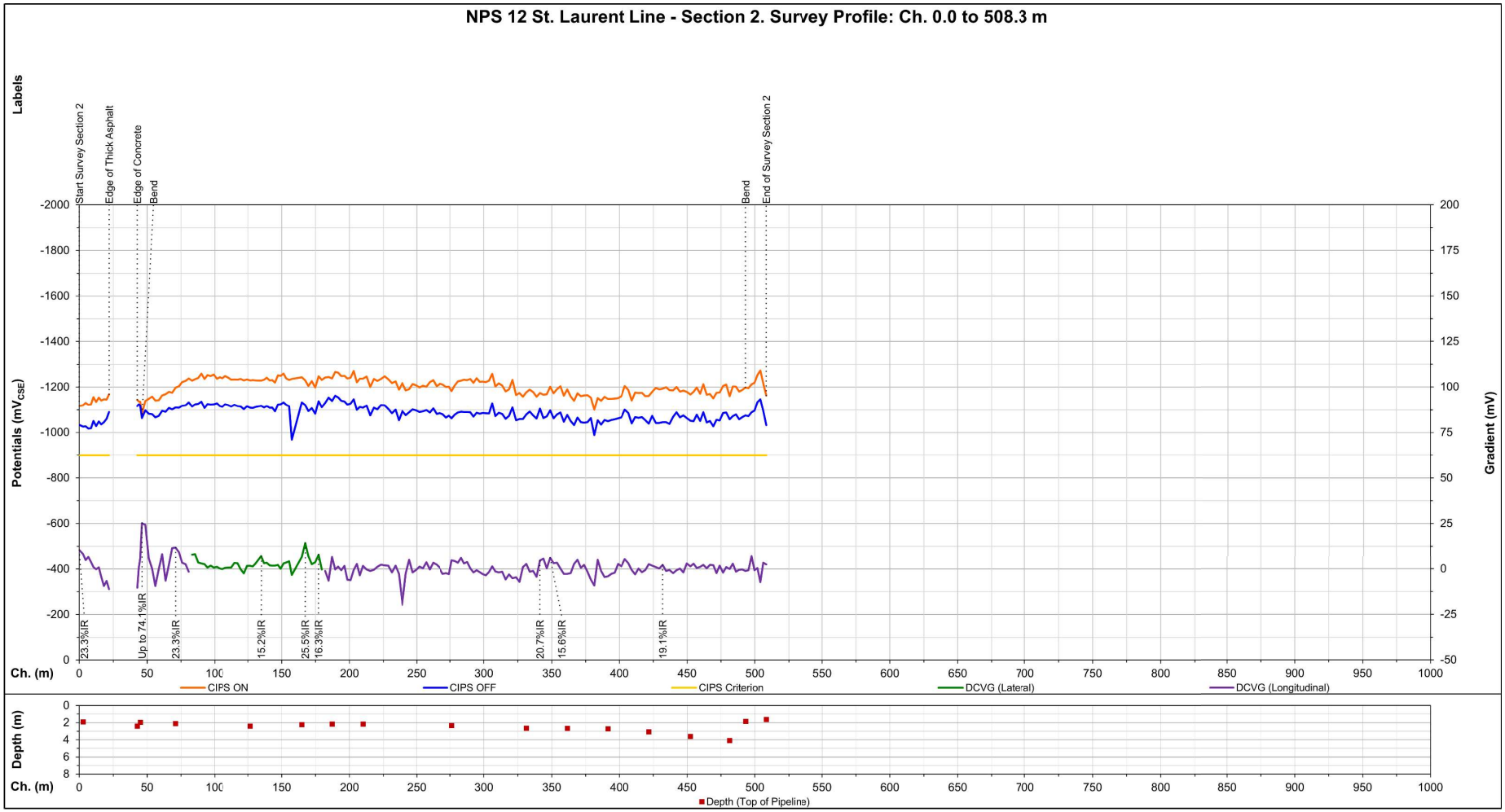
D.2 Section 2



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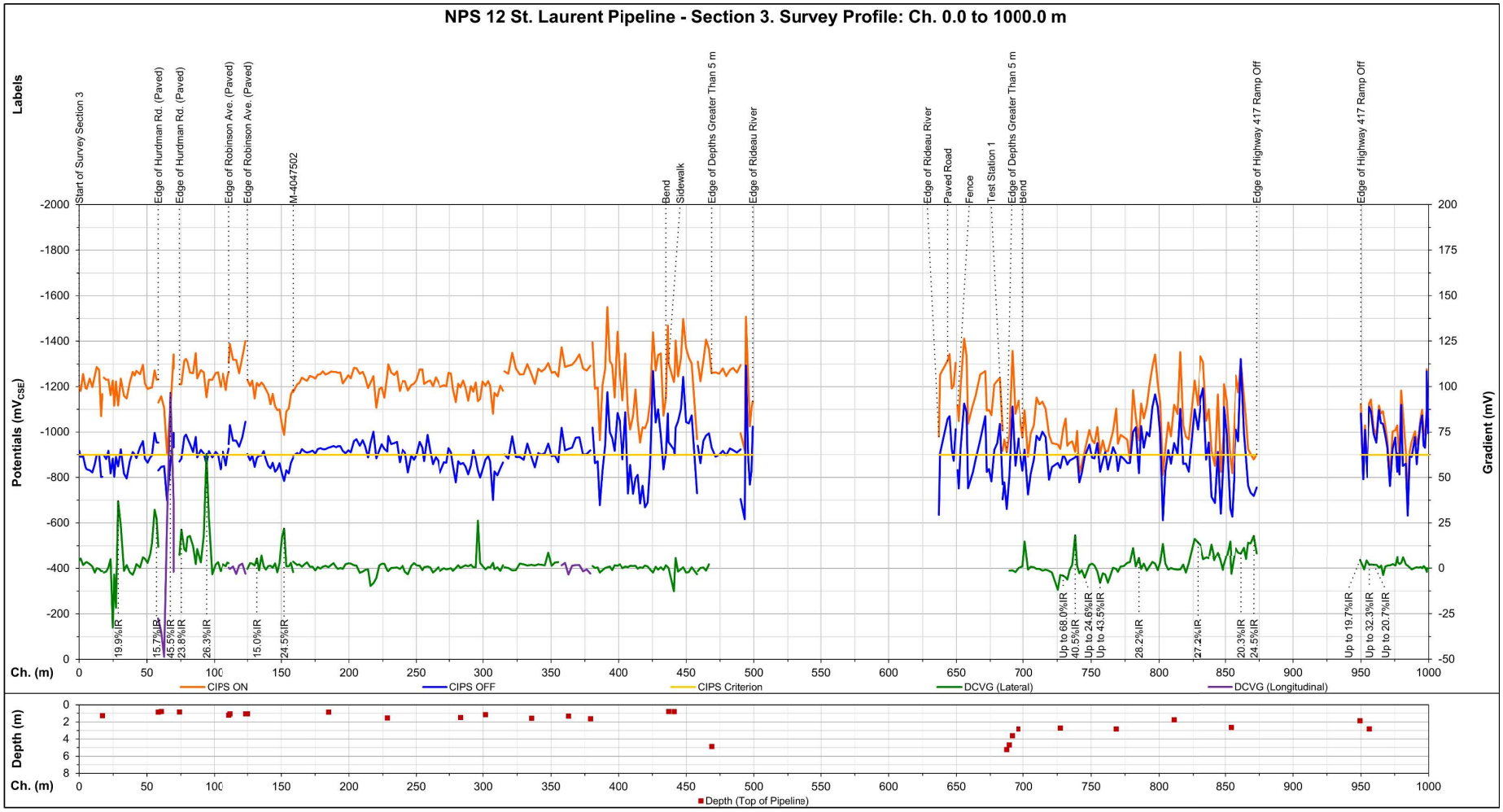
D.3 Section 3


NPS 12 St. Laurent Pipeline - Section 3. Survey Profile: Ch. 0.0 to 1000.0 m
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Start of Survey Section 3
Edge of Hurdman Rd. (Paved)
Edge of Hurdman Rd. (Paved)
Edge of Robinson Ave. (Paved)
Edge of Robinson Ave. (Paved)
M-4047502
Bend
Sidewalk
Edge of Depths Greater Than 5 m
Edge of Rideau River
Edge of Rideau River
Paved Road
Fence
Test Station 1
Edge of Depths Greater Than 5 m
Bend
Edge of Highway 417 Ramp Off
Edge of Highway 417 Ramp Off
Potentials (mV CSE)
Gradient (mV)
Ch. (m)
19.9%IR
15.7%IR
45.5%IR
23.8%IR
26.3%IR
15.0%IR
24.5%IR
Up to 68.0%IR
40.5%IR
Up to 24.6%IR
Up to 43.5%IR
28.2%IR
27.4%IR
20.3%IR
24.5%IR
Up to 19.7%IR
Up to 32.3%IR
Up to 20.7%IR
CIPS ON
CIPS OFF
CIPS Criterion
DCVG (Lateral)
DCVG (Longitudinal)
Depth (m)
Ch. (m)
Depth (Top of Pipeline)

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CIPS+DCVG Report

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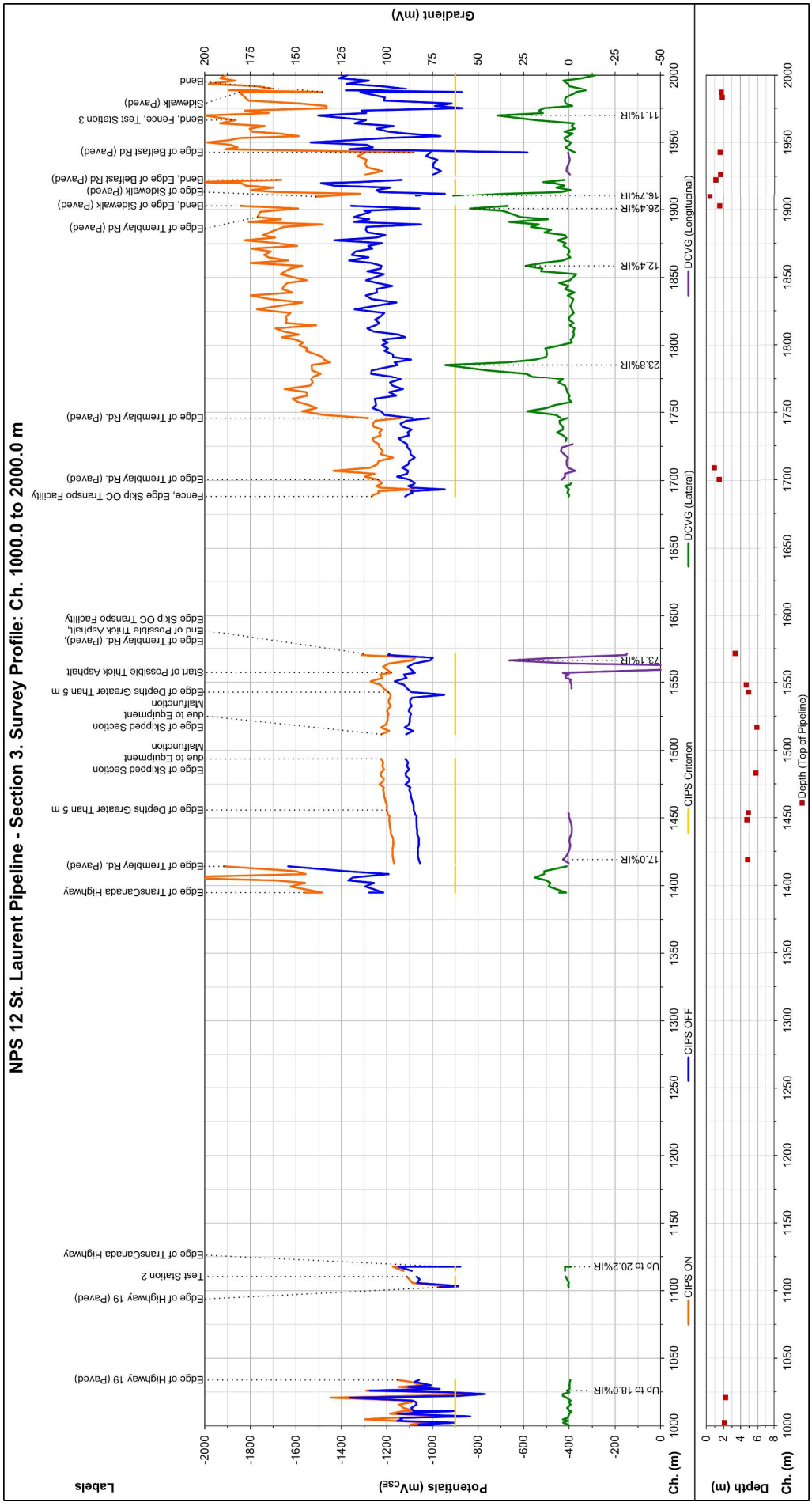

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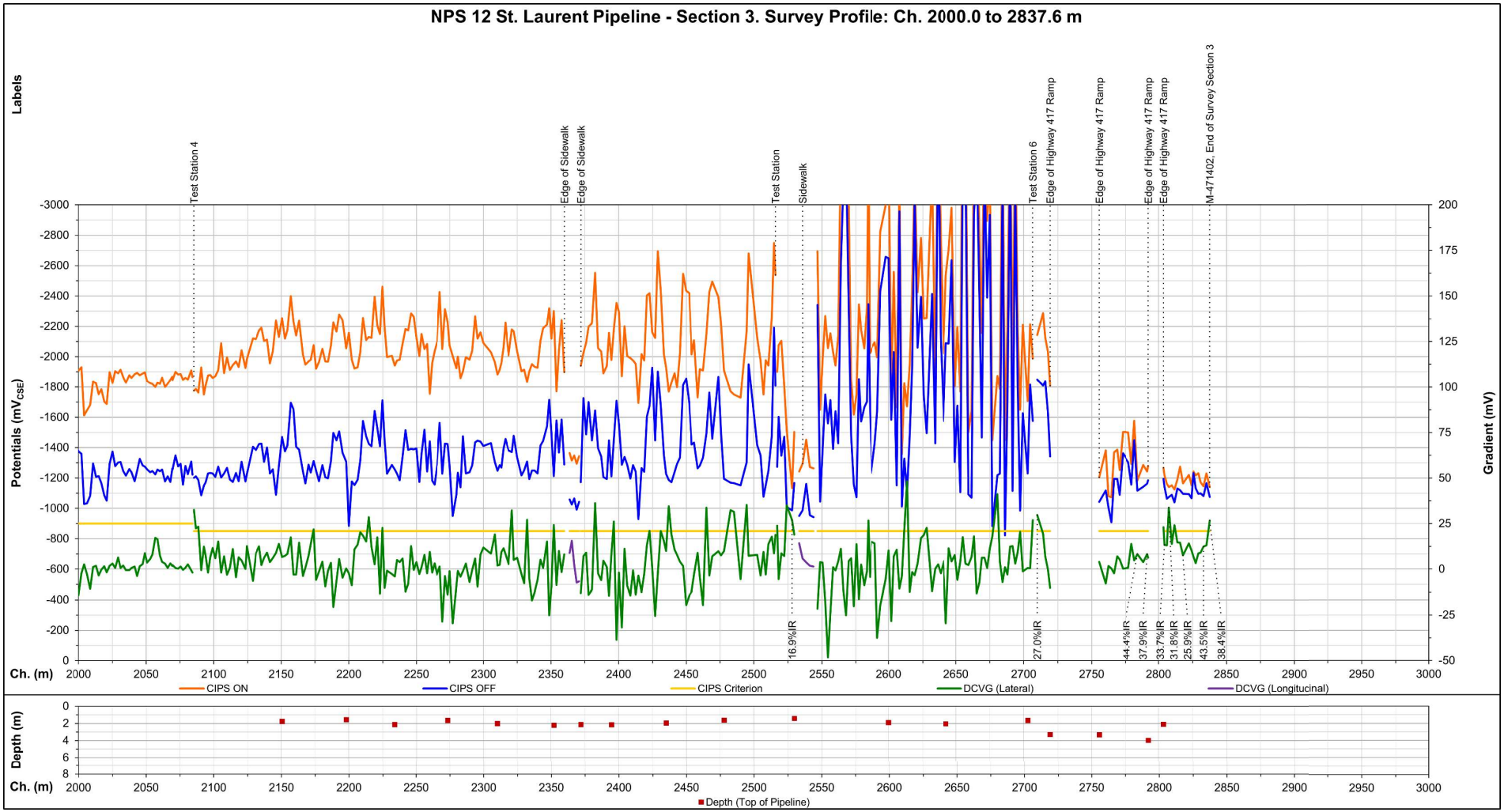
NPS 12 St. Laurent Pipeline - Section 3. Survey Profile: Ch. 2000.0 to 2837.6 m
Labels
Test Station 4
Edge of Sidewalk
Edge of Sidewalk
Test Station
Sidewalk
Test Station 6
Edge of Highway 417 Ramp
Edge of Highway 417 Ramp
Edge of Highway 417 Ramp
Edge of Highway 417 Ramp
M-471402, End of Survey Section 3
Potentials (mV CSE)
Gradient (mV)
16.9%IR
27.0%IR
44.4%IR
37.9%IR
33.7%IR
31.8%IR
25.9%IR
43.5%IR
38.4%IR
Ch. (m)
CIPS ON
CIPS OFF
CIPS Criterion
DCVG (Lateral)
DCVG (Longitucinal)
Depth (m)
Depth (Top of Pipeline)

APPENDIX E

Classification of Indications

Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.455056, -75.670585	396.0	Minor DCVG	15.0%IR
	45.455116, -75.670357 to 45.455132, -75.670320	414.6 to 418.0	Minor CIPS	-876 mV_{CSE} at Ch. 416.3 m
	45.455228, -75.669994 to 45.455228, -75.669944	445.4 to 449.7	Minor CIPS	-887 mV_{CSE} at Ch. 448.0 m
	45.455336, -75.669137	515.2	Minor DCVG	26.4%IR
	45.455928, -75.660438	1202.0	Minor DCVG	17.9%IR
	45.456021, -75.658994	1313.3	Minor DCVG	22.2%IR
	45.456231, -75.656073	1542.6	Minor DCVG	15.8%IR
	45.456261, -75.655405	1594.8	Minor DCVG	24.5%IR
	45.456176, -75.655353	1605.4	Minor DCVG	18.4%IR
	45.456090, -75.655303	1615.7	Moderate DCVG	54.4%IR
	45.455974, -75.655240	1630.2	Minor DCVG	16.2%IR
	45.455451, -75.654936	1693.4	Minor DCVG	24.2%IR
	45.455285, -75.654826	1712.3	Minor DCVG	22.7%IR
	45.455168, -75.654764	1726.9	Minor DCVG	17.0%IR
	45.455062, -75.654708	1739.4	Minor DCVG	17.4%IR
	45.454541, -75.654406	1802.3	Minor DCVG	21.1%IR
	45.454232, -75.654229	1839.4	Minor DCVG	16.7%IR
	45.452212, -75.653090	2080.7	Minor DCVG	19.9%IR
	45.450788, -75.652239	2256.0	Minor DCVG	27.3%IR
	45.449728, -75.651628	2386.7	Minor DCVG	15.7%IR
	45.449227, -75.651375	2442.2	Minor DCVG	20.7%IR
	45.449124, -75.651296 to 45.449060, -75.651267	2455.6 to 2463.8	Minor CIPS	-870 mV_{CSE} at Ch. 2458.3 m
	45.448741, -75.651082 to 45.448694, -75.651085	2502.3 to 2507.6	Minor CIPS	-885 mV_{CSE} at Ch. 2504.9 m
	45.448647, -75.651023 to 45.448518, -75.650962	2512.8 to 2529.0	Minor CIPS	-879 mV_{CSE} at Ch. 2526.5 m
	45.448472, -75.650946 to 45.448454, -75.650922	2534.0 to 2538.5	Minor CIPS	-870 mV_{CSE} at Ch. 2538.5 m
	45.448454, -75.650922	2538.5	Minor DCVG Minor CIPS	28.3%IR -870 mV_{CSE}
	45.448472, -75.650946 to 45.448389, -75.650904	2538.5 to 2543.6	Minor CIPS	-882 mV_{CSE} at Ch. 2540.7 m
	45.447585, -75.650428 to 45.447561, -75.650417	2640.2 to 2643.3	Minor CIPS	-890 mV_{CSE} at Ch. 2641.8 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.447546, -75.650410 to 45.447521, -75.650398	2645.0 to 2647.9	Minor CIPS	-894 mV_{CSE} at Ch. 2646.3 m
	45.447499, -75.650387 to 45.447471, -75.650369	2650.5 to 2654.1	Minor CIPS	-890 mV_{CSE} at Ch. 2652.5 m
	45.447058, -75.650132	2703.6	Minor DCVG	30.6%IR
	45.446983, -75.650091 to 45.446955, -75.650075	2712.2 to 2715.6	Minor CIPS	-885 mV_{CSE} at Ch. 2714.0 m
	45.446809, -75.649998 to 45.446767, -75.649970	2732.7 to 2738.4	Minor CIPS	-838 mV_{CSE} at Ch. 2737.1 m
	45.446767, -75.649970 to 45.446731, -75.649952	2738.4 to 2742.4	Moderate CIPS	-782 mV_{CSE} at Ch. 2740.5 m
	45.446731, -75.649952 to 45.446686, -75.649930	2742.4 to 2747.9	Minor CIPS	-829 mV_{CSE} at Ch. 2742.4 m
	45.446506, -75.649832 to 45.446456, -75.649800	2769.3 to 2775.1	Minor CIPS	-868 mV_{CSE} at Ch. 2773.3 m
	45.446443, -75.649796 to 45.446414, -75.649776	2776.6 to 2780.4	Minor CIPS	-887 mV_{CSE} at Ch. 2778.7 m
	45.446400, -75.649767 to 45.446285, -75.649712	2782.0 to 2793.6	Minor CIPS	-867 mV_{CSE} at Ch. 2787.4 m
	45.446278, -75.649697 to 45.446158, -75.649642	2794.9 to 2810.0	Minor CIPS	-835 mV_{CSE} at Ch. 2805.1 m
	45.446150, -75.649619	2811.7	Minor DCVG Minor CIPS	15.4%IR -929 mV_{CSE}
	45.446150, -75.649619 to 45.446143, -75.649599	2811.7 to 2813.3	Minor CIPS	-882 mV_{CSE} at Ch. 2813.3 m
	45.446143, -75.649599	2813.3	Minor DCVG Minor CIPS	29.2%IR -882 mV_{CSE}
	45.446150, -75.649619 to 45.446124, -75.649576	2813.3 to 2817.0	Minor CIPS	-871 mV_{CSE} at Ch. 2817.0 m
	45.446124, -75.649576	2817.0	Minor DCVG Minor CIPS	27.9%IR -871 mV_{CSE}
	45.446150, -75.649619 to 45.446114, -75.649565	2817.0 to 2818.8	Minor CIPS	-871 mV_{CSE} at Ch. 2817.0 m
	45.446045, -75.649535	2824.3	Minor DCVG Minor CIPS	22.5%IR -912 mV_{CSE}
	45.446045, -75.649535 to 45.446027, -75.649513	2824.3 to 2826.2	Minor CIPS	-897 mV_{CSE} at Ch. 2826.2 m
	45.446027, -75.649513 to 45.445975, -75.649493	2826.2 to 2829.9	Moderate CIPS	-799 mV_{CSE} at Ch. 2828.0 m
	45.445932, -75.649460 to 45.445913, -75.649442	2837.2 to 2839.1	Minor CIPS	-883 mV_{CSE} at Ch. 2839.1 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.445913, -75.649442 to 45.445900, -75.649439	2839.1 to 2840.9	Moderate CIPS	-799 mV_{CSE} at Ch. 2840.9 m
	45.445900, -75.649439	2840.9	Severe DCVG Moderate CIPS	69.3%IR -799 mV_{CSE}
	45.445913, -75.649442 to 45.445853, -75.649440	2840.9 to 2847.9	Moderate CIPS	-799 mV_{CSE} at Ch. 2840.9 m
	45.445727, -75.649363	2863.1	Minor DCVG	30.4%IR
	45.445694, -75.649368	2868.1	Minor DCVG	18.4%IR
	45.445610, -75.649290 to 45.445580, -75.649276	2880.1 to 2884.0	Minor CIPS	-895 mV_{CSE} at Ch. 2881.8 m
	45.445532, -75.649253	2888.9	Minor DCVG	22.3%IR
	45.445510, -75.649235 to 45.445460, -75.649208	2892.2 to 2897.9	Minor CIPS	-883 mV_{CSE} at Ch. 2897.9 m
	45.445460, -75.649208	2897.9	Minor DCVG Minor CIPS	23.0%IR -883 mV_{CSE}
	45.445510, -75.649235 to 45.445419, -75.649172	2897.9 to 2903.4	Minor CIPS	-875 mV_{CSE} at Ch. 2901.8 m
	45.445419, -75.649172 to 45.445410, -75.649170	2903.4 to 2904.8	Moderate CIPS	-817 mV_{CSE} at Ch. 2904.8 m
	45.445410, -75.649170	2904.8	Minor DCVG Moderate CIPS	31.5%IR -817 mV_{CSE}
	45.445419, -75.649172 to 45.445375, -75.649147	2904.8 to 2910.2	Moderate CIPS	-806 mV_{CSE} at Ch. 2906.3 m
	45.445375, -75.649147 to 45.445343, -75.649134	2910.2 to 2913.3	Minor CIPS	-863 mV_{CSE} at Ch. 2913.3 m
	45.445343, -75.649134	2913.3	Minor DCVG Minor CIPS	25.0%IR -863 mV_{CSE}
	45.445375, -75.649147 to 45.445249, -75.649092	2913.3 to 2923.1	Minor CIPS	-854 mV_{CSE} at Ch. 2919.6 m
	45.445249, -75.649092	2923.1	Moderate DCVG	43.4%IR
	45.445226, -75.649081 to 45.445192, -75.649056	2926.8 to 2930.3	Minor CIPS	-896 mV_{CSE} at Ch. 2928.5 m
	45.444995, -75.648952 to 45.444977, -75.648945	2953.4 to 2955.5	Minor CIPS	-858 mV_{CSE} at Ch. 2955.5 m
	45.444977, -75.648945	2955.5	Minor DCVG Minor CIPS	16.5%IR -858 mV_{CSE}
	45.444995, -75.648952 to 45.444960, -75.648932	2955.5 to 2957.6	Minor CIPS	-858 mV_{CSE} at Ch. 2955.5 m
	45.444928, -75.648912 to 45.444858, -75.648874	2961.8 to 2969.9	Minor CIPS	-847 mV_{CSE} at Ch. 2963.5 m
	45.444824, -75.648854	2974.2	Minor DCVG	18.8%IR

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.444736, -75.648796 to 45.444711, -75.648789	2984.6 to 2987.8	Minor CIPS	-895 mV_{CSE} at Ch. 2986.3 m
	45.444711, -75.648789	2987.8	Minor DCVG Minor CIPS	29.2%IR -918 mV_{CSE}
	45.444736, -75.648796 to 45.444695, -75.648781	2987.8 to 2989.3	Minor CIPS	-894 mV_{CSE} at Ch. 2989.3 m
	45.444695, -75.648781 to 45.444684, -75.648774	2989.3 to 2990.8	Moderate CIPS	-824 mV_{CSE} at Ch. 2990.8 m
	45.444684, -75.648774	2990.8	Minor DCVG Moderate CIPS	25.6%IR -824 mV_{CSE}
	45.444695, -75.648781 to 45.444692, -75.648764	2990.8 to 2992.0	Moderate CIPS	-824 mV_{CSE} at Ch. 2990.8 m
	45.444692, -75.648764 to 45.444679, -75.648754	2992.0 to 2993.6	Minor CIPS	-852 mV_{CSE} at Ch. 2992.0 m
	45.444679, -75.648754 to 45.444649, -75.648738	2993.6 to 2997.3	Moderate CIPS	-823 mV_{CSE} at Ch. 2995.8 m
	45.444649, -75.648738 to 45.444581, -75.648702	2997.3 to 3005.3	Minor CIPS	-848 mV_{CSE} at Ch. 3005.3 m
	45.444581, -75.648702 to 45.444550, -75.648676	3005.3 to 3009.3	Moderate CIPS	-818 mV_{CSE} at Ch. 3007.4 m
	45.444550, -75.648676	3009.3	Minor DCVG Minor CIPS	30.9%IR -834 mV_{CSE}
	45.444550, -75.648676 to 45.444501, -75.648650	3009.3 to 3015.2	Minor CIPS	-830 mV_{CSE} at Ch. 3015.2 m
	45.444501, -75.648650 to 45.444485, -75.648639	3015.2 to 3017.9	Moderate CIPS	-797 mV_{CSE} at Ch. 3017.9 m
	45.444485, -75.648639	3017.9	Minor DCVG Moderate CIPS	19.4%IR -797 mV_{CSE}
	45.444501, -75.648650 to 45.444471, -75.648635	3017.9 to 3019.0	Moderate CIPS	-797 mV_{CSE} at Ch. 3017.9 m
	45.444471, -75.648635 to 45.444409, -75.648575	3019.0 to 3026.8	Minor CIPS	-853 mV_{CSE} at Ch. 3022.8 m
	45.444409, -75.648575 to 45.444399, -75.648565	3026.8 to 3028.2	Moderate CIPS	-823 mV_{CSE} at Ch. 3028.2 m
	45.444399, -75.648565	3028.2	Minor DCVG Moderate CIPS	32.3%IR -823 mV_{CSE}
	45.444409, -75.648575 to 45.444389, -75.648559	3028.2 to 3029.6	Moderate CIPS	-823 mV_{CSE} at Ch. 3028.2 m
	45.444389, -75.648559 to 45.444343, -75.648571	3029.6 to 3034.6	Minor CIPS	-825 mV_{CSE} at Ch. 3029.6 m
	45.444212, -75.648518 to 45.444191, -75.648503	3051.7 to 3053.8	Minor CIPS	-886 mV_{CSE} at Ch. 3053.8 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.444191, -75.648503	3053.8	Moderate DCVG Minor CIPS	37.3%IR -886 mV_{CSE}
	45.444212, -75.648518 to 45.444147, -75.648484	3053.8 to 3058.1	Minor CIPS	-886 mV_{CSE} at Ch. 3053.8 m
	45.444116, -75.648416 to 45.444073, -75.648416	3062.3 to 3065.5	Minor CIPS	-896 mV_{CSE} at Ch. 3063.2 m
	45.444057, -75.648394	3069.2	Moderate DCVG	36.6%IR
	45.444033, -75.648383 to 45.443934, -75.648333	3072.6 to 3083.4	Minor CIPS	-837 mV_{CSE} at Ch. 3076.3 m
	45.443919, -75.648325 to 45.443895, -75.648310	3085.0 to 3088.2	Minor CIPS	-856 mV_{CSE} at Ch. 3086.5 m
	45.443840, -75.648287 to 45.443797, -75.648258	3095.0 to 3101.0	Minor CIPS	-853 mV_{CSE} at Ch. 3099.1 m
	45.443797, -75.648258 to 45.443780, -75.648251	3101.0 to 3102.9	Moderate CIPS	-818 mV_{CSE} at Ch. 3102.9 m
	45.443780, -75.648251	3102.9	Minor DCVG Moderate CIPS	29.0%IR -818 mV_{CSE}
	45.443797, -75.648258 to 45.443748, -75.648238	3102.9 to 3106.2	Moderate CIPS	-801 mV_{CSE} at Ch. 3104.6 m
	45.443748, -75.648238 to 45.443670, -75.648203	3106.2 to 3115.0	Minor CIPS	-830 mV_{CSE} at Ch. 3106.2 m
	45.443666, -75.648204 to 45.443622, -75.648156	3116.1 to 3121.2	Minor CIPS	-864 mV_{CSE} at Ch. 3120.2 m
	45.443622, -75.648156	3121.2	Minor DCVG Minor CIPS	15.9%IR -881 mV_{CSE}
	45.443666, -75.648204 to 45.443610, -75.648144	3121.2 to 3123.9	Minor CIPS	-881 mV_{CSE} at Ch. 3121.2 m
	45.443573, -75.648121	3128.6	Minor DCVG	18.5%IR
	45.443549, -75.648118 to 45.443482, -75.648086	3130.3 to 3138.3	Minor CIPS	-872 mV_{CSE} at Ch. 3133.5 m
	45.443439, -75.648059 to 45.443404, -75.648041	3143.3 to 3147.3	Minor CIPS	-895 mV_{CSE} at Ch. 3145.3 m
	45.443322, -75.647992 to 45.443295, -75.647976	3156.9 to 3160.2	Minor CIPS	-852 mV_{CSE} at Ch. 3160.2 m
	45.443295, -75.647976	3160.2	Moderate DCVG Minor CIPS	38.1%IR -852 mV_{CSE}
	45.443322, -75.647992 to 45.443276, -75.648017	3160.2 to 3164.0	Minor CIPS	-880 mV_{CSE} at Ch. 3162.6 m
	45.442563, -75.647574 to 45.442548, -75.647558	3257.7 to 3259.8	Minor CIPS	-830 mV_{CSE} at Ch. 3259.8 m
	45.442548, -75.647558 to 45.442532, -75.647503	3259.8 to 3263.0	Moderate CIPS	-807 mV_{CSE} at Ch. 3260.2 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.442532, -75.647503 to 45.442427, -75.647436	3263.0 to 3274.9	Minor CIPS	-866 mV_{CSE} at Ch. 3272.1 m
	45.442361, -75.647381 to 45.442253, -75.647328	3283.3 to 3298.5	Minor CIPS	-855 mV_{CSE} at Ch. 3289.7 m
	45.442047, -75.647283 to 45.442028, -75.647271	3321.1 to 3323.6	Minor CIPS	-885 mV_{CSE} at Ch. 3323.6 m
	45.442028, -75.647271	3323.6	Minor DCVG Minor CIPS	30.1%IR -885 mV_{CSE}
	45.442047, -75.647283 to 45.442006, -75.647268	3323.6 to 3326.1	Minor CIPS	-885 mV_{CSE} at Ch. 3323.6 m
	45.441911, -75.647209	3337.0	Minor DCVG	15.4%IR
	45.441499, -75.646969 to 45.441441, -75.646950	3386.3 to 3393.4	Severe CIPS	-705 mV_{CSE} at Ch. 3389.1 m
	45.441441, -75.646950 to 45.441223, -75.646805	3393.4 to 3419.4	Moderate CIPS	-753 mV_{CSE} at Ch. 3402.2 m
	45.441223, -75.646805 to 45.441185, -75.646790	3419.4 to 3425.6	Minor CIPS	-836 mV_{CSE} at Ch. 3425.6 m
	45.441185, -75.646790 to 45.441078, -75.646721	3425.6 to 3436.0	Moderate CIPS	-753 mV_{CSE} at Ch. 3433.9 m
	45.441078, -75.646721	3436.0	Minor DCVG Moderate CIPS	23.0%IR -763 mV_{CSE}
	45.441185, -75.646790 to 45.441071, -75.646713	3436.0 to 3438.0	Moderate CIPS	-763 mV_{CSE} at Ch. 3436.0 m
	45.441071, -75.646713 to 45.441036, -75.646698	3438.0 to 3442.2	Minor CIPS	-833 mV_{CSE} at Ch. 3438.0 m
	45.441036, -75.646698 to 45.440979, -75.646851	3442.2 to 3455.4	Moderate CIPS	-794 mV_{CSE} at Ch. 3450.8 m
	45.440979, -75.646851 to 45.440971, -75.646873	3455.4 to 3457.7	Severe CIPS	-728 mV_{CSE} at Ch. 3457.7 m
	45.440971, -75.646873	3457.7	Moderate DCVG Severe CIPS	35.9%IR -728 mV_{CSE}
	45.440979, -75.646851 to 45.440876, -75.646828	3457.7 to 3467.9	Severe CIPS	-677 mV_{CSE} at Ch. 3461.8 m
	45.440876, -75.646828 to 45.440804, -75.646773	3467.9 to 3477.9	Moderate CIPS	-768 mV_{CSE} at Ch. 3474.1 m
	45.440804, -75.646773 to 45.440764, -75.646745	3477.9 to 3482.9	Minor CIPS	-832 mV_{CSE} at Ch. 3480.0 m
	45.440764, -75.646745 to 45.440706, -75.646722	3482.9 to 3489.9	Moderate CIPS	-761 mV_{CSE} at Ch. 3489.9 m
	45.440706, -75.646722	3489.9	Severe DCVG Moderate CIPS	68.4%IR -761 mV_{CSE}

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.440764, -75.646745 to 45.440635, -75.646681	3489.9 to 3498.4	Moderate CIPS	-771 mV_{CSE} at Ch. 3495.4 m
	45.440635, -75.646681 to 45.440613, -75.646675	3498.4 to 3501.2	Minor CIPS	-869 mV_{CSE} at Ch. 3498.4 m
	45.440586, -75.646658 to 45.440541, -75.646633	3504.1 to 3509.6	Minor CIPS	-833 mV_{CSE} at Ch. 3506.7 m
	45.440520, -75.646623 to 45.440465, -75.646597	3512.4 to 3518.2	Minor CIPS	-857 mV_{CSE} at Ch. 3515.3 m
	45.440465, -75.646597 to 45.440420, -75.646571	3518.2 to 3523.9	Moderate CIPS	-763 mV_{CSE} at Ch. 3523.9 m
	45.440420, -75.646571 to 45.440396, -75.646552	3523.9 to 3526.8	Severe CIPS	-682 mV_{CSE} at Ch. 3526.8 m
	45.440396, -75.646552	3526.8	Severe DCVG Severe CIPS	82.6%IR -682 mV_{CSE}
	45.440420, -75.646571 to 45.440372, -75.646537	3526.8 to 3529.7	Severe CIPS	-682 mV_{CSE} at Ch. 3526.8 m
	45.440372, -75.646537 to 45.440193, -75.646444	3529.7 to 3551.3	Moderate CIPS	-765 mV_{CSE} at Ch. 3547.7 m
	45.440193, -75.646444 to 45.440167, -75.646425	3551.3 to 3554.8	Minor CIPS	-853 mV_{CSE} at Ch. 3554.8 m
	45.440167, -75.646425 to 45.440099, -75.646393	3554.8 to 3562.0	Moderate CIPS	-784 mV_{CSE} at Ch. 3558.4 m
	45.440099, -75.646393 to 45.440055, -75.646368	3562.0 to 3567.3	Minor CIPS	-844 mV_{CSE} at Ch. 3562.0 m
	45.440055, -75.646368 to 45.439981, -75.646326	3567.3 to 3576.5	Moderate CIPS	-788 mV_{CSE} at Ch. 3573.5 m
	45.439981, -75.646326 to 45.439879, -75.646264	3576.5 to 3588.5	Minor CIPS	-862 mV_{CSE} at Ch. 3582.4 m
	45.439854, -75.646250 to 45.439800, -75.646221	3591.7 to 3598.1	Minor CIPS	-837 mV_{CSE} at Ch. 3594.9 m
	45.439800, -75.646221 to 45.439775, -75.646206	3598.1 to 3601.2	Moderate CIPS	-815 mV_{CSE} at Ch. 3601.2 m
	45.439775, -75.646206	3601.2	Minor DCVG Moderate CIPS	25.2%IR -815 mV_{CSE}
	45.439800, -75.646221 to 45.439752, -75.646192	3601.2 to 3604.4	Moderate CIPS	-815 mV_{CSE} at Ch. 3601.2 m
	45.439752, -75.646192 to 45.439640, -75.646129	3604.4 to 3617.2	Minor CIPS	-838 mV_{CSE} at Ch. 3604.4 m
	45.439640, -75.646129 to 45.439587, -75.646098	3617.2 to 3623.6	Moderate CIPS	-794 mV_{CSE} at Ch. 3620.4 m
	45.439587, -75.646098 to 45.439514, -75.646052	3623.6 to 3632.4	Minor CIPS	-836 mV_{CSE} at Ch. 3632.4 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.439514, -75.646052 to 45.439463, -75.646032	3632.4 to 3638.3	Moderate CIPS	-797 mV_{CSE} at Ch. 3635.4 m
	45.439463, -75.646032 to 45.439393, -75.645992	3638.3 to 3646.7	Minor CIPS	-897 mV_{CSE} at Ch. 3644.0 m
	45.439356, -75.645976 to 45.439288, -75.645925	3650.9 to 3659.7	Minor CIPS	-832 mV_{CSE} at Ch. 3653.5 m
	45.439236, -75.645907 to 45.439162, -75.645867	3665.5 to 3674.0	Minor CIPS	-853 mV_{CSE} at Ch. 3668.6 m
	45.439011, -75.645782 to 45.438916, -75.645725	3692.3 to 3703.8	Minor CIPS	-864 mV_{CSE} at Ch. 3695.0 m
	45.438891, -75.645712 to 45.438843, -75.645682	3706.8 to 3712.6	Severe CIPS	-699 mV_{CSE} at Ch. 3709.8 m
	45.438809, -75.645671 to 45.438746, -75.645634	3716.5 to 3724.2	Moderate CIPS	-789 mV_{CSE} at Ch. 3718.7 m
	45.438631, -75.645568 to 45.438583, -75.645544	3738.0 to 3743.6	Minor CIPS	-863 mV_{CSE} at Ch. 3740.7 m
	45.438424, -75.645456 to 45.438361, -75.645423	3762.7 to 3770.4	Minor CIPS	-873 mV_{CSE} at Ch. 3764.5 m
	45.438300, -75.645389 to 45.438279, -75.645379	3777.7 to 3780.1	Minor CIPS	-896 mV_{CSE} at Ch. 3780.1 m
	45.438279, -75.645379 to 45.438242, -75.645353	3780.1 to 3784.6	Moderate CIPS	-813 mV_{CSE} at Ch. 3782.6 m
	45.438242, -75.645353 to 45.438196, -75.645325	3784.6 to 3790.2	Minor CIPS	-859 mV_{CSE} at Ch. 3790.2 m
	45.438196, -75.645325	3790.2	Minor DCVG Minor CIPS	32.5%IR -859 mV_{CSE}
	45.438242, -75.645353 to 45.438151, -75.645300	3790.2 to 3795.6	Minor CIPS	-859 mV_{CSE} at Ch. 3790.2 m
	45.437919, -75.645169 to 45.437835, -75.645125	3823.8 to 3833.5	Minor CIPS	-884 mV_{CSE} at Ch. 3826.3 m
	45.437835, -75.645125 to 45.437787, -75.645100	3833.5 to 3839.1	Moderate CIPS	-795 mV_{CSE} at Ch. 3839.1 m
	45.437787, -75.645100	3839.1	Minor DCVG Moderate CIPS	16.0%IR -795 mV_{CSE}
	45.437835, -75.645125 to 45.437598, -75.644977	3839.1 to 3862.4	Moderate CIPS	-762 mV_{CSE} at Ch. 3850.1 m
	45.437598, -75.644977 to 45.437506, -75.644915	3862.4 to 3874.8	Minor CIPS	-840 mV_{CSE} at Ch. 3871.6 m
	45.437506, -75.644915 to 45.437437, -75.644894	3874.8 to 3882.3	Moderate CIPS	-763 mV_{CSE} at Ch. 3882.3 m
	45.437437, -75.644894	3882.3	Moderate DCVG Moderate CIPS	47.4%IR -763 mV_{CSE}

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.437506, -75.644915 to 45.437366, -75.644854	3882.3 to 3889.3	Moderate CIPS	-804 mV_{CSE} at Ch. 3884.5 m
	45.437366, -75.644854 to 45.437340, -75.644841	3889.3 to 3891.9	Minor CIPS	-828 mV_{CSE} at Ch. 3889.3 m
	45.437340, -75.644841 to 45.437299, -75.644816	3891.9 to 3897.1	Moderate CIPS	-818 mV_{CSE} at Ch. 3894.5 m
	45.437299, -75.644816 to 45.437245, -75.644779	3897.1 to 3905.0	Minor CIPS	-826 mV_{CSE} at Ch. 3897.1 m
	45.437245, -75.644779 to 45.437198, -75.644758	3905.0 to 3910.2	Moderate CIPS	-822 mV_{CSE} at Ch. 3907.6 m
	45.437198, -75.644758 to 45.437180, -75.644746	3910.2 to 3912.8	Minor CIPS	-833 mV_{CSE} at Ch. 3910.2 m
	45.437180, -75.644746 to 45.437132, -75.644717	3912.8 to 3918.0	Moderate CIPS	-797 mV_{CSE} at Ch. 3915.4 m
	45.437132, -75.644717 to 45.436805, -75.644546	3918.0 to 3956.7	Minor CIPS	-832 mV_{CSE} at Ch. 3921.0 m
	45.436764, -75.644536 to 45.436697, -75.644494	3961.9 to 3969.6	Minor CIPS	-837 mV_{CSE} at Ch. 3967.0 m
	45.436677, -75.644475	3972.2	Minor DCVG	19.3%IR
	45.436566, -75.644422	3985.0	Moderate DCVG Minor CIPS	51.7%IR -917 mV_{CSE}
	45.436566, -75.644422 to 45.436526, -75.644391	3985.0 to 3990.3	Minor CIPS	-883 mV_{CSE} at Ch. 3987.7 m
	45.435643, -75.643901 to 45.435605, -75.643878	4095.7 to 4100.6	Minor CIPS	-893 mV_{CSE} at Ch. 4098.1 m
	45.435581, -75.643867 to 45.435540, -75.643842	4103.1 to 4108.0	Minor CIPS	-879 mV_{CSE} at Ch. 4105.6 m
	45.435197, -75.643660 to 45.435174, -75.643634	4148.6 to 4151.9	Minor CIPS	-890 mV_{CSE} at Ch. 4149.4 m
	45.435157, -75.643629 to 45.435124, -75.643619	4153.6 to 4157.4	Minor CIPS	-865 mV_{CSE} at Ch. 4155.4 m
	45.435124, -75.643619	4157.4	Minor DCVG Minor CIPS	19.3%IR -878 mV_{CSE}
	45.435157, -75.643629 to 45.435103, -75.643601	4157.4 to 4160.9	Minor CIPS	-847 mV_{CSE} at Ch. 4159.2 m
	45.435081, -75.643597 to 45.435050, -75.643559	4162.4 to 4168.0	Minor CIPS	-840 mV_{CSE} at Ch. 4168.0 m
	45.435050, -75.643559	4168.0	Minor DCVG Minor CIPS	32.7%IR -840 mV_{CSE}
	45.435081, -75.643597 to 45.434928, -75.643488	4168.0 to 4183.0	Minor CIPS	-873 mV_{CSE} at Ch. 4172.3 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.434928, -75.643488	4183.0	Minor DCVG Minor CIPS	18.0%IR -878 mV_{CSE}
	45.435081, -75.643597 to 45.434850, -75.643445	4183.0 to 4191.4	Minor CIPS	-874 mV_{CSE} at Ch. 4187.3 m
	45.434754, -75.643384	4202.5	Minor DCVG	15.4%IR
	45.434353, -75.643154 to 45.434325, -75.643137	4250.7 to 4253.3	Minor CIPS	-849 mV_{CSE} at Ch. 4253.3 m
	45.434325, -75.643137	4253.3	Minor DCVG Minor CIPS	18.2%IR -849 mV_{CSE}
	45.434353, -75.643154 to 45.434301, -75.643124	4253.3 to 4255.8	Minor CIPS	-849 mV_{CSE} at Ch. 4253.3 m
	45.434242, -75.643094 to 45.434179, -75.643065	4263.5 to 4271.2	Minor CIPS	-841 mV_{CSE} at Ch. 4266.1 m
	45.434052, -75.642993 to 45.433904, -75.642912	4286.4 to 4304.3	Minor CIPS	-813 mV_{CSE} at Ch. 4296.6 m
	45.433883, -75.642900	4306.9	Minor DCVG Minor CIPS	20.3%IR -875 mV_{CSE}
	45.433883, -75.642900 to 45.433623, -75.642741	4306.9 to 4337.7	Minor CIPS	-815 mV_{CSE} at Ch. 4327.4 m
	45.433191, -75.642497	4390.0	Minor DCVG	27.3%IR
	45.433143, -75.642472	4395.9	Minor DCVG	17.2%IR
	45.432878, -75.642330	4427.3	Minor DCVG	18.0%IR
	45.432591, -75.642177 to 45.432576, -75.642164	4460.7 to 4463.6	Moderate CIPS	-788 mV_{CSE} at Ch. 4463.6 m
	45.432576, -75.642164	4463.6	Moderate DCVG Moderate CIPS	42.3%IR -788 mV_{CSE}
	45.432591, -75.642177 to 45.432502, -75.642123	4463.6 to 4471.9	Moderate CIPS	-795 mV_{CSE} at Ch. 4469.3 m
	45.432502, -75.642123 to 45.432310, -75.642000	4471.9 to 4495.2	Minor CIPS	-824 mV_{CSE} at Ch. 4471.9 m
	45.432152, -75.641915 to 45.432126, -75.641899	4514.7 to 4517.5	Minor CIPS	-844 mV_{CSE} at Ch. 4517.5 m
	45.432126, -75.641899	4517.5	Minor DCVG Minor CIPS	15.2%IR -844 mV_{CSE}
	45.432152, -75.641915 to 45.431756, -75.641689	4517.5 to 4561.0	Minor CIPS	-820 mV_{CSE} at Ch. 4561.0 m
	45.431756, -75.641689	4561.0	Minor DCVG Minor CIPS	16.4%IR -820 mV_{CSE}
	45.432152, -75.641915 to 45.431734, -75.641674	4561.0 to 4563.4	Minor CIPS	-820 mV_{CSE} at Ch. 4561.0 m
	45.431689, -75.641654 to 45.431666, -75.641644	4568.3 to 4573.1	Minor CIPS	-849 mV_{CSE} at Ch. 4570.7 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.431639, -75.641630	4575.5	Minor DCVG Minor CIPS	15.1%IR -877 mV_{CSE}
	45.431639, -75.641630 to 45.431595, -75.641604	4575.5 to 4580.4	Minor CIPS	-819 mV_{CSE} at Ch. 4578.0 m
	45.431119, -75.641323	4637.1	Minor DCVG	28.8%IR
	45.431036, -75.641281	4647.4	Minor DCVG	31.2%IR
	45.430925, -75.641226 to 45.430887, -75.641199	4660.2 to 4665.3	Minor CIPS	-841 mV_{CSE} at Ch. 4662.7 m
	45.430887, -75.641199	4665.3	Minor DCVG Minor CIPS	18.9%IR -850 mV_{CSE}
	45.430887, -75.641199 to 45.430844, -75.641171	4665.3 to 4670.4	Moderate CIPS	-790 mV_{CSE} at Ch. 4667.8 m
	45.430803, -75.641156 to 45.430762, -75.641134	4675.3 to 4680.2	Minor CIPS	-841 mV_{CSE} at Ch. 4677.7 m
	45.430743, -75.641123 to 45.430443, -75.640945	4682.6 to 4719.2	Minor CIPS	-806 mV_{CSE} at Ch. 4699.6 m
	45.430443, -75.640945 to 45.430420, -75.640940	4719.2 to 4721.7	Moderate CIPS	-772 mV_{CSE} at Ch. 4721.7 m
	45.430420, -75.640940 to 45.430336, -75.640887	4721.7 to 4731.6	Severe CIPS	-724 mV_{CSE} at Ch. 4731.6 m
	45.430336, -75.640887	4731.6	Minor DCVG Severe CIPS	25.7%IR -724 mV_{CSE}
	45.430420, -75.640940 to 45.430315, -75.640875	4731.6 to 4734.0	Severe CIPS	-724 mV_{CSE} at Ch. 4731.6 m
	45.430315, -75.640875 to 45.430290, -75.640866	4734.0 to 4736.5	Moderate CIPS	-789 mV_{CSE} at Ch. 4736.5 m
	45.430290, -75.640866 to 45.430255, -75.640838	4736.5 to 4741.4	Severe CIPS	-719 mV_{CSE} at Ch. 4741.4 m
	45.430255, -75.640838	4741.4	Minor DCVG Severe CIPS	28.7%IR -719 mV_{CSE}
	45.430290, -75.640866 to 45.430234, -75.640826	4741.4 to 4743.9	Severe CIPS	-719 mV_{CSE} at Ch. 4741.4 m
	45.430234, -75.640826 to 45.430168, -75.640800	4743.9 to 4751.2	Moderate CIPS	-752 mV_{CSE} at Ch. 4743.9 m
	45.430168, -75.640800	4751.2	Minor DCVG Minor CIPS	19.8%IR -806 mV_{CSE}
	45.430168, -75.640800 to 45.430130, -75.640777	4751.2 to 4756.1	Minor CIPS	-806 mV_{CSE} at Ch. 4751.2 m
	45.429882, -75.640633 to 45.429857, -75.640622	4786.4 to 4788.8	Minor CIPS	-828 mV_{CSE} at Ch. 4788.8 m
	45.429857, -75.640622	4788.8	Moderate DCVG Minor CIPS	39.0%IR -828 mV_{CSE}

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.429882, -75.640633 to 45.429833, -75.640608	4788.8 to 4791.3	Minor CIPS	-828 mV_{CSE} at Ch. 4788.8 m
	45.428889, -75.640069 to 45.428862, -75.640071	4904.2 to 4906.9	Minor CIPS	-802 mV_{CSE} at Ch. 4906.9 m
	45.428862, -75.640071	4906.9	Moderate DCVG Minor CIPS	41.7%IR -802 mV_{CSE}
	45.428889, -75.640069 to 45.428844, -75.640058	4906.9 to 4909.6	Minor CIPS	-802 mV_{CSE} at Ch. 4906.9 m
	45.428759, -75.639999	4920.3	Minor DCVG	16.0%IR
	45.428507, -75.639859	4950.6	Minor DCVG	15.9%IR
	45.428248, -75.639712	4980.9	Moderate DCVG	56.7%IR
	45.428178, -75.639671	4988.9	Minor DCVG	17.8%IR
	45.426766, -75.638868	5158.5	Minor DCVG	30.8%IR
	45.426626, -75.638785	5175.4	Minor DCVG	19.2%IR
	45.426331, -75.638616	5211.2	Minor DCVG	20.9%IR
	45.426250, -75.638568	5220.6	Minor DCVG	32.2%IR
	45.426198, -75.638562	5225.3	Minor DCVG	15.7%IR
	45.426146, -75.638532	5232.4	Minor DCVG	29.1%IR
	45.425935, -75.638398 to 45.425882, -75.638348	5258.1 to 5265.4	Minor CIPS	-804 mV_{CSE} at Ch. 5261.4 m
	45.425511, -75.638155	5309.6	Moderate DCVG	56.3%IR
	45.424770, -75.637737	5398.2	Minor DCVG	18.5%IR
	45.424624, -75.637655 to 45.424536, -75.637605	5415.3 to 5426.2	Minor CIPS	-833 mV_{CSE} at Ch. 5426.2 m
	45.424536, -75.637605	5426.2	Minor DCVG Minor CIPS	29.4%IR -833 mV_{CSE}
	45.424624, -75.637655 to 45.424448, -75.637549	5426.2 to 5435.4	Minor CIPS	-815 mV_{CSE} at Ch. 5429.1 m
	45.424372, -75.637508 to 45.424291, -75.637465	5446.0 to 5456.0	Minor CIPS	-833 mV_{CSE} at Ch. 5453.8 m
	45.424191, -75.637403 to 45.424087, -75.637347	5467.3 to 5480.7	Minor CIPS	-815 mV_{CSE} at Ch. 5474.0 m
	45.424044, -75.637321	5485.2	Minor DCVG	26.2%IR
	45.423962, -75.637272 to 45.423926, -75.637249	5494.8 to 5499.5	Minor CIPS	-807 mV_{CSE} at Ch. 5497.2 m
	45.423909, -75.637240 to 45.423825, -75.637190	5501.9 to 5511.4	Minor CIPS	-821 mV_{CSE} at Ch. 5504.3 m
	45.423807, -75.637181 to 45.423770, -75.637161	5513.6 to 5518.1	Minor CIPS	-849 mV_{CSE} at Ch. 5515.9 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.423670, -75.637108 to 45.423634, -75.637087	5531.4 to 5535.9	Minor CIPS	-835 mV_{CSE} at Ch. 5533.7 m
	45.423167, -75.636841 to 45.423122, -75.636815	5590.7 to 5595.7	Minor CIPS	-829 mV_{CSE} at Ch. 5593.2 m
	45.422238, -75.636364	5699.4	Minor DCVG	19.9%IR
	45.421965, -75.636227	5732.2	Minor DCVG	32.2%IR
	45.421889, -75.636254	5740.3	Minor DCVG	22.2%IR
	45.421812, -75.636214 to 45.421749, -75.636192	5747.7 to 5755.5	Minor CIPS	-803 mV_{CSE} at Ch. 5752.1 m
	45.421749, -75.636192	5755.5	Minor DCVG Minor CIPS	25.1%IR -815 mV_{CSE}
	45.421812, -75.636214 to 45.421660, -75.636158	5755.5 to 5765.8	Minor CIPS	-843 mV_{CSE} at Ch. 5761.9 m
	45.421625, -75.636153 to 45.421565, -75.636127	5769.8 to 5777.3	Minor CIPS	-817 mV_{CSE} at Ch. 5772.5 m
	45.421484, -75.636095 to 45.421442, -75.636074	5786.4 to 5791.4	Minor CIPS	-800 mV_{CSE} at Ch. 5791.4 m
	45.421442, -75.636074 to 45.421361, -75.636021	5791.4 to 5800.9	Moderate CIPS	-761 mV_{CSE} at Ch. 5798.7 m
	45.421361, -75.636021 to 45.421358, -75.636003	5800.9 to 5805.0	Minor CIPS	-813 mV_{CSE} at Ch. 5800.9 m
	45.421358, -75.636003 to 45.421322, -75.635970	5805.0 to 5810.0	Moderate CIPS	-750 mV_{CSE} at Ch. 5807.3 m
	45.421300, -75.635955 to 45.421256, -75.635926	5812.6 to 5818.0	Moderate CIPS	-750 mV_{CSE} at Ch. 5815.3 m
	45.421256, -75.635926 to 45.421235, -75.635912	5818.0 to 5820.6	Minor CIPS	-829 mV_{CSE} at Ch. 5820.6 m
	45.421235, -75.635912 to 45.421224, -75.635905	5820.6 to 5822.0	Moderate CIPS	-799 mV_{CSE} at Ch. 5822.0 m
	45.421224, -75.635905 to 45.421187, -75.635889	5822.0 to 5825.2	Severe CIPS	-733 mV_{CSE} at Ch. 5823.3 m
	45.421187, -75.635889 to 45.421132, -75.635863	5825.2 to 5832.7	Moderate CIPS	-752 mV_{CSE} at Ch. 5827.1 m
	45.421132, -75.635863 to 45.421141, -75.635837	5832.7 to 5834.5	Minor CIPS	-802 mV_{CSE} at Ch. 5834.5 m
	45.421141, -75.635837 to 45.421128, -75.635786	5834.5 to 5840.3	Severe CIPS	-738 mV_{CSE} at Ch. 5838.2 m
	45.421128, -75.635786 to 45.421091, -75.635783	5840.3 to 5844.5	Moderate CIPS	-794 mV_{CSE} at Ch. 5842.4 m
	45.421091, -75.635783 to 45.421058, -75.635760	5844.5 to 5848.7	Severe CIPS	-732 mV_{CSE} at Ch. 5846.6 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.421058, -75.635760 to 45.421054, -75.635757	5848.7 to 5849.3	Minor CIPS	-823 mV_{CSE} at Ch. 5848.7 m
	45.421054, -75.635757 to 45.421051, -75.635748	5849.3 to 5849.9	Moderate CIPS	-780 mV_{CSE} at Ch. 5849.9 m
	45.421051, -75.635748 to 45.421024, -75.635733	5849.9 to 5853.1	Severe CIPS	-538 mV_{CSE} at Ch. 5853.1 m
	45.421024, -75.635733	5853.1	Minor DCVG Severe CIPS	18.3%IR -538 mV_{CSE}
	45.419710, -75.635612 to 45.419630, -75.635597	6031.1 to 6040.6	Minor CIPS	-807 mV_{CSE} at Ch. 6036.6 m
	45.419597, -75.635588 to 45.419558, -75.635575	6044.6 to 6048.2	Minor CIPS	-846 mV_{CSE} at Ch. 6047.3 m
	45.419558, -75.635575	6048.2	Moderate DCVG	57.9%IR
	45.419050, -75.635033	6138.6	Moderate DCVG	45.8%IR
	45.417551, -75.633940 to 45.417542, -75.633924	6328.8 to 6330.2	Minor CIPS	-849 mV_{CSE} at Ch. 6330.2 m
	45.417542, -75.633924	6330.2	Minor DCVG Minor CIPS	22.2%IR -849 mV_{CSE}
	45.417551, -75.633940 to 45.417532, -75.633891	6330.2 to 6334.0	Minor CIPS	-849 mV_{CSE} at Ch. 6330.2 m
	45.417516, -75.633853 to 45.417456, -75.633812	6336.8 to 6344.0	Severe CIPS	-709 mV_{CSE} at Ch. 6338.2 m
	45.417446, -75.633814 to 45.417220, -75.633723	6345.1 to 6371.5	Minor CIPS	-822 mV_{CSE} at Ch. 6350.7 m
	45.417187, -75.633715 to 45.416410, -75.633407	6375.3 to 6465.0	Minor CIPS	-807 mV_{CSE} at Ch. 6461.8 m
	45.416410, -75.633407 to 45.416355, -75.633387	6465.0 to 6472.3	Moderate CIPS	-798 mV_{CSE} at Ch. 6467.7 m
	45.416355, -75.633387 to 45.416223, -75.633334	6472.3 to 6486.6	Minor CIPS	-803 mV_{CSE} at Ch. 6486.6 m
	45.416223, -75.633334 to 45.416025, -75.633244	6486.6 to 6508.6	Moderate CIPS	-779 mV_{CSE} at Ch. 6490.9 m
	45.416025, -75.633244 to 45.416011, -75.633244	6508.6 to 6509.9	Minor CIPS	-806 mV_{CSE} at Ch. 6508.6 m
	45.416011, -75.633244 to 45.415990, -75.633237	6509.9 to 6512.5	Moderate CIPS	-798 mV_{CSE} at Ch. 6511.2 m
	45.415990, -75.633237	6512.5	Minor DCVG Moderate CIPS	Up to 17.6%IR -804 mV_{CSE}
	45.416011, -75.633244 to 45.415953, -75.633199	6512.5 to 6518.0	Moderate CIPS	-788 mV_{CSE} at Ch. 6514.7 m
	45.415953, -75.633199	6518.0	Minor DCVG Minor CIPS	Up to 15.3%IR -809 mV_{CSE}

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.415953, -75.633199 to 45.415938, -75.633203	6518.0 to 6520.3	Minor CIPS	-807 mV_{CSE} at Ch. 6520.3 m
	45.415938, -75.633203 to 45.415769, -75.633112	6520.3 to 6539.5	Moderate CIPS	-758 mV_{CSE} at Ch. 6537.3 m
	45.415769, -75.633112 to 45.415749, -75.633115	6539.5 to 6540.8	Severe CIPS	-739 mV_{CSE} at Ch. 6540.8 m
	45.415749, -75.633115	6540.8	Minor DCVG Severe CIPS	17.8%IR -739 mV_{CSE}
	45.415769, -75.633112 to 45.415665, -75.633066	6540.8 to 6552.1	Severe CIPS	-678 mV_{CSE} at Ch. 6552.1 m
	45.415665, -75.633066	6552.1	Minor DCVG Severe CIPS	33.8%IR -678 mV_{CSE}
	45.415769, -75.633112 to 45.415634, -75.633019	6552.1 to 6557.6	Severe CIPS	-673 mV_{CSE} at Ch. 6553.3 m
	45.415259, -75.632807	6602.5	Minor DCVG Severe CIPS	15.6%IR -739 mV_{CSE}
	45.415259, -75.632807 to 45.415259, -75.632800	6602.5 to 6603.2	Severe CIPS	-739 mV_{CSE} at Ch. 6602.5 m
	45.415259, -75.632800 to 45.415084, -75.632672	6603.2 to 6625.0	Moderate CIPS	-750 mV_{CSE} at Ch. 6603.2 m
	45.415084, -75.632672 to 45.415043, -75.632661	6625.0 to 6629.2	Minor CIPS	-802 mV_{CSE} at Ch. 6625.0 m
	45.414995, -75.632638 to 45.414728, -75.632443	6634.7 to 6668.1	Minor CIPS	-823 mV_{CSE} at Ch. 6646.3 m
	45.414616, -75.632368 to 45.414341, -75.632190	6683.3 to 6715.7	Minor CIPS	-833 mV_{CSE} at Ch. 6713.1 m
	45.412881, -75.631185 to 45.412861, -75.631172	6897.2 to 6900.2	Minor CIPS	-827 mV_{CSE} at Ch. 6899.1 m
	45.412861, -75.631172	6900.2	Moderate DCVG Minor CIPS	37.3%IR -827 mV_{CSE}
	45.412881, -75.631185 to 45.412849, -75.631167	6900.2 to 6901.2	Minor CIPS	-827 mV_{CSE} at Ch. 6899.1 m
	45.412172, -75.630796	6982.2	Moderate DCVG	39.9%IR
	45.412011, -75.630709	7001.1	Severe DCVG	65.8%IR
	45.411850, -75.630756	7021.5	Moderate DCVG	38.8%IR
	45.411601, -75.630471	7056.6	Moderate DCVG	39.0%IR
	45.411447, -75.630391	7074.6	Minor DCVG	24.8%IR
	45.411228, -75.630301	7099.7	Minor DCVG	23.2%IR
	45.411062, -75.630233	7120.0	Moderate DCVG	42.5%IR
	45.410553, -75.630024	7179.6	Minor DCVG	15.1%IR
	45.409533, -75.629584	7297.2	Minor DCVG	26.4%IR

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Section	GPS	Chainage (m)	Classification	Notes
Section 1	45.409406, -75.629537 to 45.409391, -75.629533	7315.0 to 7316.6	Minor CIPS	-810 mV_{CSE} at Ch. 7315.9 m
	45.408505, -75.628946	7427.1	Minor DCVG	17.5%IR
	45.408319, -75.628846	7450.9	Minor DCVG	Up to 20.1%IR
Section 2	45.406141, -75.627368	0.0	Minor DCVG	23.3%IR
	45.405824, -75.627004	46.2	Severe DCVG	Up to 74.1%IR
	45.405621, -75.626871	71.0	Minor DCVG	23.3%IR
	45.405096, -75.626580	134.9	Minor DCVG	15.2%IR
	45.404814, -75.626424	167.3	Minor DCVG	25.5%IR
	45.404730, -75.626374	177.2	Minor DCVG	16.3%IR
	45.403358, -75.625605	341.3	Minor DCVG	20.7%IR
	45.403296, -75.625572	348.9	Minor DCVG	15.6%IR
	45.402600, -75.625178	432.0	Minor DCVG	19.1%IR
Section 3	45.418381, -75.669210 to 45.418338, -75.669134	0.0 to 7.8	Minor CIPS	-831 mV_{CSE} at Ch. 7.8 m
	45.418338, -75.669134 to 45.418308, -75.669113	7.8 to 11.5	Moderate CIPS	-822 mV_{CSE} at Ch. 9.7 m
	45.418308, -75.669113 to 45.418294, -75.669109	11.5 to 13.0	Minor CIPS	-859 mV_{CSE} at Ch. 11.5 m
	45.418282, -75.669098 to 45.418259, -75.669065	14.7 to 18.2	Moderate CIPS	-801 mV_{CSE} at Ch. 16.1 m
	45.418259, -75.669065 to 45.418231, -75.669050	18.2 to 21.6	Minor CIPS	-881 mV_{CSE} at Ch. 20.0 m
	45.418231, -75.669050 to 45.418193, -75.669004	21.6 to 27.1	Moderate CIPS	-803 mV_{CSE} at Ch. 25.8 m
	45.418193, -75.669004 to 45.418173, -75.669014	27.1 to 28.8	Minor CIPS	-848 mV_{CSE} at Ch. 28.8 m
	45.418173, -75.669014	28.8	Minor DCVG Minor CIPS	19.9%IR -848 mV_{CSE}
	45.418193, -75.669004 to 45.418153, -75.668994	28.8 to 30.7	Minor CIPS	-848 mV_{CSE} at Ch. 28.8 m
	45.418153, -75.668994 to 45.418100, -75.668960	30.7 to 37.4	Moderate CIPS	-796 mV_{CSE} at Ch. 35.1 m
	45.418100, -75.668960 to 45.418087, -75.668948	37.4 to 39.4	Minor CIPS	-872 mV_{CSE} at Ch. 37.4 m
	45.418076, -75.668933 to 45.418044, -75.668910	41.0 to 45.0	Minor CIPS	-885 mV_{CSE} at Ch. 42.2 m
	45.418028, -75.668903 to 45.417947, -75.668890	47.0 to 55.7	Minor CIPS	-865 mV_{CSE} at Ch. 50.5 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 3	45.417932, -75.668886	57.1	Minor DCVG Minor CIPS	15.7%IR -954 mV_{CSE}
	45.417932, -75.668886 to 45.417882, -75.668871	57.1 to 62.6	Minor CIPS	-831 mV_{CSE} at Ch. 58.3 m
	45.417882, -75.668871 to 45.417844, -75.668869	62.6 to 67.3	Severe CIPS	-698 mV_{CSE} at Ch. 64.8 m
	45.417844, -75.668869	67.3	Moderate DCVG Minor CIPS	45.5%IR -865 mV_{CSE}
	45.417844, -75.668869 to 45.417775, -75.668882	67.3 to 75.4	Minor CIPS	-865 mV_{CSE} at Ch. 67.3 m
	45.417775, -75.668882	75.4	Minor DCVG Minor CIPS	23.8%IR -882 mV_{CSE}
	45.417844, -75.668869 to 45.417761, -75.668878	75.4 to 77.6	Minor CIPS	-882 mV_{CSE} at Ch. 75.4 m
	45.417693, -75.668816 to 45.417675, -75.668780	86.0 to 89.7	Minor CIPS	-888 mV_{CSE} at Ch. 87.2 m
	45.417664, -75.668755 to 45.417660, -75.668730	91.9 to 94.0	Minor CIPS	-860 mV_{CSE} at Ch. 94.0 m
	45.417660, -75.668730	94.0	Minor DCVG Minor CIPS	26.3%IR -860 mV_{CSE}
	45.417664, -75.668755 to 45.417642, -75.668656	94.0 to 100.7	Minor CIPS	-888 mV_{CSE} at Ch. 98.2 m
	45.417634, -75.668635 to 45.417610, -75.668521	102.5 to 111.1	Minor CIPS	-836 mV_{CSE} at Ch. 104.5 m
	45.417567, -75.668375 to 45.417568, -75.668284	125.0 to 132.0	Minor CIPS	-847 mV_{CSE} at Ch. 130.3 m
	45.417568, -75.668284	132.0	Minor DCVG Minor CIPS	15.0%IR -886 mV_{CSE}
	45.417567, -75.668375 to 45.417516, -75.668073	132.0 to 148.7	Minor CIPS	-825 mV_{CSE} at Ch. 145.4 m
	45.417516, -75.668073 to 45.417504, -75.668039	148.7 to 152.1	Moderate CIPS	-784 mV_{CSE} at Ch. 152.1 m
	45.417504, -75.668039	152.1	Minor DCVG Moderate CIPS	24.5%IR -784 mV_{CSE}
	45.417516, -75.668073 to 45.417493, -75.667979	152.1 to 157.1	Moderate CIPS	-818 mV_{CSE} at Ch. 155.4 m
	45.417493, -75.667979 to 45.417469, -75.667879	157.1 to 165.3	Minor CIPS	-865 mV_{CSE} at Ch. 157.1 m
	45.417334, -75.667307 to 45.417326, -75.667258	211.9 to 215.9	Minor CIPS	-889 mV_{CSE} at Ch. 214.0 m
	45.417320, -75.667234 to 45.417304, -75.667188	217.9 to 222.3	Minor CIPS	-884 mV_{CSE} at Ch. 220.2 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 3	45.417262, -75.667029 to 45.417257, -75.666976	235.3 to 239.9	Minor CIPS	-867 mV_{CSE} at Ch. 237.5 m
	45.417252, -75.666950 to 45.417243, -75.666892	241.7 to 246.3	Moderate CIPS	-822 mV_{CSE} at Ch. 243.9 m
	45.417243, -75.666892 to 45.417235, -75.666842	246.3 to 250.2	Minor CIPS	-878 mV_{CSE} at Ch. 248.3 m
	45.417231, -75.666791 to 45.417228, -75.666747	254.4 to 258.1	Minor CIPS	-872 mV_{CSE} at Ch. 255.7 m
	45.417223, -75.666717 to 45.417206, -75.666643	260.2 to 266.1	Minor CIPS	-858 mV_{CSE} at Ch. 262.2 m
	45.417206, -75.666643 to 45.417192, -75.666580	266.1 to 271.0	Moderate CIPS	-820 mV_{CSE} at Ch. 267.8 m
	45.417192, -75.666580 to 45.417183, -75.666535	271.0 to 274.4	Minor CIPS	-865 mV_{CSE} at Ch. 272.7 m
	45.417180, -75.666516 to 45.417184, -75.666497	276.1 to 277.7	Minor CIPS	-853 mV_{CSE} at Ch. 277.7 m
	45.417184, -75.666497 to 45.417181, -75.666450	277.7 to 281.5	Moderate CIPS	-779 mV_{CSE} at Ch. 279.7 m
	45.417181, -75.666450 to 45.417170, -75.666385	281.5 to 286.9	Minor CIPS	-848 mV_{CSE} at Ch. 286.9 m
	45.417170, -75.666385 to 45.417164, -75.666334	286.9 to 291.0	Moderate CIPS	-813 mV_{CSE} at Ch. 289.0 m
	45.417164, -75.666334 to 45.417154, -75.666269	291.0 to 296.1	Minor CIPS	-830 mV_{CSE} at Ch. 296.1 m
	45.417154, -75.666269 to 45.417149, -75.666225	296.1 to 299.6	Moderate CIPS	-799 mV_{CSE} at Ch. 297.7 m
	45.417149, -75.666225 to 45.417140, -75.666159	299.6 to 305.1	Minor CIPS	-834 mV_{CSE} at Ch. 299.6 m
	45.417140, -75.666159 to 45.417136, -75.666117	305.1 to 308.4	Severe CIPS	-701 mV_{CSE} at Ch. 307.2 m
	45.417136, -75.666117 to 45.417132, -75.666065	308.4 to 312.5	Moderate CIPS	-809 mV_{CSE} at Ch. 310.5 m
	45.417132, -75.666065 to 45.417086, -75.665705	312.5 to 340.5	Minor CIPS	-841 mV_{CSE} at Ch. 312.5 m
	45.417067, -75.665598 to 45.417052, -75.665495	347.9 to 357.8	Minor CIPS	-867 mV_{CSE} at Ch. 355.3 m
	45.417058, -75.665209 to 45.417063, -75.665163	380.6 to 384.3	Minor CIPS	-863 mV_{CSE} at Ch. 382.4 m
	45.417063, -75.665163 to 45.417066, -75.665115	384.3 to 388.1	Severe CIPS	-678 mV_{CSE} at Ch. 386.1 m
	45.417066, -75.665115 to 45.417067, -75.665089	388.1 to 389.9	Minor CIPS	-830 mV_{CSE} at Ch. 388.1 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 3	45.417080, -75.664950 to 45.417083, -75.664898	400.9 to 405.0	Minor CIPS	-880 mV_{CSE} at Ch. 402.9 m
	45.417083, -75.664898 to 45.417091, -75.664802	405.0 to 412.6	Severe CIPS	-728 mV_{CSE} at Ch. 410.8 m
	45.417091, -75.664802 to 45.417092, -75.664781	412.6 to 414.2	Moderate CIPS	-795 mV_{CSE} at Ch. 412.6 m
	45.417092, -75.664781 to 45.417101, -75.664663	414.2 to 423.4	Severe CIPS	-668 mV_{CSE} at Ch. 419.5 m
	45.417101, -75.664663 to 45.417103, -75.664636	423.4 to 425.5	Minor CIPS	-854 mV_{CSE} at Ch. 423.4 m
	45.417110, -75.664563 to 45.417113, -75.664516	431.4 to 435.0	Minor CIPS	-836 mV_{CSE} at Ch. 433.2 m
	45.417162, -75.664502 to 45.417165, -75.664487	441.0 to 442.2	Minor CIPS	-899 mV_{CSE} at Ch. 441.5 m
	45.417175, -75.664341 to 45.417182, -75.664295	454.0 to 458.5	Severe CIPS	-730 mV_{CSE} at Ch. 458.1 m
	45.417182, -75.664295 to 45.417189, -75.664249	458.5 to 462.6	Minor CIPS	-862 mV_{CSE} at Ch. 460.6 m
	45.417188, -75.664164 to 45.417204, -75.664092	468.8 to 474.3	Minor CIPS	-891 mV_{CSE} at Ch. 471.8 m
	45.417203, -75.664056 to 45.417203, -75.663989	477.1 to 482.3	Minor CIPS	-897 mV_{CSE} at Ch. 479.5 m
	45.417202, -75.663922 to 45.417253, -75.663872	487.5 to 494.1	Severe CIPS	-616 mV_{CSE} at Ch. 493.1 m
	45.417253, -75.663872 to 45.417258, -75.663846	494.1 to 495.8	Minor CIPS	-895 mV_{CSE} at Ch. 495.8 m
	45.417258, -75.663846 to 45.417265, -75.663815	495.8 to 498.2	Moderate CIPS	-769 mV_{CSE} at Ch. 496.9 m
	45.417265, -75.663815 to 45.417263, -75.663801	498.2 to 499.2	Minor CIPS	-831 mV_{CSE} at Ch. 498.2 m
	45.417372, -75.662048 to 45.417372, -75.662038	637.0 to 637.9	Severe CIPS	-635 mV_{CSE} at Ch. 637.0 m
	45.417376, -75.661929 to 45.417385, -75.661872	646.5 to 650.9	Minor CIPS	-833 mV_{CSE} at Ch. 650.9 m
	45.417385, -75.661872 to 45.417391, -75.661847	650.9 to 652.9	Moderate CIPS	-752 mV_{CSE} at Ch. 651.8 m
	45.417396, -75.661789 to 45.417403, -75.661696	657.5 to 664.2	Moderate CIPS	-752 mV_{CSE} at Ch. 658.6 m
	45.417403, -75.661696 to 45.417391, -75.661658	664.2 to 667.5	Minor CIPS	-879 mV_{CSE} at Ch. 664.2 m
	45.417403, -75.661622 to 45.417417, -75.661588	671.4 to 674.0	Minor CIPS	-825 mV_{CSE} at Ch. 672.4 m

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Section	GPS	Chainage (m)	Classification	Notes
Section 3	45.417417, -75.661588 to 45.417416, -75.661535	674.0 to 677.9	Moderate CIPS	-783 mV_{CSE} at Ch. 675.9 m
	45.417418, -75.661477 to 45.417423, -75.661359	682.1 to 689.1	Severe CIPS	-661 mV_{CSE} at Ch. 687.0 m
	45.417423, -75.661359 to 45.417424, -75.661330	689.1 to 691.3	Moderate CIPS	-807 mV_{CSE} at Ch. 689.1 m
	45.417424, -75.661330 to 45.417409, -75.661230	691.3 to 701.1	Minor CIPS	-830 mV_{CSE} at Ch. 699.5 m
	45.417409, -75.661230 to 45.417413, -75.661183	701.1 to 705.6	Severe CIPS	-725 mV_{CSE} at Ch. 703.7 m
	45.417413, -75.661183 to 45.417416, -75.661153	705.6 to 707.9	Moderate CIPS	-816 mV_{CSE} at Ch. 705.6 m
	45.417416, -75.661153 to 45.417418, -75.661126	707.9 to 710.0	Minor CIPS	-879 mV_{CSE} at Ch. 707.9 m
	45.417428, -75.661044 to 45.417433, -75.660988	716.6 to 721.2	Moderate CIPS	-790 mV_{CSE} at Ch. 719.0 m
	45.417433, -75.660988 to 45.417446, -75.660882	721.2 to 729.5	Minor CIPS	-842 mV_{CSE} at Ch. 727.3 m
	45.417446, -75.660882	729.5	Severe DCVG Minor CIPS	Up to 68.0%IR -900 mV_{CSE}
	45.417433, -75.660988 to 45.417458, -75.660773	729.5 to 738.2	Minor CIPS	-856 mV_{CSE} at Ch. 732.6 m
	45.417458, -75.660773	738.2	Moderate DCVG Minor CIPS	40.5%IR -888 mV_{CSE}
	45.417433, -75.660988 to 45.417458, -75.660754	738.2 to 739.7	Minor CIPS	-888 mV_{CSE} at Ch. 738.2 m
	45.417458, -75.660754 to 45.417465, -75.660684	739.7 to 745.2	Moderate CIPS	-778 mV_{CSE} at Ch. 741.3 m
	45.417465, -75.660684	745.2	Minor DCVG Minor CIPS	Up to 24.6%IR -891 mV_{CSE}
	45.417465, -75.660684 to 45.417470, -75.660536	745.2 to 756.6	Minor CIPS	-825 mV_{CSE} at Ch. 756.6 m
	45.417470, -75.660536	756.6	Moderate DCVG Minor CIPS	Up to 43.5%IR -825 mV_{CSE}
	45.417465, -75.660684 to 45.417482, -75.660415	756.6 to 766.2	Minor CIPS	-825 mV_{CSE} at Ch. 756.6 m
	45.417484, -75.660388 to 45.417500, -75.660232	768.4 to 780.8	Minor CIPS	-829 mV_{CSE} at Ch. 769.7 m
	45.417497, -75.660204 to 45.417501, -75.660176	782.8 to 785.1	Moderate CIPS	-819 mV_{CSE} at Ch. 785.1 m
	45.417501, -75.660176	785.1	Minor DCVG Moderate CIPS	28.2%IR -819 mV_{CSE}

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 3	45.417497, -75.660204 to 45.417500, -75.660154	785.1 to 786.8	Moderate CIPS	-819 mV_{CSE} at Ch. 785.1 m
	45.417511, -75.659974 to 45.417518, -75.659928	800.8 to 804.5	Severe CIPS	-612 mV_{CSE} at Ch. 802.8 m
	45.417518, -75.659928 to 45.417524, -75.659847	804.5 to 811.0	Minor CIPS	-826 mV_{CSE} at Ch. 804.5 m
	45.417529, -75.659788 to 45.417541, -75.659656	815.5 to 826.1	Minor CIPS	-825 mV_{CSE} at Ch. 821.7 m
	45.417545, -75.659625	828.6	Minor DCVG	27.2%IR
	45.417547, -75.659569 to 45.417555, -75.659513	832.9 to 837.2	Minor CIPS	-878 mV_{CSE} at Ch. 835.2 m
	45.417555, -75.659513 to 45.417569, -75.659376	837.2 to 848.2	Severe CIPS	-641 mV_{CSE} at Ch. 846.0 m
	45.417587, -75.659351 to 45.417602, -75.659263	850.4 to 857.7	Severe CIPS	-628 mV_{CSE} at Ch. 854.4 m
	45.417607, -75.659214	861.4	Minor DCVG	20.3%IR
	45.417604, -75.659186 to 45.417610, -75.659166	863.8 to 865.1	Minor CIPS	-891 mV_{CSE} at Ch. 865.1 m
	45.417610, -75.659166 to 45.417613, -75.659141	865.1 to 866.9	Moderate CIPS	-765 mV_{CSE} at Ch. 866.9 m
	45.417613, -75.659141 to 45.417622, -75.659092	866.9 to 871.0	Severe CIPS	-719 mV_{CSE} at Ch. 871.0 m
	45.417622, -75.659092	871.0	Minor DCVG Severe CIPS	24.5%IR -719 mV_{CSE}
	45.417613, -75.659141 to 45.417628, -75.659067	871.0 to 873.1	Severe CIPS	-719 mV_{CSE} at Ch. 871.0 m
	45.417688, -75.658096	949.4	Minor DCVG	Up to 19.7%IR
	45.417688, -75.658096 to 45.417702, -75.658011	949.4 to 956.2	Moderate CIPS	-792 mV_{CSE} at Ch. 951.3 m
	45.417702, -75.658011	956.2	Minor DCVG	Up to 32.3%IR
	45.417715, -75.657969	959.6	Minor DCVG	Up to 20.7%IR
	45.417748, -75.657849 to 45.417758, -75.657804	969.8 to 973.6	Moderate CIPS	-763 mV_{CSE} at Ch. 971.6 m
	45.417760, -75.657781 to 45.417766, -75.657760	975.6 to 977.2	Minor CIPS	-825 mV_{CSE} at Ch. 977.1 m
	45.417766, -75.657760 to 45.417774, -75.657727	977.2 to 979.9	Moderate CIPS	-814 mV_{CSE} at Ch. 978.7 m
	45.417774, -75.657727 to 45.417785, -75.657687	979.9 to 983.4	Minor CIPS	-851 mV_{CSE} at Ch. 981.1 m
	45.417785, -75.657687 to 45.417795, -75.657653	983.4 to 986.2	Severe CIPS	-632 mV_{CSE} at Ch. 984.8 m

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Table E-1: Classification of Indications

Section	GPS	Chainage (m)	Classification	Notes
Section 3	45.417795, -75.657653 to 45.417816, -75.657573	986.2 to 992.8	Minor CIPS	-859 mV_{CSE} at Ch. 991.5 m
	45.417856, -75.657416 to 45.417864, -75.657379	1005.9 to 1009.1	Minor CIPS	-834 mV_{CSE} at Ch. 1007.1 m
	45.417903, -75.657235 to 45.417910, -75.657210	1020.9 to 1022.2	Minor CIPS	-889 mV_{CSE} at Ch. 1022.2 m
	45.417910, -75.657210 to 45.417921, -75.657181	1022.2 to 1024.8	Moderate CIPS	-769 mV_{CSE} at Ch. 1023.5 m
	45.417925, -75.657156	1026.1	Minor DCVG	Up to 18.0%IR
	45.418076, -75.656225 to 45.418072, -75.656206	1102.3 to 1103.8	Minor CIPS	-886 mV_{CSE} at Ch. 1103.0 m
	45.418067, -75.656059 to 45.418069, -75.656041	1114.5 to 1117.6	Minor CIPS	-878 mV_{CSE} at Ch. 1117.6 m
	45.418069, -75.656041	1117.6	Minor DCVG Minor CIPS	Up to 20.2%IR -878 mV_{CSE}
	45.418306, -75.652938	1419.2	Minor DCVG	17.0%IR
	45.418515, -75.651120	1566.1	Severe DCVG	73.1%IR
	45.418616, -75.648793	1785.7	Minor DCVG	23.8%IR
	45.418733, -75.647327	1900.8	Minor DCVG	26.4%IR
	45.418794, -75.647252	1910.3	Minor DCVG	16.7%IR
	45.418899, -75.646932 to 45.418914, -75.646884	1939.9 to 1944.9	Severe CIPS	-583 mV_{CSE} at Ch. 1942.6 m
	45.418884, -75.646548 to 45.418862, -75.646517	1973.2 to 1976.7	Minor CIPS	-868 mV_{CSE} at Ch. 1975.0 m
	45.418788, -75.646442 to 45.418788, -75.646423	1986.8 to 1988.2	Minor CIPS	-871 mV_{CSE} at Ch. 1986.9 m
	45.419260, -75.639560	2528.1	Minor DCVG	16.9%IR
	45.419396, -75.637572 to 45.419399, -75.637519	2684.4 to 2688.1	Minor CIPS	-822 mV_{CSE} at Ch. 2686.2 m
	45.419419, -75.637263	2709.9	Minor DCVG	27.0%IR
	45.419491, -75.636311	2784.4	Moderate DCVG	44.4%IR
	45.419490, -75.636232	2791.7	Moderate DCVG	37.9%IR
	45.419502, -75.636053	2804.4	Minor DCVG	33.7%IR
	45.419507, -75.636016	2807.5	Minor DCVG	31.8%IR
	45.419519, -75.635886	2817.9	Minor DCVG	25.9%IR
	45.419534, -75.635693	2833.0	Moderate DCVG	43.5%IR
	45.419534, -75.635635	2837.6	Moderate DCVG	38.4%IR

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APPENDIX F

Prioritization of Indications

Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.455056, -75.670585	396.0	Minor DCVG (15.0%IR)	Suitable for monitoring	-	1
	45.455336, -75.669137	515.2	Minor DCVG (26.4%IR)	Suitable for monitoring	-	2
	45.455928, -75.660438	1202.0	Minor DCVG (17.9%IR)	Suitable for monitoring	-	3
	45.456021, -75.658994	1313.3	Minor DCVG (22.2%IR)	Suitable for monitoring	-	4
	45.456231, -75.656073	1542.6	Minor DCVG (15.8%IR)	Suitable for monitoring	-	5
	45.456261, -75.655405	1594.8	Minor DCVG (24.5%IR)	Suitable for monitoring	-	6
	45.456176, -75.655353	1605.4	Minor DCVG (18.4%IR)	Suitable for monitoring	-	7
	45.456090, -75.655303	1615.7	Moderate DCVG (54.4%IR)	Suitable for monitoring	-	8
	45.455974, -75.655240	1630.2	Minor DCVG (16.2%IR)	Suitable for monitoring	-	9
	45.455451, -75.654936	1693.4	Minor DCVG (24.2%IR)	Suitable for monitoring	-	10
	45.455285, -75.654826	1712.3	Minor DCVG (22.7%IR)	Suitable for monitoring	-	11
	45.455168, -75.654764	1726.9	Minor DCVG (17.0%IR)	Suitable for monitoring	-	12
	45.455062, -75.654708	1739.4	Minor DCVG (17.4%IR)	Suitable for monitoring	-	13
	45.454541, -75.654406	1802.3	Minor DCVG (21.1%IR)	Suitable for monitoring	Recommended for DE Phase 1	14
	45.454232, -75.654229	1839.4	Minor DCVG (16.7%IR)	Suitable for monitoring	-	15
	45.452212, -75.653090	2080.7	Minor DCVG (19.9%IR)	Suitable for monitoring	-	16
	45.450788, -75.652239	2256.0	Minor DCVG (27.3%IR)	Suitable for monitoring	-	17
	45.449728, -75.651628	2386.7	Minor DCVG (15.7%IR)	Suitable for monitoring	-	18
	45.449227, -75.651375	2442.2	Minor DCVG (20.7%IR)	Suitable for monitoring	-	19

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.448454, -75.650922	2538.5	Minor DCVG (28.3%IR) Minor CIPS (-870 mV_{CSE})	Suitable for monitoring	-	20
	45.447058, -75.650132	2703.6	Minor DCVG (30.6%IR)	Suitable for monitoring	-	21
	45.446150, -75.649619	2811.7	Minor DCVG (15.4%IR) Minor CIPS (-929 mV_{CSE})	Suitable for monitoring	-	22
	45.446143, -75.649599	2813.3	Minor DCVG (29.2%IR) Minor CIPS (-882 mV_{CSE})	Suitable for monitoring	-	23
	45.446124, -75.649576	2817.0	Minor DCVG (27.9%IR) Minor CIPS (-871 mV_{CSE})	Suitable for monitoring	-	24
	45.446045, -75.649535	2824.3	Minor DCVG (22.5%IR) Minor CIPS (-912 mV_{CSE})	Suitable for monitoring	-	25
	45.445900, -75.649439	2840.9	Severe DCVG (69.3%IR) Moderate CIPS (-799 mV_{CSE})	Scheduled action required	-	26
	45.445727, -75.649363	2863.1	Minor DCVG (30.4%IR)	Suitable for monitoring	-	27
	45.445694, -75.649368	2868.1	Minor DCVG (18.4%IR)	Suitable for monitoring	-	28
	45.445532, -75.649253	2888.9	Minor DCVG (22.3%IR)	Suitable for monitoring	-	29
	45.445460, -75.649208	2897.9	Minor DCVG (23.0%IR) Minor CIPS (-883 mV_{CSE})	Suitable for monitoring	-	30
	45.445410, -75.649170	2904.8	Minor DCVG (31.5%IR) Moderate CIPS (-817 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	31
	45.445343, -75.649134	2913.3	Minor DCVG (25.0%IR) Minor CIPS (-863 mV_{CSE})	Suitable for monitoring	-	32

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.445249, -75.649092	2923.1	Moderate DCVG (43.4%IR)	Suitable for monitoring	-	33
	45.444977, -75.648945	2955.5	Minor DCVG (16.5%IR) Minor CIPS (-858 mV_{CSE})	Suitable for monitoring	-	34
	45.444824, -75.648854	2974.2	Minor DCVG (18.8%IR)	Suitable for monitoring	-	35
	45.444711, -75.648789	2987.8	Minor DCVG (29.2%IR) Minor CIPS (-918 mV_{CSE})	Suitable for monitoring	-	36
	45.444684, -75.648774	2990.8	Minor DCVG (25.6%IR) Moderate CIPS (-824 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	37
	45.444550, -75.648676	3009.3	Minor DCVG (30.9%IR) Minor CIPS (-834 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	38
	45.444485, -75.648639	3017.9	Minor DCVG (19.4%IR) Moderate CIPS (-797 mV_{CSE})	Suitable for monitoring	-	39
	45.444399, -75.648565	3028.2	Minor DCVG (32.3%IR) Moderate CIPS (-823 mV_{CSE})	Suitable for monitoring	-	40
	45.444191, -75.648503	3053.8	Moderate DCVG (37.3%IR) Minor CIPS (-886 mV_{CSE})	Suitable for monitoring	-	41
	45.444057, -75.648394	3069.2	Moderate DCVG (36.6%IR)	Suitable for monitoring	-	42
	45.443780, -75.648251	3102.9	Minor DCVG (29.0%IR) Moderate CIPS (-818 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	43
	45.443622, -75.648156	3121.2	Minor DCVG (15.9%IR) Minor CIPS (-881 mV_{CSE})	Suitable for monitoring	-	44
	45.443573, -75.648121	3128.6	Minor DCVG (18.5%IR)	Suitable for monitoring	-	45

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.443295, -75.647976	3160.2	Moderate DCVG (38.1%IR) Minor CIPS (-852 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	46
	45.442028, -75.647271	3323.6	Minor DCVG (30.1%IR) Minor CIPS (-885 mV_{CSE})	Suitable for monitoring	-	47
	45.441911, -75.647209	3337.0	Minor DCVG (15.4%IR)	Suitable for monitoring	-	48
	45.441078, -75.646721	3436.0	Minor DCVG (23.0%IR) Moderate CIPS (-763 mV_{CSE})	Suitable for monitoring	-	49
	45.440971, -75.646873	3457.7	Moderate DCVG (35.9%IR) Severe CIPS (-728 mV_{CSE})	Scheduled action required	Reduced confidence. At section with possible thick asphalt	50
	45.440706, -75.646722	3489.9	Severe DCVG (68.4%IR) Moderate CIPS (-761 mV_{CSE})	Scheduled action required	Reduced confidence. At section with possible thick asphalt	51
	45.440396, -75.646552	3526.8	Severe DCVG (82.6%IR) Severe CIPS (-682 mV_{CSE})	Immediate action required	Recommended for DE Phase 2 Reduced confidence. At section with possible thick asphalt	52
	45.439775, -75.646206	3601.2	Minor DCVG (25.2%IR) Moderate CIPS (-815 mV_{CSE})	Suitable for monitoring	-	53
	45.438196, -75.645325	3790.2	Minor DCVG (32.5%IR) Minor CIPS (-859 mV_{CSE})	Suitable for monitoring	-	54
	45.437787, -75.645100	3839.1	Minor DCVG (16.0%IR) Moderate CIPS (-795 mV_{CSE})	Suitable for monitoring	-	55
	45.437437, -75.644894	3882.3	Moderate DCVG (47.4%IR) Moderate CIPS (-763 mV_{CSE})	Scheduled action required	Reduced confidence. At section with possible thick asphalt	56
	45.436677, -75.644475	3972.2	Minor DCVG (19.3%IR)	Suitable for monitoring	-	57

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.436566, -75.644422	3985.0	Moderate DCVG (51.7%IR) Minor CIPS (-917 mV_{CSE})	Suitable for monitoring		58
	45.435124, -75.643619	4157.4	Minor DCVG (19.3%IR) Minor CIPS (-878 mV_{CSE})	Suitable for monitoring	-	59
	45.435050, -75.643559	4168.0	Minor DCVG (32.7%IR) Minor CIPS (-840 mV_{CSE})	Suitable for monitoring	-	60
	45.434928, -75.643488	4183.0	Minor DCVG (18.0%IR) Minor CIPS (-878 mV_{CSE})	Suitable for monitoring	-	61
	45.434754, -75.643384	4202.5	Minor DCVG (15.4%IR)	Suitable for monitoring	-	62
	45.434325, -75.643137	4253.3	Minor DCVG (18.2%IR) Minor CIPS (-849 mV_{CSE})	Suitable for monitoring	-	63
	45.433883, -75.642900	4306.9	Minor DCVG (20.3%IR) Minor CIPS (-875 mV_{CSE})	Suitable for monitoring		64
	45.433191, -75.642497	4390.0	Minor DCVG (27.3%IR)	Suitable for monitoring	-	65
	45.433143, -75.642472	4395.9	Minor DCVG (17.2%IR)	Suitable for monitoring	-	66
	45.432878, -75.642330	4427.3	Minor DCVG (18.0%IR)	Suitable for monitoring	-	67
	45.432576, -75.642164	4463.6	Moderate DCVG (42.3%IR) Moderate CIPS (-788 mV_{CSE})	Scheduled action required	-	68
	45.432126, -75.641899	4517.5	Minor DCVG (15.2%IR) Minor CIPS (-844 mV_{CSE})	Suitable for monitoring	-	69
	45.431756, -75.641689	4561.0	Minor DCVG (16.4%IR) Minor CIPS (-820 mV_{CSE})	Suitable for monitoring	-	70

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.431639, -75.641630	4575.5	Minor DCVG (15.1%IR) Minor CIPS (-877 mV_{CSE})	Suitable for monitoring	-	71
	45.431119, -75.641323	4637.1	Minor DCVG (28.8%IR)	Suitable for monitoring	-	72
	45.431036, -75.641281	4647.4	Minor DCVG (31.2%IR)	Suitable for monitoring	-	73
	45.430887, -75.641199	4665.3	Minor DCVG (18.9%IR) Minor CIPS (-850 mV_{CSE})	Suitable for monitoring	-	74
	45.430336, -75.640887	4731.6	Minor DCVG (25.7%IR) Severe CIPS (-724 mV_{CSE})	Scheduled action required	Recommended for DE Phase 2	75
	45.430255, -75.640838	4741.4	Minor DCVG (28.7%IR) Severe CIPS (-719 mV_{CSE})	Scheduled action required	Recommended for DE Phase 2	76
	45.430168, -75.640800	4751.2	Minor DCVG (19.8%IR) Minor CIPS (-806 mV_{CSE})	Suitable for monitoring	-	77
	45.429857, -75.640622	4788.8	Moderate DCVG (39.0%IR) Minor CIPS (-828 mV_{CSE})	Suitable for monitoring	-	78
	45.428862, -75.640071	4906.9	Moderate DCVG (41.7%IR) Minor CIPS (-802 mV_{CSE})	Suitable for monitoring	-	79
	45.428759, -75.639999	4920.3	Minor DCVG (16.0%IR)	Suitable for monitoring	-	80
	45.428507, -75.639859	4950.6	Minor DCVG (15.9%IR)	Suitable for monitoring	-	81
	45.428248, -75.639712	4980.9	Moderate DCVG (56.7%IR)	Suitable for monitoring	-	82
	45.428178, -75.639671	4988.9	Minor DCVG (17.8%IR)	Suitable for monitoring	-	83
	45.426766, -75.638868	5158.5	Minor DCVG (30.8%IR)	Suitable for monitoring	-	84
	45.426626, -75.638785	5175.4	Minor DCVG (19.2%IR)	Suitable for monitoring	-	85

Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.426331, -75.638616	5211.2	Minor DCVG (20.9%IR)	Suitable for monitoring	-	86
	45.426250, -75.638568	5220.6	Minor DCVG (32.2%IR)	Suitable for monitoring	-	87
	45.426198, -75.638562	5225.3	Minor DCVG (15.7%IR)	Suitable for monitoring	-	88
	45.426146, -75.638532	5232.4	Minor DCVG (29.1%IR)	Suitable for monitoring	-	89
	45.425511, -75.638155	5309.6	Moderate DCVG (56.3%IR)	Suitable for monitoring	-	90
	45.424770, -75.637737	5398.2	Minor DCVG (18.5%IR)	Suitable for monitoring	-	91
	45.424536, -75.637605	5426.2	Minor DCVG (29.4%IR) Minor CIPS (-833 mV_{CSE})	Suitable for monitoring	-	92
	45.424044, -75.637321	5485.2	Minor DCVG (26.2%IR)	Suitable for monitoring	-	93
	45.422238, -75.636364	5699.4	Minor DCVG (19.9%IR)	Suitable for monitoring	-	94
	45.421965, -75.636227	5732.2	Minor DCVG (32.2%IR)	Suitable for monitoring	-	95
	45.421889, -75.636254	5740.3	Minor DCVG (22.2%IR)	Suitable for monitoring	-	96
	45.421749, -75.636192	5755.5	Minor DCVG (25.1%IR) Minor CIPS (-815 mV_{CSE})	Suitable for monitoring	-	97
	45.421024, -75.635733	5853.1	Minor DCVG (18.3%IR) Severe CIPS (-538 mV_{CSE})	Scheduled action required	-	98
	45.419558, -75.635575	6048.2	Moderate DCVG (57.9%IR)	Suitable for monitoring	-	99
	45.419050, -75.635033	6138.6	Moderate DCVG (45.8%IR)	Suitable for monitoring	-	100
	45.417542, -75.633924	6330.2	Minor DCVG (22.2%IR) Minor CIPS (-849 mV_{CSE})	Suitable for monitoring	-	101

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.415990, -75.633237	6512.5	Minor DCVG (Up to 17.6%IR) Moderate CIPS (-804 mV_{CSE})	Suitable for monitoring	-	102
	45.415953, -75.633199	6518.0	Minor DCVG (Up to 15.3%IR) Minor CIPS (-809 mV_{CSE})	Suitable for monitoring	-	103
	45.415749, -75.633115	6540.8	Minor DCVG (17.8%IR) Severe CIPS (-739 mV_{CSE})	Scheduled action required	-	104
	45.415665, -75.633066	6552.1	Minor DCVG (33.8%IR) Severe CIPS (-678 mV_{CSE})	Scheduled action required	-	105
	45.415259, -75.632807	6602.5	Minor DCVG (15.6%IR) Severe CIPS (-739 mV_{CSE})	Scheduled action required	-	106
	45.412861, -75.631172	6900.2	Moderate DCVG (37.3%IR) Minor CIPS (-827 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	107
	45.412172, -75.630796	6982.2	Moderate DCVG (39.9%IR)	Suitable for monitoring	-	108
	45.412011, -75.630709	7001.1	Severe DCVG (65.8%IR)	Scheduled action required	-	109
	45.411850, -75.630756	7021.5	Moderate DCVG (38.8%IR)	Suitable for monitoring	-	110
	45.411601, -75.630471	7056.6	Moderate DCVG (39.0%IR)	Suitable for monitoring	-	111
	45.411447, -75.630391	7074.6	Minor DCVG (24.8%IR)	Suitable for monitoring	-	112
	45.411228, -75.630301	7099.7	Minor DCVG (23.2%IR)	Suitable for monitoring	-	113
	45.411062, -75.630233	7120.0	Moderate DCVG (42.5%IR)	Suitable for monitoring	-	114
	45.410553, -75.630024	7179.6	Minor DCVG (15.1%IR)	Suitable for monitoring	-	115
	45.409533, -75.629584	7297.2	Minor DCVG (26.4%IR)	Suitable for monitoring	-	116

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 1	45.408505, -75.628946	7427.1	Minor DCVG (17.5%IR)	Suitable for monitoring	-	117
	45.408319, -75.628846	7450.9	Minor DCVG (Up to 20.1%IR)	Suitable for monitoring	-	118
Section 2	45.406141, -75.627368	0.0	Minor DCVG (23.3%IR)	Suitable for monitoring	-	119
	45.405824, -75.627004	46.2	Severe DCVG (Up to 74.1%IR)	Scheduled action required	Recommended for DE Phase 2	120
	45.405621, -75.626871	71.0	Minor DCVG (23.3%IR)	Suitable for monitoring	-	121
	45.405096, -75.626580	134.9	Minor DCVG (15.2%IR)	Suitable for monitoring	-	122
	45.404814, -75.626424	167.3	Minor DCVG (25.5%IR)	Suitable for monitoring	-	123
	45.404730, -75.626374	177.2	Minor DCVG (16.3%IR)	Suitable for monitoring	-	124
	45.403358, -75.625605	341.3	Minor DCVG (20.7%IR)	Suitable for monitoring	-	125
	45.403296, -75.625572	348.9	Minor DCVG (15.6%IR)	Suitable for monitoring	-	126
	45.402600, -75.625178	432.0	Minor DCVG (19.1%IR)	Suitable for monitoring	-	127
Section 3	45.418173, -75.669014	28.8	Minor DCVG (19.9%IR) Minor CIPS (-848 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	128
	45.417932, -75.668886	57.1	Minor DCVG (15.7%IR) Minor CIPS (-954 mV_{CSE})	Suitable for monitoring	-	129
	45.417844, -75.668869	67.3	Moderate DCVG (45.5%IR) Minor CIPS (-865 mV_{CSE})	Suitable for monitoring	-	130
	45.417775, -75.668882	75.4	Minor DCVG (23.8%IR) Minor CIPS (-882 mV_{CSE})	Suitable for monitoring	-	131
	45.417660, -75.668730	94.0	Minor DCVG (26.3%IR) Minor CIPS (-860 mV_{CSE})	Suitable for monitoring	-	132

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 3	45.417568, -75.668284	132.0	Minor DCVG (15.0%IR) Minor CIPS (-886 mV_{CSE})	Suitable for monitoring	-	133
	45.417504, -75.668039	152.1	Minor DCVG (24.5%IR) Moderate CIPS (-784 mV_{CSE})	Suitable for monitoring	Recommended for DE Phase 1	134
	45.417446, -75.660882	729.5	Severe DCVG (Up to 68.0%IR) Minor CIPS (-900 mVCSE)	Scheduled action required	-	135
	45.417458, -75.660773	738.2	Moderate DCVG (40.5%IR) Minor CIPS (-888 mV_{CSE})	Suitable for monitoring	-	136
	45.417465, -75.660684	745.2	Minor DCVG (Up to 24.6%IR) Minor CIPS (-891 mV_{CSE})	Suitable for monitoring	-	137
	45.417470, -75.660536	756.6	Moderate DCVG (Up to 43.5%IR) Minor CIPS (-825 mV_{CSE})	Suitable for monitoring	-	138
	45.417501, -75.660176	785.1	Minor DCVG (28.2%IR) Moderate CIPS (-819 mV_{CSE})	Suitable for monitoring	-	139
	45.417545, -75.659625	828.6	Minor DCVG (27.2%IR)	Suitable for monitoring	-	140
	45.417607, -75.659214	861.4	Minor DCVG (20.3%IR)	Suitable for monitoring	-	141
	45.417622, -75.659092	871.0	Minor DCVG (24.5%IR) Severe CIPS (-719 mV_{CSE})	Scheduled action required	-	142
	45.417688, -75.658096	949.4	Minor DCVG (Up to 19.7%IR)	Suitable for monitoring	-	143
	45.417702, -75.658011	956.2	Minor DCVG (Up to 32.3%IR)	Suitable for monitoring	-	144
	45.417715, -75.657969	959.6	Minor DCVG (Up to 20.7%IR)	Suitable for monitoring	-	145

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Table F-1: Prioritization of Indications

Section	GPS Coordinate	Survey Chainage (m)	Classification	Prioritization	Notes	Indication ID
Section 3	45.417925, -75.657156	1026.1	Minor DCVG (Up to 18.0%IR)	Suitable for monitoring		146
	45.418069, -75.656041	1117.6	Minor DCVG (20.2%IR) Minor CIPS (-878 mV_{CSE})	Suitable for monitoring	-	147
	45.418306, -75.652938	1419.2	Minor DCVG (17.0%IR)	Suitable for monitoring	-	148
	45.418515, -75.651120	1566.1	Severe DCVG (73.1%IR)	Scheduled action required	Reduced confidence. At section with possible thick asphalt	149
	45.418616, -75.648793	1785.7	Minor DCVG (23.8%IR)	Suitable for monitoring	Recommended for DE Phase 1	150
	45.418733, -75.647327	1900.8	Minor DCVG (26.4%IR)	Suitable for monitoring	-	151
	45.418794, -75.647252	1910.3	Minor DCVG (16.7%IR)	Suitable for monitoring	-	152
	45.419260, -75.639560	2528.1	Minor DCVG (16.9%IR)	Suitable for monitoring	-	153
	45.419419, -75.637263	2709.9	Minor DCVG (27.0%IR)	Suitable for monitoring	-	154
	45.419491, -75.636311	2784.4	Moderate DCVG (44.4%IR)	Suitable for monitoring	-	155
	45.419490, -75.636232	2791.7	Moderate DCVG (37.9%IR)	Suitable for monitoring	-	156
	45.419502, -75.636053	2804.4	Minor DCVG (33.7%IR)	Suitable for monitoring	-	157
	45.419507, -75.636016	2807.5	Minor DCVG (31.8%IR)	Suitable for monitoring	-	158
	45.419519, -75.635886	2817.9	Minor DCVG (25.9%IR)	Suitable for monitoring	-	159
	45.419534, -75.635693	2833.0	Moderate DCVG (43.5%IR)	Suitable for monitoring	-	160
	45.419534, -75.635635	2837.6	Moderate DCVG (38.4%IR)	Suitable for monitoring	-	161

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ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 13

To provide a copy of the Enbridge standard operational risk assessment matrix, including any internal guides or reference document.

Response:

Please refer to Attachment 1 for the “Guideline to Operational Risk Assessment Matrix – GDS Reference”.

Guideline to Operational Risk Assessment Matrix – GDS Reference

Effective Date: 28-Feb-2024

Version #: <1.1>

Version Date: 28-Feb-2024

Document Version Register

Version Number	Version Date	Approved By	Details of Version
V 1.0	28-Sept-2023	Bob Wellington	Created document to provide guidance on the use of the operational risk assessment matrix for GDS
V 1.1	28-Feb-2024	Bob Wellington	Improves guidance for assessing environmental impacts on species

Contents

1.0 PURPOSE & SCOPE

The Operational Risk Assessment Matrix is used to assess operational risks as detailed in the HIRA procedure. It expresses the risk in the business through the ranking of risk using the likelihood and potential consequences of events and provides guidance regarding the required level of risk authorities for escalation and risk acceptance based on the endorsed level of risk. The Operational Risk Assessment Matrix Guideline provides GDS-specific interpretation of the matrix to reflect its alignment with the GDS business.

2.0 ROLES & RESPONSIBILITIES

The following section outlines the responsibilities between corporate and business functions in stewardship of the operational risk matrix.

Safety and Reliability	• Responsible for stewardship of the Operational Risk Assessment Matrix and its alignment across all business units as expressed in the Framework Standard - Risk Management. • Administers and maintains the Operational Risk Assessment Matrix current with business conditions. • Maintains governance and approval of alternate risk matrices used in corporate and central functions outside the scope of operational risk management
GDS Risk Governance	• Provides GDS input towards the risk characterization defined in the Framework Standard - Risk Management Standard. • Assures integration of its content into GDS and alignment to the HIRA procedure • Defines Risk Criteria and Risk Reporting Authorities in GDS • Responsible of maintaining and updating this document.

3.0 OPERATIONAL RISK ASSESSMENT MATRIX USE

To use the Operational Risk Assessment Matrix requires an understanding of the specific hazard, risk, and event that is to be assessed.

To establish Risk Level, each scenario pair of consequence and likelihood ratings is plotted on the Risk Matrix. The location of the plotted risk on the Risk Matrix identifies the risk level. For guidance on risk reduction and reporting requirements based on level of assessed risk, see HIRA procedure for further details.

Likelihood \ Consequence	1	2	3	4	5	6	7
G	G1	G2	G3	G4	G5	G6	G7
F	F1	F2	F3	F4	F5	F6	F7
E	E1	E2	E3	E4	E5	E6	E7
D	D1	D2	D3	D4	D5	D6	D7
C	C1	C2	C3	C4	C5	C6	C7
B	B1	B2	B3	B4	B5	B6	B7
A	A1	A2	A3	A4	A5	A6	A7

Colour	Risk	Description
	Very High	Very high risk remains after existing controls have been considered. Risk reduction options, including interim measures, must be considered, and risk escalated as quickly as possible, as per Business Unit reporting requirements.
	High	High risk remains after existing controls have been considered. Re-evaluation and / or risk reduction options must be considered, and risk escalated, as per Business Unit reporting requirements.
	High / Medium	If related to health or safety, treat as High. If unrelated to health or safety, treat as Medium.
	Medium	Escalation / risk reduction may be warranted. Consider options to further reduce risk, where feasible.
	Low	No action or escalation required.

Figure 1: Operational Risk Assessment Matrix

To ensure consistency of assessment, the Operational Risk Assessment Matrix provides descriptions of both consequence and likelihood levels for all consequence categories of principal concern to Enbridge. Interpretation may be required to address certain scenarios. **Table *1*** provides details regarding Enbridge consequence categories and what should be considered in the risk assessment. Consequence and Likelihood levels are described in detail in **Table *6*** and **Table *7***, respectively. Section 4.0 provides checklists as supporting tool for risk assessment.

Table 1: Consequence Categories and Considerations in Risk Assessment

Consequence Category	Description
Financial	Financial impact should include measures for the mitigation of any potential financial risks such as financial losses due to damage of company or public assets (i.e. office equipment, pressure control valves, vehicles, public property), including emergency costs to quickly bring an asset back in to service (e.g.: an emergency install of a generator to restore power, emergency repair, installation of small parts, contractor time to hot-shot parts to site, etc.) Here are some examples of financial impact that should be included: • replacement equipment and emergency repair: • for STO: purchasing gas to supplement supply, • damage to vehicles, property, etc. For damages to non-Enbridge properties and assets caused by Enbridge, the financial impact is cap at $1M as Enbridge's liability limit as per guidance from Enterprise Asset Management.
Health and Safety	The Health and Safety category applies to both employee / contractor and public. The risk matrix cannot describe all potential health impacts associated with an operational incident. The terms and definitions in **Table *2*** are intended to provide context but should not be considered exhaustive. It is important to note that the hatched cells on the risk matrix shall be treated as “High” risk when assessing safety-related risks, otherwise they shall be treated as “Medium” risk. Note: Additional risk assessment methods exist that may be appropriate to assess high or very high-risk vs the Operational Risk Assessment Matrix more comprehensively. Contact the Risk Service team for guidance
Environmental	Consequence descriptions reflect increasing sensitivity of potentially affected areas with a focus on land and water impacts with descriptive relevance for offsite impacts. The remediation and restoration cost are used as proxy for evaluating consequence ranking. It is important to consider magnitude of impact as well as the nature of the receptor such as types of wildlife / species, particularly protected (threatened) species and / or associated habitats, land or water bodies when assessing environmental risk.

Consequence Category	Description
	The consequence descriptions may be applied to many mechanisms of environmental damage e.g., hydrocarbon liquid releases, fire damage, non-hydrocarbon liquids releases, etc.; however, consideration should be given to the mechanism of damage and scaling applied e.g., identical volumes of wastewater or chemical release may have very different environmental impacts in the same location. In addition to direct impact to the environment, indirect impact like reputational and health and safety concerns should be considered. e.g., an environmental event affecting certain species might trigger regulatory repercussions, which should be assessed under the reputational impact category. Similarly, contaminant release into drinking water sources should be considered under the Health and Safety impact category. Risk associated with non-land/water-based contaminants (e.g., unplanned air emissions, noise, odor) should also be considered; for example, air-release events compared to other mechanisms such as liquids releases or fire, other consequence categories may be more appropriate e.g., fines due to compliance issue would be considered under reputational category, shutdowns leading to supply interruption would be considered under operational category; and potential toxicity of emissions would be evaluated under Health and Safety impact category.
Operational	When assessing potential operational impacts, consideration should be given to the magnitude, duration, location, season and type of customer or organizational impact that an operational interruption may create. Factors such as how long it takes to restore services, whether there are significant disruptions to customers lives due to loss of supply (for example: loss of heating during winter months), how quickly alternative resources can be brought in to mitigate the loss of gas supply to the customers, or, whether there are bypass options, give a better sense of severity. Use discretion, taking these factors into account, when assessing potential consequence severity. If there are nuanced extenuating circumstances, the potential consequence severity may be higher than the customer numbers alone may indicate on the risk matrix. Duration of a gas outage for transportation customers has been added to the GDS guidance for considering customer impact severity. Aggravating circumstances such as an outage occurring in a remote community, the

Consequence Category	Description
	need to fly or drive employees long distances to repair the cause of an outage, service interruptions that are likely to occur during winter months which can cause safety issues to customers due to cold exposure, can all increase the severity of a given consequence scenario beyond what is indicated by the duration of the outage alone on the risk matrix.
Reputational	When assessing potential reputational impacts, consideration should be given to the visibility of the potential event i.e., remoteness of affected location; any cultural/social significance associated with the area that the event may occur in (e.g., parkland/public spaces, Indigenous lands, cemeteries etc.); and any existing or anticipated sensitivity associated with the affected asset. i.e., assets currently under media, public, or regulatory scrutiny are more likely to cause significant reputational impacts if they are involved in an incident. These factors may influence the media and regulatory descriptions provided in the matrix. The risk assessment team should be aware of the permits that are related to the project or asset as well as the conservation authorities/Indigenous groups that may have jurisdiction in the geographical area of the asset being risk assessed. The team should discuss whether any of the scenarios being assessed could result in failing to meet a permit requirement or issuing of corrective actions, stop work order from an external organization. Examples of permit issuers include but are not limited to: Railways, Metrolinx, Hydro One, other pipelines, conservation authorities.

Table 2: Definitions and Terminology

Health & Safety	
Major Injuries	Long-term/life altering; life-altering fractures, significant third-degree burns, disfigurement, and limb-loss. Examples: • Disfigurement: level 3, with itch or pain • Disfigurement: level 3 • Lower airway burns: with or without treatment • Spinal cord lesion below neck: treated • Traumatic brain injury: long-term consequences, moderate, with or without treatment

	• Burns of ≥20% total surface area or ≥10% total surface area if head or neck, or hands or wrist involved: long term, with treatment • Amputation of both arms: long term, with treatment • Amputation of one arm: long term, with or without treatment • Amputation of both legs: long term, with treatment • Amputation of one leg: long term, with treatment • Fracture of pelvis: long term • Fracture of vertebral column: short or long term, with or without treatment
Moderate Injuries	Moderate recovery (weeks to months); fractures, 2nd/3rd degree burns, and significant strains/sprains. Examples: • Burns of ≥20% total surface area: short term, with or without treatment • Dislocation of knee: long term, with or without treatment • Fracture other than neck of femur: short term, with or without treatment • Fracture of sternum or fracture of one or two ribs: short term, with or without treatment • Dislocation of shoulder: long term, with or without treatment • Fracture of patella, tibia or fibula, or ankle: short term, with or without treatment • Fracture of radius or ulna: short term, with or without treatment • Dislocation of hip: long term, with or without treatment
Minor Injuries	Short recovery; minor lacerations, minor burns, and minor sprains/strains. Examples: • Burns of <20% total surface area without lower airway burns: short term, with or without treatment • Disfigurement: level 1 with itch or pain [closest equivalent of minor lacerations] • Concussion • Injury to eyes: short term • Other injuries of muscle and tendon (includes sprains, strains, and dislocations other than shoulder, knee, or hip)
First aid	Minor abrasions and minor bruises. Examples: • Open wound: short term, with or without treatment
Operational	
General Service Customer	Smaller volume customers which include residential, commercial, and some industrial which do not require a specific contract in the distribution system. Examples are a condo, a single home, a coffee shop, or a farm.

Contract Customer	Commercial or industrial large volume customers in the distribution system. This could include a hospital, manufacturing facility, or a power plant. They could receive supply from a transmission line or distribution network. In addition, they may have a transportation contract. (Examples of large volume customers include hydro customers, some hospitals, detention centers, care homes, industrial operations such a smelting or mining.)
Order of Curtailment	GDS customers are categorised by Priority Groups for 'Order of Curtailment' as follows: interruptible, firm, and general service. Interruptible customers may have supply that is a mix of interruptible and firm. If curtailment is needed, only the interruptible supply would be curtailed. Within the firm category, there are priority categories for emergency curtailment ranging from large volume customers where service interruption is undesired but would likely only result in production losses to commercial/institutional and apartment customers where there could be health and safety implications as a result of loss of supply. The operational consequences described are based on the risk associated with interrupting these Priority Groups as they pertain to emergency curtailment.
Transportation Customers	Customers that move gas from any one point on the Enbridge Gas transmission system to another (using Enbridge pipe capacity). The gas may not be owned by Enbridge (customer has title to the gas) and the gas movement may connect with gas external to the Enbridge piping network. There are specific points within the transmission system where gas can be transported to and from. Source: https://www.enbridgegas.com/storage-transportation/services/c1
Vital Mains	Criteria for what is defined as vital mains are described at the following link: Pipeline Designations
Environmental	
Protected Species	As defined by the Canadian Federal Species at Risk Act and, in Ontario, the Endangered Species Act.
Drinking Water	Water that is safe to drink or use for food preparation without posting a risk to health. Examples are: • Private water wells • Wellhead Protection Area (WHPA), or other municipal drinking water feature
Ecological Importance	Relate to the significance of an ecosystem, species, or natural process in maintaining ecological balance and diversity. Important factors might include

	biodiversity, trophic interactions, water quality, carbon sequestration, and habitat provision. Ecological importance often addresses the intrinsic value of nature and how different elements contribute to the health and balance of an ecosystem as a whole.
Socioeconomic Importance	Focuses on the social and economic aspects of a system, such as job creation, income generation, cultural values, and human well-being. It includes the benefits people derive from natural resources, like agriculture, fisheries, and tourism, as well as non-material gains like aesthetic and cultural values.
Soil Vapor Intrusion	The process by which volatile chemicals move from a subsurface source into the indoor air of overlying building.
Water Bodies	Physical locations where water is found, such as lakes, rivers, oceans, and groundwater aquifers. They are the actual “containers” or “locations” where water is stored or flows. They can be natural, like rivers and lakes, or man-made, like reservoirs and canals.
Water Resources	Sources of water that are useful or potentially useful for specific purposes, such as drinking, agriculture, and industry. Water resources encompass both the water bodies and structure. Agency might implement controls to protect water resources e.g., Wellhead Protection Area, Intake Protection Zone, and Source Water Protection Area.
Remediation	The process of cleaning up pollutants or contaminants from the environment to meet established standards or guidelines. The focus is on removing or treating the harmful substances themselves, which may involve processes like soil excavation, groundwater treatment, or chemical neutralization
Restoration	The process aimed at returning an ecosystem to its original condition. It involves re-establishing native vegetation, improving water quality, and possibility reintroducing native species to the area.

4.0 QUESTIONS TO CONSIDER IN RISK ASSESSMENTS:

Below in ***Table 3***, ***Table 4***,***Table 5*** are questions that can help a risk assessment facilitator gain clarity on the nuances of a risk scenario. These questions have been identified based on experience from past risk assessments and are meant to provide guidance, to be used with the risk assessment facilitator's discretion. These questions are not an inclusive list.

Table *3*: Environmental Question Cues

Categories	Questions
Understand undesired events	• What is the magnitude of the impact? How far can the contamination travel? • What is the mechanism of the damage? Examples: release of contaminants, fire damage.

Understand direct impact	• What environmental receptors can be impacted and how are they being impacted?
	  ○ What species / wildlife can be impacted? Are there any protected species (threatened) being impacted? Could the habit for species/wildlife be impacted?
	  ○ What are the nearby water resources that can be impacted by an environmental incident? Examples are wetland, water resources, lakes, groundwater, wells, any other water bodies.
	  ○ Are there any socioeconomic important areas that can be impacted? Examples are cultural heritage resources.
	  ○ Are there any emissions that release to atmosphere?
	  ○ Is there a potential for noise disturbance to the surrounding environment?
	  ○ How would the land be impacted? Examples are contaminated soils, eroded land.
	• How significant is the effort to remediate the impact and restore the impacted area to its original condition? Consider potential technical challenges in clean up and restoration effort. Is there on-going effort required to monitor the impacted area?

Understand secondary impact	• Are there any secondary impacts from the environmental incident?

Categories	Questions
	○ Can contaminants impact the health & safety of public or workers? If so, evaluate associated risk separately under "Health and Safety". Examples of health and safety scenarios are: - Consumption of contaminated drinking water - Exposure to soil vapour released from contaminants. - Contact with contaminates such as liquids or contaminated soils. ○ What could be potential non-compliance issue with environmental laws and regulations? What permits, regulations, conservation authorities have jurisdiction over the impacted areas? Evaluate risk under "Reputational Impact." ○ What could be potential impact to stakeholders and company reputation? Evaluate risk under "Reputational Impact".
Understand existing controls	• What existing controls in are placed to prevent, detect, and mitigate risk? • How effective are existing controls?
Evaluate likelihood	• With the consideration of existing controls and their effectiveness, how likely is it that the consequence would take place?

Table *4*: Operational Question Cues

Categories	Questions
Understand undesired events	• How is supply being reduced or interrupted? Due to planned (examples are planned repair or pressure restriction due to integrity issues on a pipeline) or unplanned interruption (examples are damages to or sudden failure of an asset)? • How long will the pressure reduction or interruption last? This could be affected by the urgency and complexity of the repair, number of customers needing to be relit, gas demand and company policy. • How long would re-lighting take? (Assume 0.5 days for 150 customers, 1 day for 600 customers, 2 days for 3000 customers)

Categories	Questions
	• Is this a multi-feed system? What bypass options are there? • During what seasons (example would be winter vs summer) would supply be reduced or interrupted? There could be multiple cases to be considered. Winter scenarios or design day scenarios can be worse than summer due to colder temperatures, making a customer interruption more severe and disruptive to the public.
Understand direct impact	• Which types and proportion of customers are going to be interrupted? (Residential, commercial, apartment, industrial, remote mines, remote communities, transportation customers, high volume contract customers, firm vs interruptible customers)? To determine the magnitude of customer impact, it is best to determine representable temperatures for the undesired events and reach out to Distribution Optimization Engineering (DOE) or Transmission System Planning group to understand the impact to customers. • Who will be responding to the operational issue? For example, would employees need to be diverted from a remote hub and drive hours to get to a site to mitigate an issue?
Understand secondary impact	• Are there any secondary impacts from the operational incident? ○ What would be the repair cost and relight cost? Could there be any alternate supply cost? If so, evaluate risk separately under "Financial" impact". ○ Could there be potential health & safety impact to customer and workers? If so, evaluate risk separately under "Health and Safety" impact. ○ What could be potential impact to stakeholders and company reputation? Evaluate risk under "Reputational Impact".
Understand existing controls	• What existing controls are in place to prevent, detect and mitigate risk? • How effective are existing controls? • Are there interruptible customers?
Evaluate likelihood	• With the consideration of existing controls and their effectiveness, how likely the consequence would take place? If the scenario is season or temperature sensitive, it should be accounted for in evaluating the likelihood of the consequence.

Categories	Questions
	• How frequently would the failure lead to a service disruption? It is important to note that not all failures would lead to service disruption.

Table 5: Reputational Question Cues

Categories	Questions
Understand undesired events	• Where is the asset located? • What permits, regulations, conservation authorities have jurisdiction over this asset? • Is this scenario a particularly sensitive scenario from a public perception/media perspective?
Understand direct impact	• Would the scenario draw particularly large public/media attention? • What is the current reputational climate around this asset that could increase or decrease the degree of public/regulatory attention that a scenario with the asset could result in?
Understand secondary impact	• Are there any secondary impacts from the reputational incident?
Understand existing controls	• What are existing controls in place to prevent, detect and mitigate risk? • How effective are existing controls?
Evaluate likelihood	• With the consideration of existing controls and their effectiveness, how likely is it that the consequence will take place?

Table 6: Consequence Descriptions

- Grey cells represent consequence descriptions provided by Enterprise S&R.
- White cells represent GDS-specific guidance.
- Apply GDS guidance for Environmental and Operational consequences.
- For other consequences, follow Enterprise S&R descriptions.

	1	2	3	4	5	6	7
FINANCIAL	Total financial impact ≤$10,000	Total financial impact >$10k and ≤$100k	Total financial impact >$100k and ≤$1M	Total financial impact > $1M and ≤ $10M	Total financial impact >$10M and ≤$100M	Total financial impact >$100M and ≤$1B	Total financial impact of >$1B
HEALTH & SAFETY	1 to 10 first aids First aid: Minor abrasions and minor bruises	1 to 10 minor injuries Minor Injuries: Short recovery; minor lacerations, minor burns, and minor sprains/strains	1 to 10 moderate injuries Moderate Injuries: Moderate recovery (weeks to months); fractures, 2nd/3rd degree burns, and significant strains/sprains	1 to 10 major injuries Major Injuries: Long-term/life altering; life-altering fractures, significant third-degree burns, disfigurement, and limb-loss	1 to 10 fatalities	10 to 100 fatalities	> 100 fatalities
ENVIRONMENTAL **(Apply GDS description)**	Barren land or land used for industrial purposes where a spill would have minimal potential for water resource impact	Grassland, grazing areas, or forested areas where a spill would have minimal potential for water resource	Agricultural areas where a spill would have minimal potential for water resource, impact.	Cropland, grassland, or forested areas where a spill would have significant potential for water resource impact, or a water body with limited ecological or socioeconomic importance.	Populated areas containing ecologically or socioeconomically important spill sensitive resources; or similarly sensitive water bodies including water that serves as a major drinking and/or food source.	Areas with very important ecologically or socioeconomically spill sensitive resources; or similarly sensitive water bodies that include habitat for threatened species.	Areas with extremely important ecologically or socioeconomically spill sensitive resources; or similarly sensitive water bodies including those that serve as endangered species habitat.
	No impact to any water resource	No impact to any water resource	Minor impact to any water resource	Limited impact to water resources with ecological or socioeconomic importance	Impacts to ecologically or socioeconomically important areas, or similarly sensitive water resources including water that serves as a major drinking (e.g., a few private water wells) and / or food source; alternative water	Impacts to very important ecologically or socioeconomically areas or similarly sensitive water resources, including water that serves as critical drinking water or food source (e.g., multiple private water	Impact to extremely important ecologically or socioeconomically areas including water that serves endangered species habitat and / or as critical drinking water or food source; alternative water supply required to be established for the long-term.

	1	2	3	4	5	6	7
					supply required in the short term.	wells, major municipal drinking water sources or Wellhead protection area); alternative water supply required to be established for the long-term	Potential permanent and irreversible damage to land, water resources or wildlife habitat
	Impact can be remediated immediately. (e.g., release on land such as concrete, asphalt, soils, vegetation that can be cleaned up immediately through use of a spill kit, vegetation /soils removal or vacuum truck, no impact to wildlife and / or associated natural habitat)	Impact can be remediated, and impacted area fully restored with no requirement for ongoing monitoring. (e.g., Noise complaints resulting minor remediation or intervention effort, minor disturbance to wildlife and / or associated natural habitat)	Impact is expected to be remediated under a short-term program (i.e., <6 months) with partial to full restoration of the impacted area. Ongoing monitoring may be required. (e.g., Noise complaints resulting in moderate remediation or intervention effort, moderate disturbance to wildlife and / or associated natural habitat)	Impact is likely to be remediated over time with partial to full restoration of the impacted area. Ongoing monitoring is required. (e.g., serious disturbance to wildlife and / or associated natural habitat)	Impact is likely to be remediated under a long-term program (i.e., > 6 months) with major resources applied to remediation and restoration. Partial restoration is expected with ongoing monitoring. (e.g., Major disturbance to wildlife and / or associated natural habitat)	Impact requires extensively long-term remediation (i.e., years) and restoration of a significant area. Partial restoration is expected with long-term ongoing monitoring. (e.g., extensive disturbance to protected species and / or associated natural habitat.	Full remediation and restoration cannot be achieved and / or generational effort required to re-establish impacted species / habitat. Extensive long-term ongoing monitoring is required.
OPERATIONAL **(Apply GDS description)**	No significant capacity disruption	Minor reduction in capacity/ability to deliver.	Significant reduction in capacity/ability to deliver.	Loss of a major asset/facility for a short period of time	Inability to operate or loss of a major asset/facility for an extended period.	Loss of multiple major asset/facilities for an extended period	Loss of multiple major assets/facilities for an indefinite or permanent period.
	No disruption to transport customers.	Minor transportation customer disruption which can be quickly mitigated.	Transportation customers impacted for a day or more to as much as one week.	Short term disruption to transportation customers (1 week - 1 month).	Considerable disruption and inconvenience to transportation customers (1-3 months).	Long-term impact to transportation customers (3-6 months).	Indefinite unavailability of transportation assets (> 6 months).

	1	2	3	4	5	6	7
	No general service or large volume contract customer impact.	General service customer impact <100 customers.	General service customer impact 100-499 customers.	General service customer impact 500-999 customers. Minor short-term interruption of a remote large volume contract customer	General service customer impact 1000 - 4999 customers; or a large volume contract customer (end user in-franchise). Moderate short-term interruption of a remote large volume contract customer (e.g., impacting remote customer such as a hydro customer in the winder) The area where the incident occurs may not have a large amount of employees locally available to respond quickly.	General service customer impact 5000-20,000 customers; or multiple large volume contract customers; or: a strategic account customer (end user in-franchise) or a customer where significant facility damage would occur if natural gas service is discontinued or multiple communities would be impacted. Significant diversion of resources required by Enbridge such as employees flying into remote communities, specialized training requirements, etc. For example: services could be interrupted to a remote community or to a large hydro customer.	General Service customer impact > 20,000 customers; or multiple strategic account customer (end user in-franchise), or a customer where significant facility damage would occur if natural gas service is discontinued. Long term impact to general service customers (>6 months) Larger population communities impacted.
REPUTATIONAL	No significant media coverage.	Isolated individual concern at municipal/county level. No media attention.	Localized concern with short term local media and interest group concerns	State/Provincial concern, public and media attention beyond local area, customer attention on the issue	National concern and extended media coverage; significant public response causing major impact on current and prospective customers.	Extended national media coverage; significant public response causing long term impact on customers; inability to expand operations.	Extended national media coverage; severe public response causing potentially permanent impact on customers; irreparable reputation damage resulting in the inability to continue operations
	No unplanned regulatory engagement.	Regulator notification and/or informal and unplanned meetings or information requests from regulator; no monetary penalty imposed.	Non-compliance identified by a regulator in writing without a monetary penalty; may require corrective actions; follow up communication with the regulator regarding the issue expected.	Non-compliance identified by a regulator in writing including a monetary penalty; may require corrective actions; follow up communication with the regulator regarding the issue expected; permit/approval conditions or approval agency change causing	Non-compliance identified by a regulator in writing requiring significant corrective actions; may include a monetary penalty; operating permit/approval suspended causing significant operational impacts.	Non-compliance identified by regulator in writing directing Enbridge to stop operating specific assets; may include criminal prosecutions; operating permit/approval canceled causing indefinite suspension of operations.	Unable to gain regulatory approval for continued operation; may require decommissioning of major facilities; criminal prosecutions.

	1	2	3	4	5	6	7
			Example: TSSA, MOL, MOE, CER and conservation authorities can issue orders in the form of corrective actions.	moderate operational impacts. Example: TSSA/CER orders could reach this consequence level depending on severity. Permits could be affected from municipalities, conservation authorities, indigenous groups.	Example: Stop work order from MOL (ex: due to employee fatality). Permits could be affected from municipalities, conservation authorities, Indigenous groups which could include stop work.	Example: Stop work order from MOL, OEB would possibly get involved at this severity to investigate risks of repeat incidents.	

Table 7: Likelihood Descriptions

FS-RM*	Ranking in Encompass & Copperleaf	Description	Annual Likelihood (Event per yr.)	
			Fractional Range	Scientific Notation
G	7	One or more event events expected per year at a given facility	>1	>1
F	6	Event expected several times in a business unit in a one-year period	1/10 to 1	10^{-1} to 1
E	5	Event expected several times across Enbridge over a one-year period	1/10 to 1/100	10^{-1} to 10^{-2}
D	4	Isolated prior or expected cases at Enbridge	1/100 to 1/1,000	10^{-2} to 10^{-3}
C	3	Expected to occur periodically in industry over a one-year period; limited cases at Enbridge	1/1,000 to 1/10,000	10^{-3} to 10^{-4}
B	2	Known to have happened once in the industry	1/10,000 to 1/100,000	10^{-4} to 10^{-5}
A	1	No known prior occurrenceS in industry, unlikely to occur at Enbridge.	< 1/100,000	< 10^{-5}

*Framework Standard – Risk Management

<End of Document>

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 18

To file the slabbing study and the dig-difficulty study.

Response:

The Dig-Difficulty/Accessibility study and the Slabbing study are comprised of maps portraying the different accessibility conditions and slabbing potential in the St. Laurent Pipeline area. These maps can be found at Attachment 1.

For the slabbing study, it was assumed that high visibility slabbing installation would not be feasible if any of the following conditions existed:

- Other third-party utilities were installed within 0.8 m of, and ran parallel to, the existing natural gas main;
- At road, railway or water crossings;
- At locations where natural features such as trees would need to be removed to facilitate the installation of high visibility slabbing.

Below is the list of assumptions and considerations used to develop the slabbing study:

- High visibility slabbing would be installed via open cut excavations.
- Road moratoriums are unknown and not considered.
- Access to third party utility services that cross Enbridge Gas's gas main is not accounted for (slabbing would need to be modified/cut to accommodate access).
- City of Ottawa indicated it is not in favour of this method due to concerns about impacts to the City's roadway assets.
- Enbridge Gas inline main valve locations not accounted for (slabbing would need to be modified/cut to accommodate access).
- Enbridge Gas service valve locations not accounted for (slabbing would need to be modified/cut to accommodate access).
- ILI launcher sites required for Extensive Inspection and Repair alternative have not been accounted for.

- Potential interference with corrosion-protection materials/methods has not been considered (if applicable).

Below is a non-exhaustive list of potential ongoing operational concerns associated with the implementation of high visibility slabbing as a mitigation to protect against third party damage:

- If a third-party excavation requires the removal of high visibility slabbing (i.e., to access third party below grade infrastructure), there is a risk that they may not replace the sections that were removed.
- Future Enbridge Gas excavations on gas main/services will have an added cost due to larger excavation and restoration requirements (high visibility slabs are 1.6 m x 1.8 m)
- High visibility slabbing does not mitigate risk to asset from drills/torpedo installation methods.
- Historically, installation of high visibility slabs is used for pipelines with depth of cover issues on shorter segments. An expanded use of high visibility slabbing option may require an Engineering assessment prior to implementation.
- Slabbing increases the potential risk of gas migration from a small leak.

The dig-difficulty study assigned each segment of the existing natural gas main into one of four accessibility categories, defined below:

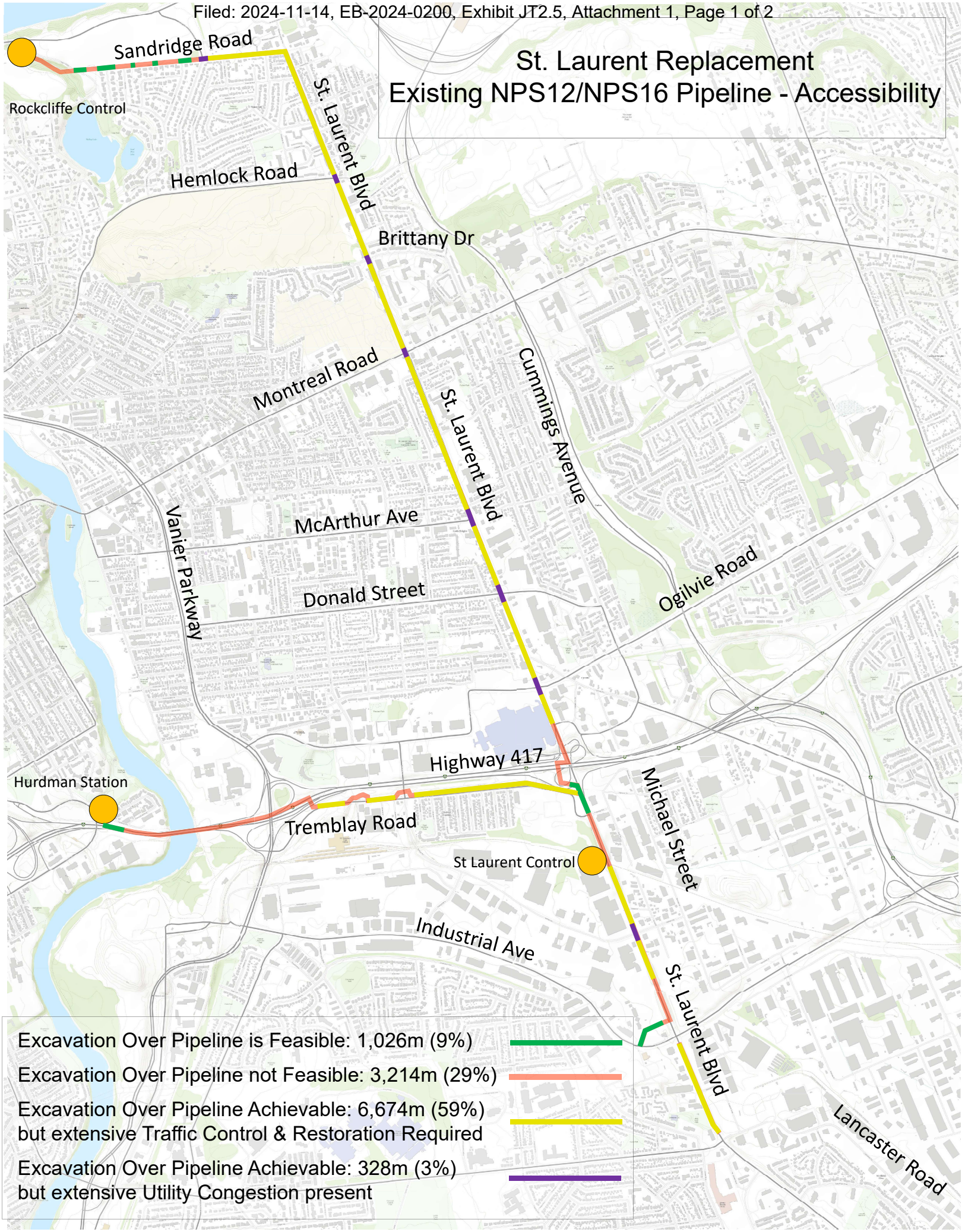
- Excavation over pipeline is feasible (“Accessible”): Pipeline is located within the boulevard and there are no known or observed impediments to access the existing pipeline based on a desktop study, including depth of cover considerations.
- Excavation over pipeline is not feasible (“Inaccessible”): The pipeline cannot be accessed due to observable impediments (i.e., railway crossing) or due to the depth of the existing pipeline.
- Excavation over pipeline is feasible, but extensive traffic control and restoration is required (“Challenging”): Pipeline is located beneath a hard surface within travelled portions of the road, but there are no known or observed impediments to access the existing pipeline based on a desktop study, including depth of cover considerations.
- Excavation over pipeline is feasible, but extensive utility congestion is present: Pipeline is located beneath a hard surface within travelled portions of the road, and there are extensive utilities in the vicinity of the existing pipeline, either crossing the main or running parallel to the main. This classification is primarily found at road intersections.

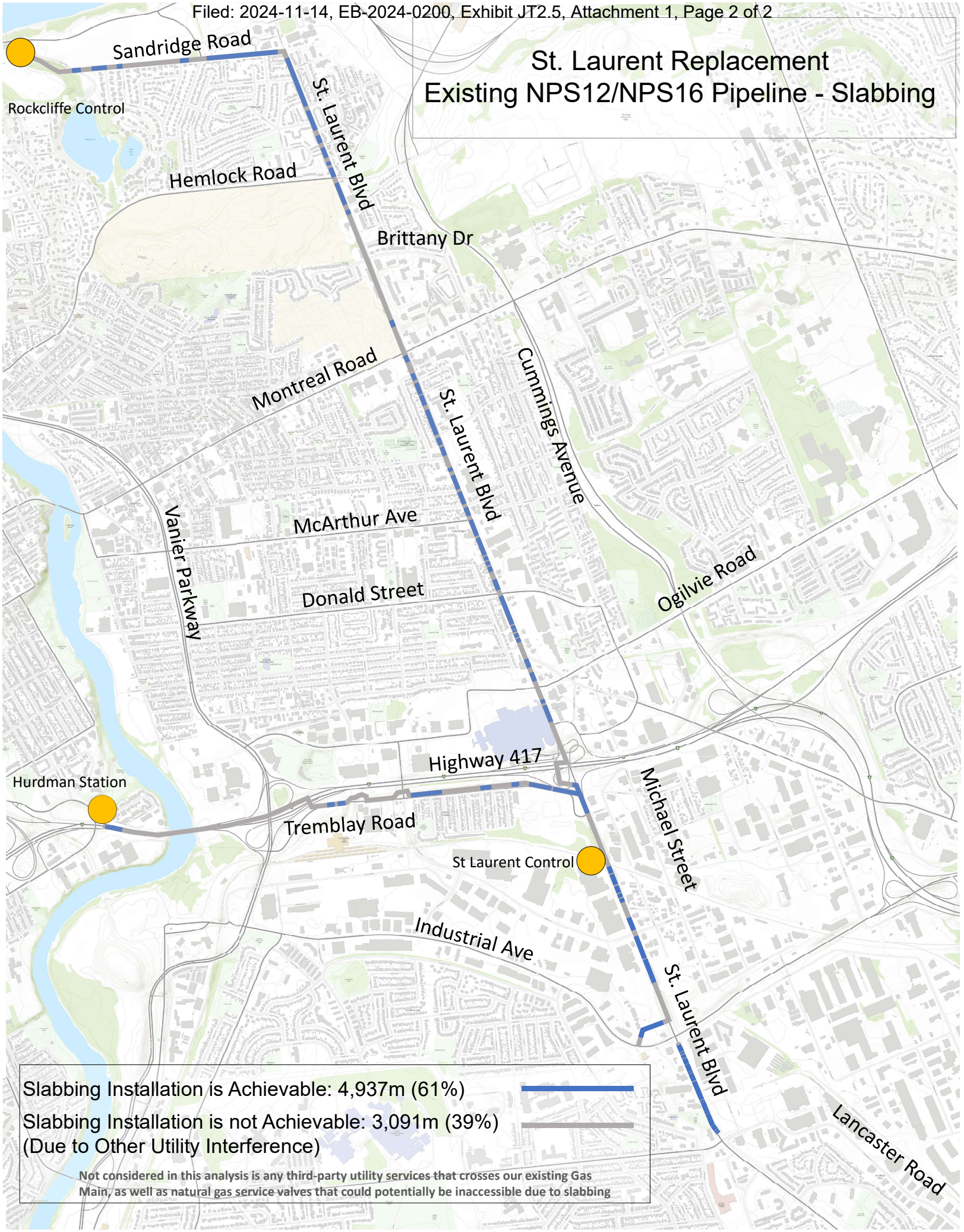
Table 1 shows the expected costs associated with repairs or cutouts for each category of accessibility.

Table 1: Costs for Integrity Dig per Category of Accessibility

	Accessible (Green)	**Challenging (Yellow)**	**Inaccessible (Red)**
Clockspring / Grind and Recoat / Sleeve Repair	$350,000	$500,000	N/A – automatically becomes a cutout
Cutout	$600,000	$1,000,000	$3,000,000

Note: The purple categories (feasible but extensive utility congestion present) have not had costs estimated. However, they would be more costly than yellow, but less costly than red on average.


St. Laurent Replacement
Existing NPS12/NPS16 Pipeline - Accessibility
Sandridge Road
Rockcliffe Control
St. Laurent Blvd
Hemlock Road
Brittany Dr
Montreal Road
St. Laurent Blvd
Cummings Avenue
Vanier Parkway
McArthur Ave
Donald Street
Ogilvie Road
Highway 417
Hurdman Station
Tremblay Road
St Laurent Control
Michael Street
Industrial Ave
St. Laurent Blvd
Lancaster Road
Excavation Over Pipeline is Feasible: 1,026m (9%)
Excavation Over Pipeline not Feasible: 3,214m (29%)
Excavation Over Pipeline Achievable: 6,674m (59%)
but extensive Traffic Control & Restoration Required
Excavation Over Pipeline Achievable: 328m (3%)
but extensive Utility Congestion present


St. Laurent Replacement
Existing NPS12/NPS16 Pipeline - Slabbing
Sandridge Road
Rockcliffe Control
St. Laurent Blvd
Hemlock Road
Brittany Dr
Montreal Road
St. Laurent Blvd
Cummings Avenue
Vanier Parkway
McArthur Ave
Donald Street
Ogilvie Road
Highway 417
Hurdman Station
Tremblay Road
St Laurent Control
Michael Street
Industrial Ave
St. Laurent Blvd
Lancaster Road
Slabbing Installation is Achievable: 4,937m (61%)
Slabbing Installation is not Achievable: 3,091m (39%)
(Due to Other Utility Interference)
Not considered in this analysis is any third-party utility services that crosses our existing Gas Main, as well as natural gas service valves that could potentially be inaccessible due to slabbing

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 21

To confirm payment dates related to contract cancellations; to advise amounts of lease-breaking costs.

Response:

The following costs were incurred in 2022 due to cancellation of contracts and payment of lease agreements for the temporary construction yard:

- Approximately $872,000 was paid to Aecon in Q2, 2022 for the Centrifuge commitment (equipment to clean up soil so it can be reused). These costs included labour and equipment to mobilize and demobilize the Centrifuge equipment from the project yard, materials required for pressure testing and cleaning the pipeline, and the costs related to the rental of equipment for the project yard.

- $139,669 was paid to QSP Geographics Inc. in Q2, 2022 for project startup costs, including onboarding (and ultimately offboarding) staff, initial project development activities, and procurement of equipment (and associated monthly use subscriptions).

- $550,880 was paid out in Q2, 2022 for the leasing of land to be used as our temporary construction yard. The breakdown of payments was as follows:
  - $198,880 paid to 1201966 Ontario Inc.
  - $176,000 paid to 1384673 Ontario Inc.
  - $176,000 paid to 1663321 Ontario Inc.

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 23

To describe accounting treatment of costs referred to in jt2.

Response:

Enbridge Gas can confirm that the costs incurred as part of the EB-2020-0293 project have been carried forward as part of the costs included in the current leave to construct application, as these expenditures informed the current Application. These costs include, just by way of example, costs related to the preparation of the original Environmental Report and the original Subsurface Utility Engineering and Topography, which - although updated for the current Application - did not have to be fully re-incurred, along with other types of costs.

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 24

To itemize and quantify, as is possible, costs in the budget in this application that would not have been there if you had gone forward with the proposal in this application, as opposed to the 0293 proposal and application.

Response:

In addition to the costs provided in the response to Exhibit JT2.6, the following costs in the budget for the current Application would not have been included if the EB-2020-0293 application had not occurred:

Approximately $35,600 was spent to have the Subsurface Utility Engineering (SUE) and Topography refreshed and updated on construction drawings.

Approximately $49,000 was spent on reviewing the Environmental Report – Amendment 2

There would also have been some additional internal labour costs (e.g. Planning, Environmental, Land, Legal, Regulatory etc.) prior to May 2022. However, these costs would likely have resulted in efficiencies in the preparation of the current Application and therefore would be difficult to quantify with any precision.

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 25

To review and clarify the response to ir 1.3-sec-15

Response:

The total forecast for the St. Laurent Pipeline Project in the 2024 Capital Update was $215,291,542.[1] The comparable forecast for the Project is $216,065,181 and is shown in Item 12 of Exhibit E, Tab 1, Schedule 1, Table 1.

Forecasts are continually updated throughout the lifecycle of the Project for a variety of reasons (i.e. scope changes, installation timing, crew availability). The variance between the 2024 Capital Update and the St. Laurent Replacement Project costs can be explained by an updated scope and a revised work plan that informed the leave to construct costs. A more granular comparison between the 2024 Capital Update and the St. Laurent Replacement Project costs is not possible, as the 2024 Capital Update cost estimates were not developed to a similar level of detail as the Project costs.

[1] EB-2022-0200, Exhibit JT5.34.

ENBRIDGE GAS INC.

Answer to Undertaking from
School Energy Coalition (SEC)

Undertaking:

Tr: 25

To provide an update if the company expects to qualify for ICM funding and plans to bring forward a request.

Response:

Enbridge Gas is evaluating whether ICM treatment for the St. Laurent Pipeline Replacement Project is appropriate in light of the proposed Settlement Agreement in Phase 2 of the 2024 Rebasing Application[1] and will inform the OEB and parties whether it intends to file for ICM funding request at the appropriate time.

[1] EB-2024-0111

ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 27

To provide the number of customers in Ottawa added by year since January 2020 that would by served off the current St. Laurent pipeline.

Response:

The number of customers added within Area 60 (Ontario), and customer additions within the area of benefit of the St. Laurent pipeline (direct and indirect benefit) from January 2020 to 2023 are outlined in the table provided. It should be noted that the customer count for 2023 may underestimate the actual number of attachments made during this period, due to delays associated with data updates.

Table 1: Customer Additions 2020-2023

Year	**2020**	**2021**	**2022**	**2023**
Customer Additions - SLP Area of Benefit	867	873	687	319
Customer Additions - Area 60	8133	8705	7917	5916

ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 32

To provide detail regarding ET adjustments by customer segment, residential versus commercial-industrial.

Response:

Exhibit 1, Tab 10, Schedule 4 in the 2024 Rebasing Application and Evidence (EB-2022-0200) describes how energy transition assumptions and considerations have been integrated into the forecasts. Energy transition adjustments are discussed on pages 3 - 12, and the adjustments specifically related to design hour are on page 10.

ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 41

To consider further the request for communication materials and provide, and if not, to advise.

Response:

In addition to the communication materials provided in Exhibit1.1-CAFES Ottawa-10, Enbridge Gas ran a targeted “dig safe” awareness campaign in the area of the St. Laurent pipeline from June 6 - August 29, 2023, including the following in respect of Google, Meta, and YouTube:

- Responsive Search
- Discovery
- Display and Responsive
- Performance Max
- YouTube
- Meta

Attachment 1 includes examples of the advertisements that ran on these platforms.

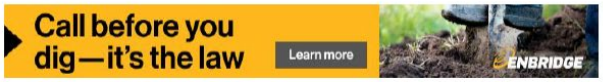
Enbridge Gas also runs a Safety Dig Safe campaign across Ontario annually, which includes digital ads.

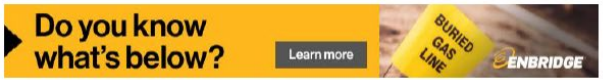
Google Display

Google Ads

Google Display

Google Ads





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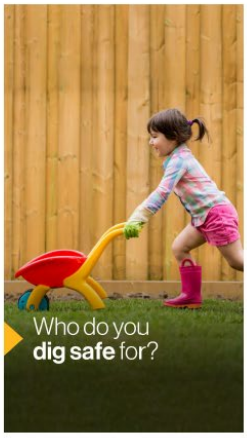

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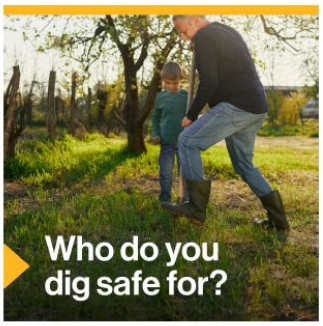

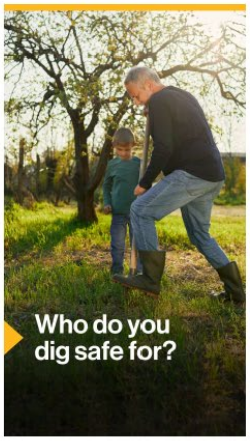

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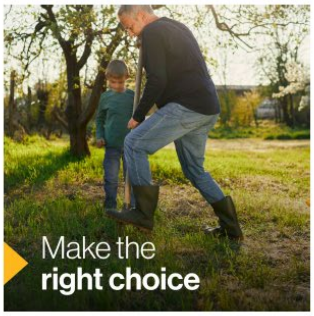

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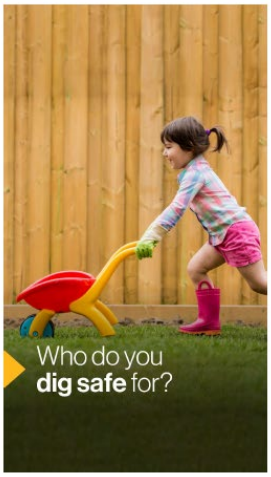
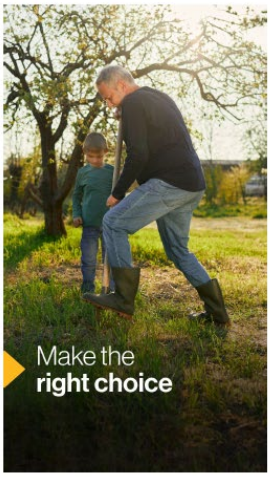
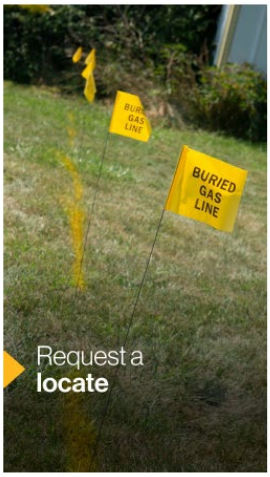
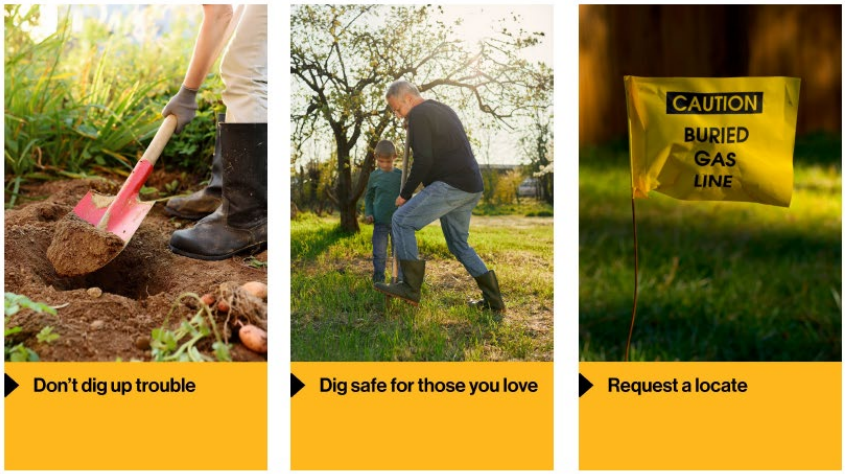




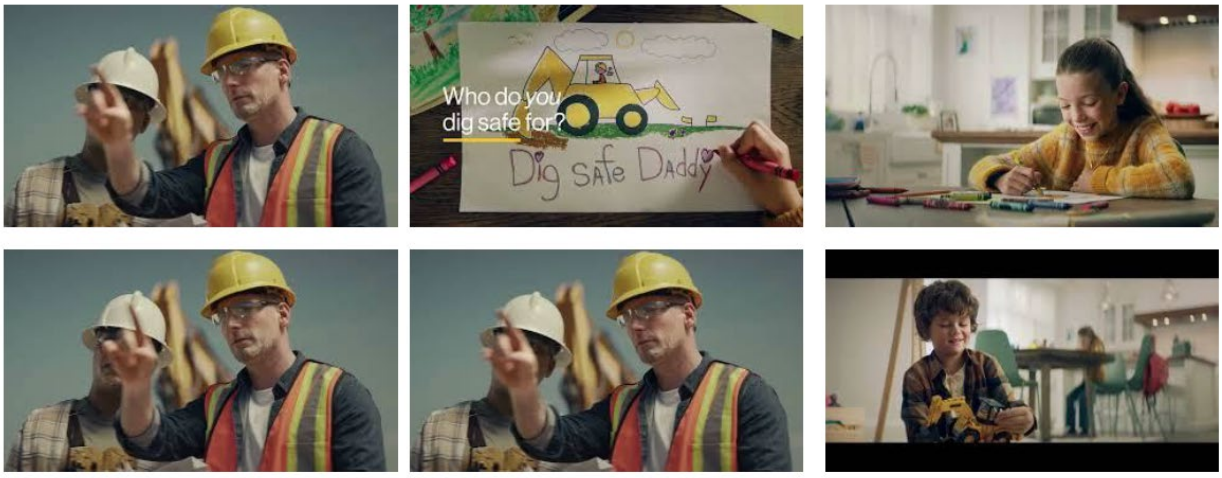


Meta carousel

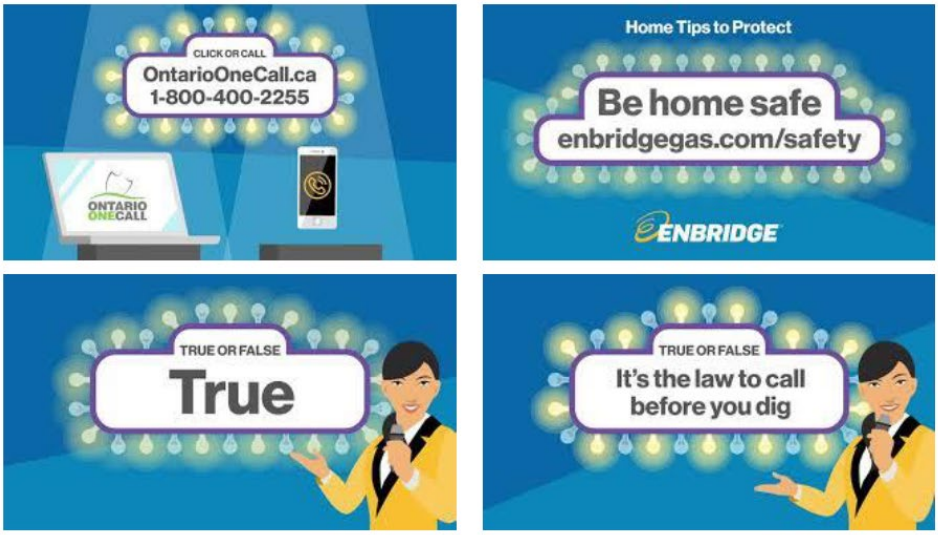
Meta carousel



YouTube video 15s, 30s & 60s



YouTube video 15s, 30s & 60s



ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 55

To consider the question of how many kilometres of pipeline are 60 years or older, and if possible, to respond; otherwise, to advise why.

Response:

As of the end of 2023, there are approximately 10,900 km of active steel pipe main 60 years of age or older in the Enbridge Gas distribution system across Ontario. Approximately 14% of this cohort falls within the Enhanced Distribution Integrity Management Program (EDIMP), with the other 86% falling within the traditional Distribution Integrity Management Program (DIMP), as it is comprised mostly of smaller diameter and lower pressure steel pipe. Age is only one factor that determines the condition and risk of buried steel gas pipes; there are also a number of other factors. Thus, as mentioned during the technical conference, vintage and risk condition may or may not be correlated in any particular case, depending on a variety of factors.

For the smaller diameter and lower pressure steel pipe, DIMP incorporates a program to assess the broader cohort of “vintage” steel distribution gas mains which incorporates factors affecting asset life (e.g., wall thickness, total number of fittings, and cathodic protection history) as well as factors affecting the consequence of asset failure (e.g., asset location, number of potential customers lost) and consideration of third party damage history to provide a holistic view of system risk. Additionally, Operations personnel are consulted for input and validation as they observe pipe condition during routine maintenance functions in the field. This holistic view of vintage steel distribution gas mains enables risk-based prioritization for smaller diameter and lower pressure steel pipelines that are not part of the EDIMP.

ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 58

To have the appropriate witness listen to that part of the interview, and if they have further comments or responses, they can provide in response to your question they will.

What's at stake if Ottawa does not back the replacement of an aging natural gas pipeline? | Ottawa Morning with Robyn Bresnahan | Live Radio | CBC Listen

Response:

The CBC interview with Enbridge Gas Construction Manager Steven Rogers reinforces evidence in Enbridge Gas's Application, including that the current condition of the St. Laurent Pipeline is unacceptable and that the Company does not run its pipeline assets to failure.

ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 61

To review the document and advise which line entries relate to discussions or documents with councilor Tierney; if there are any additional discussions or meetings with councilor Tierney that occurred that aren't reflected here, to indicate that as part of the response.

Response:

Please see Attachment 1 for line entries from the Municipal Engagement Consultation Log filed at Exhibit B, Tab 2, Schedule 1, Attachment 1 involving Councillor Tierney, and a summary of additional engagements with Councillor Tierney that have occurred since filing the St. Laurent Application on June 17, 2024.

Engagements connected to Councillor Tim Tierney from Exhibit B, Tab 2, Schedule 1, Attachment 1

Source Line Item	Date	Method	Summary of Enbridge Gas Inc. (Enbridge Gas) Engagement Activity	Summary of Stakeholder's Engagement Activity
31	Sept 8, 2023	Email	Enbridge Gas representative to Councillor Carr, Plante, Tierney, King	Councillor Tierney called with respect to the email and advised of his support.
34	Sept 15, 2023	Email	Enbridge Gas representative to Councillors Carr, Plante, Tierney, King, City Manager Wendy Stephanson, General Manager Herweyer, and seven other municipal staff members (transit planning, public works, emergency services, OC Transpo) to provide the Notice of Study Commencement and Public Information Sessions letter for the Project.	City of Ottawa Manager's Office provided assistance with some re-direction of emails to staff who had departed.
37	Sept 25, 2023	Virtual meeting	Enbridge Gas representative met with Councillors Carr, King, and Tierney and staff.	A general discussion was held. General support expressed for the Project.
48	Oct 15, 2023	Call		Councillor Tim Tierney called to advise he was going to table a motion related to St Laurent. A copy was not provided nor was exact wording discussed.
49	Oct 16, 2023	Email and call	Enbridge Gas representative to Scott Moffatt, Director of Issue and Outreach to discuss Tierney motion.	
50	Oct 18, 2023	Email		Charmaine Forgie provided a copy of the Tierney motion.
52	Oct 19, 2023	Meeting	Enbridge Gas representative spoke briefly with Councillors Tierney, Carr, and King at Ottawa Board of Trade Mayor's Breakfast.	
53	Oct 19, 2023	Meeting	Enbridge Gas representative spoke briefly with Scott Moffatt, Director of Issue and Outreach to discuss Enbridge Gas proposing amendments to Tierney motion, Moffatt agreed to approach.	
55	Oct 23, 2023	Email and Call	Enbridge Gas representative to Councillor Tierney proposing amendments to his original motion.	
57	Oct 23, 2023	Email	Enbridge Gas representative to Scott Moffatt, Charmaine Forgie, Melissa Jort-Conway to provide suggested amendments to Councillor Tierney motion	
59	Oct 24, 2023	Email	Enbridge Gas representative to City of Ottawa inquiring about procedural steps related to Tierney motion	Reply received October 25 to advise of process.

62	Oct 31, 2023	Email	Enbridge Gas representative individually to members of the Environment and Climate Change Committee (Councillors Brockington, Brown, Curry, Devine, Hill, Kavanagh, Luloff, King, Tierney, Carr, Menard) to advise of the St. Laurent pipeline replacement proposal and offer to answer any questions.	Received call from Councillor Luloff to express support. Email from Councillor Brockington advising of absence on Nov 21 but appreciative of receipt of background. Emails from Councillor Tierney appreciating info. Emails from Councillor Curry, Councillor Carr, Councillor Hill, and Councillor Brown's staff (Brett Byers) in support of the Project.
67	Nov 20, 2023	Call		Call to Enbridge Gas representative from Councillor Tim Tierney to advise of a revised motion and media interest
71	Nov 22, 2023	Voicemail and Email	Enbridge Gas representative to Councillor Tierney to follow up on second CBC Ottawa Morning interview with Enbridge Gas representative.	No reply.

Additional engagements with Councillor Tierney since filing evidence (June 17, 2024)

Line	**Date**	**Method**	**Summary of Enbridge Gas Inc. (Enbridge Gas) Engagement Activity**	**Summary of Stakeholder's Engagement Activity**
N/A	July 13, 2024	Call	Phone call to advise Councillor Tierney of new LTC submission for SLP.	
N/A	Aug 20, 2024	Meeting	Discussion with Councillor Tierney at the Association of Municipalities Ontario (AMO) Conference.	
N/A	Sept 13, 2024	Meeting	Introductory meeting with new Municipal Affairs Advisor and Councillor Tierney.	
N/A	Oct 23, 2024	Email		Councillor Tierney contacted Enbridge Gas rep to ask for an update on OEB schedule. Enbridge Gas informed Councillor Tierney the technical conference would take place Oct 30-31.

ENBRIDGE GAS INC.

Answer to Undertaking from
Community Association for Environmental Sustainability (CAFES)

Undertaking:

Tr: 64

To review if EGI's approved stakeholder plan will be filed.

Response:

In July-August 2023, Enbridge Gas developed a stakeholder engagement plan at the time for the St. Laurent Pipeline Replacement Project, which can be found at Attachment 1. Although this document is marked "Confidential Draft," it contained the operational plan that reflected the Company's engagement intentions and context at that point in time. The plan was approved and this document was not subsequently updated or marked as "final."

In November 2023, Enbridge Gas developed an additional engagement plan in respect of various steps, which can be found at Attachment 2.

These plans are the basis for the Stakeholder Engagement summary provided in the Company's pre-filed evidence at Exhibit B, Tab 2, Schedule 1.

St Laurent Pipeline Replacement Project (2023) Stakeholder Engagement Plan

CONFIDENTIAL DRAFT, August 31, 2023

PURPOSE

To outline engagement with the City of Ottawa and key Ottawa stakeholders prior to Enbridge Gas' next OEB application for Leave to Construct the St. Laurent Pipeline Replacement Project.

KEY ASK

With Ottawa residents, businesses and stakeholders, we seek a broad-based understanding of Enbridge Gas' need to maintain a state of good repair for the natural gas pipelines that serve the city.

PRIMARY MESSAGES

- The proposed St. Laurent Pipeline Replacement is about maintaining a safe, secure, and reliable source of energy for almost half of Ottawa's existing natural gas consumers, especially during the winter months.
- The reality is that there is no other immediately and sufficiently available source of energy to supply three out of every four homes in this city.
- As Ottawa's Energy Evolution plan states, "Residents, business, utility companies, governments large and small. We are all in this together and together is how we will find success." Ottawans are relying on successful and productive relations between Enbridge Gas and the City to deliver the progress future generations will depend on.
- Enbridge Gas continues to stand as a willing partner with the City of Ottawa to advance shared climate change objectives. This includes continued collaboration on demand side management, integrated resource planning, renewable natural gas development and blending, hydrogen blending, and the delivery of federally funded programs which support improved home energy efficiency.
- Replacing an existing pipeline does not take away from advancing our shared environmental objectives.
- By replacing it with a more modern pipeline, we can be sure that it is ready to bring RNG to more Ottawans and allow the system to more easily potentially accept hydrogen in the future.

BACKGROUND and KEY MESSAGES

- Enbridge Gas remains committed to delivering safe and reliable natural gas to Ottawa residents, businesses and institutions in Ottawa and Gatineau. This includes hospitals, Parliament Hill, RCMP (Royal Canadian Mounted Police) Headquarters, City Hall, and the University of Ottawa – all are serviced by the St Laurent pipeline.
- Enbridge Gas delivers natural gas to almost 400,000 customers – residents, business, industries, and institutions, in the City of Ottawa. Enbridge Gas operates nearly 5,000 kilometers of pipeline within the city to do that.
- The St. Laurent Pipeline Replacement Project seeks to install approximately 21 km of new pipe to replace the existing St. Laurent pipeline.
- The St. Laurent pipeline directly and indirectly supplies approximately 165,000 customers in the City of Ottawa and Gatineau. Some of these customers include those

providing critical services, like hospitals, which, like all customers, count on a reliable, dependable energy source for their heating and daily operations, especially in the winter months.

- Enbridge Gas is resubmitting an application to the Ontario Energy Board (OEB) to seek approval to install approximately 21 km of pipeline as part of the St. Laurent Pipeline Replacement Project. The application represented the construction of phases three and four of a four-phase plan for replacing the existing St. Laurent Pipeline; Phase 1 and 2 have already been completed.
- The OEB denied Enbridge Gas' original application in May 2022. It urged Enbridge Gas to "...thoroughly examine other alternatives such as the development and implementation of an in-line inspection and maintenance program using available modern technology, and propose appropriate action based on its findings." The OEB sought more sufficient evidence that the pipeline replacement is the best alternative. It also seeks from Enbridge Gas, further collaborations with the City of Ottawa and, "to undertake in-depth quantitative and qualitative analyses of alternatives that specifically include the impacts of IRP (integrated resource planning), DSM (demand side management) programs and de-carbonization efforts."
- Since then, Enbridge Gas has completed a deeper analysis on the pipeline's condition and engagement with Hydro Ottawa and the City of Ottawa on long-term integrated resource planning. Assessing the pipeline's condition has included inline inspection work, lab testing on pipeline cut-outs, and enhanced leak detection. In Enbridge Gas' view, this work has solidified and confirmed the case for pipeline replacement to ensure its long-term safety and reliability. This analysis will be part of the resubmission to be presented to the OEB in the late fall of 2023.
- One factor in the OEB's decision-making process were the objections raised by City of Ottawa staff in a letter dated March 24, 2022. Enbridge Gas is not aware that these objections reflected a position taken by Ottawa City Council.
- The letter acknowledged that City staff are not pipeline subject matter experts, but staff did claim expertise related to energy and emission planning.
- In seeking the OEB's rejection of Enbridge Gas' application, City of Ottawa staff made four arguments at the time, summarized as follows:
    1. Pipeline construction is disruptive particularly given the severity of pandemic impacts.
    2. It allows for time to see how energy transition activities (like building envelope improvements) are proceeding.
    3. It allows for time to better study the condition of the St. Laurent pipeline; and
    4. It permits a greater integration of gas infrastructure planning with the Energy Evolution plan.
- How do those arguments stand up today?
    - Well, first off, the pandemic is over. Construction is always disruptive and Ottawans are no strangers to that.
    - Second, nothing in the pipeline replacement proposal has or will prevent greater progress being made on building envelope improvements or accelerated energy efficiency. In fact, Enbridge Gas delivers the Home Efficiency Rebate Plus residential offering in partnership with the federal government. Launched in January of 2023, the program includes the ability for existing natural gas customers to receive large incentives for electrification measures, consistent with

the Energy Evolution plan. It complements Ottawa's Better Homes Loan Program.
    - Third, Enbridge Gas has spent the past 14 months completing a much deeper analysis of the St. Laurent pipeline. An additional $6 million has been spent on inline inspection work, lab testing on pipeline cut-outs, and enhanced leak detection analysis. Enbridge Gas has used that time wisely.
    - And finally, since May 2022, Enbridge Gas has met with City of Ottawa staff 16 times. Six of these meetings focused on: (1) the St. Laurent Pipeline Replacement Project, including pipeline integrity updates, (2) IRP implementation at Enbridge Gas, (3) IRP analysis completed for St. Laurent project, including capacity scenarios, demand forecast process and assumptions, translating the Energy Evolution plan and an analysis of IRP alternatives, and (4) a list of Enbridge Gas' Ottawa area projects.
    - Additionally, since the decision in November 2022 on Enbridge Gas's Application for the Multi-Year Natural Gas Demand Side Management Plan, Enbridge Gas has met with the City of Ottawa ten times to discuss demand side management and activities related to the energy transition. The topics of those meetings included Enbridge Gas's offerings and collaboration opportunities to enhance activity in Ottawa to reduce greenhouse gas emissions.
- Enbridge Gas and the City of Ottawa are collaborating on a pilot to strengthen knowledge on technologies which significantly reduce a building's energy usage, targeting multi-unit residential buildings to support deep energy retrofits and conversations across city departments on multiple energy related issues are ongoing.
- In summary, the four arguments the City of Ottawa outlined as key merits in urging the OEB to reject the St. Laurent application are either, a) no longer applicable (i.e., the pandemic), or b) remain ongoing priorities for Enbridge Gas for which considerable progress is demonstrable.
- What is disappointing for Enbridge Gas is to see that none of this work was reflected in the latest City of Ottawa staff submission to the OEB dated July 21, 2023. This intervention, during a 2024 rate setting hearing, was entirely unrelated to the St. Laurent project. In addition, the July 2023 letter also made sweeping assertions about Enbridge Gas' outreach efforts with the other 312 municipalities in Ontario where we operate to which Ottawa is not a party and would have limited knowledge of.
- Enbridge Gas values its relations with municipalities across the province and has actively participated, in good faith, on several fronts, with the City of Ottawa to further progress on energy and climate change issues. Ontarians, and Ottawans in particular, are relying on successful and productive relations between utilities like Enbridge Gas and municipalities to help deliver that progress.
- Ottawa's Energy Evolution plan acknowledges there will be a need for natural gas in the future. Regardless of the quantity of natural gas used now, or in 2030 or in 2050, Enbridge Gas' responsibility is to deliver that natural gas safely and reliability with a pipeline that is fit for purpose and in a state of good repair, now and into the future.
- The vast majority of the pipeline that Enbridge Gas is seeking to replace is the same size as the existing one.

ADDITIONAL CONTEXT

Evidence suggests that the interventions lodged by City of Ottawa with the Ontario Energy Board to both the St. Laurent pipeline project and the rebasing application were done without specific approval or the knowledge of Ottawa City Council. The authority of staff to communicate with the OEB is drawn from two sources. The first being Council's declaration of a climate emergency on April 26, 2019, and second, the unanimously endorsed community energy transition plan called Energy Evolution, adopted by Council on October 28, 2020.

The original March 24, 2022, letter to the OEB related to St. Laurent followed a very tumultuous period for Council. The "Trucker Convoy" has just taken place in January of 2022 and in the months that followed, factional infighting on Council dominated all issues as the term of Council ended. Likely, Council was not focused on the Ontario Energy Board submission even if it was brought to their attention.

Similarly, and more recently, both the Mayor's Office and the City Manager's Office were unaware of the July 21, 2023, letter to the Ontario Energy Board, which reasserted its previous St. Laurent submission and which significantly under-represented Enbridge Gas' work with the City of Ottawa staff on a host of issues. This work was meticulously itemized in Enbridge's July 27, 2023, rebuttal reply to the Ontario Energy Board. This reply has been shared with the Mayor and City Manager. Assurance has been provided by the Mayor's Office that further OEB interventions would not occur without approval from elected officials first.

While the recent letter reflects historic council positions, likely it serves as an example of staff, "getting in front of" Council and especially so given this is still the first year of a four-year mandate and the potential difficulties it raises with a major stakeholder like Enbridge Gas. If the sidelining of a major utility by city staff in a public forum does not reflect council's views or causes political problems, the intervention will not have been welcomed by elected officials.

KEY STAKEHOLDERS TO ENGAGE

For the reasons noted above, it is recommended that Enbridge Gas' St. Laurent advocacy at the City of Ottawa should be focused in two parts.

First, local elected officials in the wards affected by the construction should be individually engaged prior to and following the Public Information Session, tentatively scheduled for early fall.

Second, Enbridge Gas should seek the establishment of a centrally coordinated task force to include senior municipal staff, Hydro Ottawa, and Enbridge Gas, to facilitate and coordinate the Ontario Energy Board's ruling.

Outside of City Hall, it is advisable for Enbridge Gas to engage with local stakeholders to ensure interested community groups and organizations are fully briefed on the need for the pipeline's replacement. This engagement should supplement, before and after the Public Information Session, and stakeholders are listed below.

Michele Harradence's July 12, 2023, meeting with the Mayor was a strong starting point. While follow up with the Mayor's Office is ongoing, based on the advice received, specific outreach with locally affected elected officials should proceed.

It is recommended that such outreach commence with information sharing meetings with four members of Council listed below (in the St Laurent construction catchment area):

- Rideau-Rockcliffe Councillor Rawlson King (Ward 13)
- Alta Vista Councillor Marty Carr (Ward 18)
- Beacon Hill-Cyrville Councillor Tim Tierney (Ward 11)
- Rideau-Vanier Councillor Stephanie Plante (Ward 12)

In addition, Enbridge Gas should continue to brief the Mayor through the Mayor's Office on all aspects of the OEB application, city and stakeholder engagement as required, and we will request standing update meetings with the Mayor's Office to that effect.

A formal request to the City Manager should be made to establish a task force of senior staff, Hydro Ottawa, and Enbridge Gas to implement the Ontario Energy Board decision.

DESIRED OUTCOMES

- No further negative interventions related to the St. Laurent pipeline project with the Ontario Energy Board from the City of Ottawa.
- Ideally pre-OEB decision, a positive intervention with the OEB related to the St. Laurent pipeline project from Ottawa City Council. Desirable but not required. It is recommended that we do not explicitly seek the Council's endorsement but focus engagement on the task force with staff to implement the OEB decision.
- Recognition for the efforts Enbridge Gas has undertaken in the last 14 months on several files to improve climate change outcomes and coordination in future months through the task force.
- Establish a truly collaborative relationship between Enbridge Gas, Hydro Ottawa and the City of Ottawa based on trust and good faith in areas of mutual interest and program delivery, and which reflects the many areas of collaboration currently underway (i.e., Deep energy retrofits, etc.).

ENGAGEMENT INITIATION

Item	Timing	Accountability	Status
Connect with Scott Moffatt, Director of Issues Management and Outreach, Mayor's Office - – briefing meeting, and request ongoing meetings with Mayor's office	current	MW, 3 emails, 1 conversation related to OEB letter and seeking engagement advice	Reply pending
Connect with Wendy Stephanson, Interim City Manager - – briefing meeting, and ongoing follow up	completed	MW, 2 emails, 2 conversations related to OEB letter	Hold on further discussion pending Mayor's Office feedback
Write to newly confirmed City Manager Wendy Stephanson to establish an OEB decision implementation task force and advise of intention to re-apply to OEB to replace the St Laurent pipeline	Last week of August	MW	Pending approval
Councillor Rawlson King – briefing meeting, and ongoing follow up	First two weeks of September	MW seek meeting	To be scheduled
Councillor Tim Tiernay – briefing meeting, and ongoing follow up	First two weeks of September	MW seek meeting	To be scheduled
Councillor Marty Carr – briefing meeting, and ongoing follow up	First two weeks of September	MW seek meeting	To be scheduled
Councillor Stephanie Plante – briefing meeting, and ongoing follow up	First two weeks of September	MW seek meeting	To be scheduled
Complete Outreach to the following organizations: • Ottawa Board of Trade (priority) • Heating, Refrigeration and Air Conditioning Institute of Canada • Industrial Gas Users Association • Canadian Manufacturers and Exporters • Greater Ottawa Home Builder's Association • Public Services and Procurement Canada • University of Ottawa	Throughout September, October, and November	MW	To be scheduled

• Area hospitals (Ottawa General, CHEO, others? Confirm list) • Ottawa-Carleton District School Board • Ottawa Catholic School Board • Conseil des écoles publiques de l'Est de l'Ontario • Conseil des écoles catholiques du Centre-Est (CECCE) • Rockcliffe Park Residents Association			
Tina Nicholson, Ottawa Climate Action Fund, Ottawa Community Foundation	Sept 13	MW	Scheduled
Compare and add necessary additions from Sussex and EA (Environment Assessment) Stakeholder list	Early September	MW	To be completed

Updated St Laurent Engagement Plan (November 22 – December 6, 2023)

Date	Action	Goal	Accountable	Status	Additional Info/Other
Nov 22	Outreach to Crs Tierney and King	Shore up/ restore support	Matthew	Complete	
Nov 24	Outreach to Environment and Climate Change Committee Councillors	Correct record/statements from deputations, express availability if there are any outstanding questions	Matthew	Complete	
Nov 24	Outreach to Scott Moffatt, Mayor's office Follow up with Wendy Stephanson, City Manager	Ask how we can help, discuss path forward	Matthew	Complete	City likely to ask Councillor Tierney to pull back motion
Nov 27	Briefing with MPP Blais (Orleans)	Brief MPP, share information	Trevor	Compete	Briefing went well Indicated fully supportive of the project. Consider requesting letter in the future.
Nov 27	Update Issue Brief, confirm key messages, draft advertisement		Lesley Matthew	Complete	Ensure message alignment re: report from OEB evidence that says SLP doesn't need to be replaced until 2040 and other deputation remarks
Week of Nov 27 **(Occurred Dec 1)**	Outreach to all councillors Outreach to mayor's office	Give information related to upcoming consideration of motion, offer to meet	Matthew	Complete	
Week of Nov 27	Outreach to large customers served by SLP to discuss project and support		Key Accounts (Ian Macpherson) Kendra		
Week of Nov 27 **(Occurred Dec 1)**	Outreach to Ottawa Board of Trade mailing list	Educate business community regarding St. Laurent Pipeline replacement, encourage	Matthew	Complete	Issued through OBOT mailing list

		questions, ask for support			
Dec 2 and 5 (new dates)	Place paid advertising in Citizen and le Droit Support with organic social media posts	Educate public regarding St. Laurent Pipeline replacement, set the record state, encourage questions from the public	Lesley Matthew Brian Kemp	Ad purchased	Could also place following week (as December 6 date may not be as critical)
Dec 4,5	Outreach again to all councillors/mayor	Address any last minute issues	Matthew	If needed, based on status of motion	
Dec 6	Council meeting – voting day	Monitor, report back to team, be available to support any questions	Matthew	If needed, based on status of motion	
Dec 7	Revisit ward councillor conversation, request meeting and letter of support				

ENBRIDGE GAS INC.

Answer to Undertaking from
Pollution Probe (PP)

Undertaking:

Tr: 83

TO CONFIRM THE NUMBER OF SERVICES OR RECONNECTS WOULD BE INVOLVED IN THE XHP PIPELINE

Response:

There will be approximately 2 service relays off the XHP pipeline due to the age of the service and approximately 106 service reconnects off the XHP pipeline, affecting approximately 220 customers.

Many of these services will be completed in 2027 once the proposed gas main has been installed and energized. The quantities of affected services are an approximation based on previous planning work and the actual number of services will be determined as drawing packages are finalized prior to construction.

ENBRIDGE GAS INC.

Answer to Undertaking from
Pollution Probe (PP)

Undertaking:

Tr: 95

To look for additional documents that haven't been produced, and file if possible; if otherwise, to confirm.

Response:

The TSSA Application for a Consultation for the St. Laurent Pipeline Assessment can be found at Attachment 1.

The “St. Laurent Pipeline (SLP) Conditional Fitness-for-Service Assessment” and the “NPS 12/16 St. Laurent Pipeline Integrity Plan” documents referenced in the TSSA’s letter regarding Engineering Consultation (dated September 20, 2024)[1] are included in Attachment 2.

[1] Exhibit I.1-STAFF-12, Attachment 2, p. 1.

Technical Standards and Safety Authority
345 Carlingview Drive
Toronto, Ontario M9W 6N9
Tel: 416.734.3300
Fax: 416.734.3202
Customer Service: 1.877.682.8772
Email: fssubmissions@tssa.org
www.tssa.org

Application for a Consultation

Technical Standards and Safety Act

Fuels Safety Regulations

Clear Form | Print Form

A. Applicant/Invoicee (Company/Person who will be invoiced for engineering and/or inspection fees.)

Company Name	Corporation No.
Enbirdge Gas Inc.	

Mailing Address Street No.	Street Name / 911 Number/Address if applicable
500	Consumers Road

Town / City or Township / County	Province	Postal Code
North York	ON	M2J 1P8

Contact Name	Telephone No.	Fax No.	E-mail
M. Hildebrand	(519) 365-0458		mike.hildebrand@enbridge.com

B. Location of Considered or Proposed Equipment (If more than one location attach list)

Street No.	Street Name / 911 Number/Address if applicable

Town / City or Township / County	Province	Postal Code
Ottawa	ON	

C. Owner of Facility

Owner Name: Enbridge Gas Inc.

Address of Owner of Facility ☑ Same as applicant ☐ If different, specify below.

Street No.	Street Name / 911 Number/Address if applicable

Town / City or Township / County	Province	Postal Code

D. Fuel Type

☐ CNG ☐ Gasoline (LF) ☐ Fuel Oil ☑ Natural Gas ☐ Propane ☐ Digester Gas ☐ Other: _____

Code:	Section:

Equipment/Appliance/Component Involved	Make	Model	Serial No.
Distribution Pipeline	n/a	n/a	n/a

E. Consultation

☑ Engineering Review of Documents ☐ Site Review ☐ Code Interpretation ☐ Other: _____

Description:

Enbridge is submitting an application to the Ontario Energy Board for a project to mitigate risks associated with its St. Laurent Distributi
Pipeline in Ottawa Ontario. This application is to request a review of analysis involving inspection findings and the conclusions drawn
by Enbridge that the risk associated with he pipeline requires mitigation. Specific results and analysis are attached to this application.

Print Name of Applicant	Signature of Applicant	Date (dd-mmm-yyyy)
Mike Hildebrand		18-Jun-2024

Technical Standards and Safety Authority
345 Carlingview Drive
Toronto, Ontario M9W 6N9
Tel: 416.734.3300
Fax: 416.734.3202
Customer Service: 1.877.682.8772
Email: fssubmissions@tssa.org
www.tssa.org

Application for a Consultation

Technical Standards and Safety Act

Fuels Safety Regulations

Fees

(HST Registration No: 891131369)

Select	Service	Fee Type	Engineering	HST	Fee (Including HST)	Total Fees Due
☑	**Engineering** (up to 4 hours included)	Minimum*	$ 533.50	$ 69.36	$ 602.86	
	Expedited Services**					
☐	**Expedited Engineering Services** (Additional charge to engineering review per site application)	Flat	$ 533.50	$ 69.36	$ 602.86	
☐	**Expedited Inspection Service** (invoiced separately at 2 x standard rates)					
		Total Fees Due				

1

If paying by credit card, amount in Box 1 to be entered in TSSA Service Prepayment Portal

All required fees must be prepaid for application to be processed. Fees are non-refundable.
For payment options, see Payment Instructions

*All minimum fees include specified hours. Excess time above the specified included hours will be billed in 1/4 hour increments at the applicable hourly labour rate based on TSSA's posted fee schedule. All labour rates are per inspector or engineer.

Inspection services, if applicable, will be invoiced separately

****Expedited Services**
Expedited service fees are non-refundable
Expedited services places your application in an expedited service line
Expedited inspection services (inspection & travel time included in the flat fee, plus any excess hours) will be billed at 2 x the standard inspection rate.

Technical Standards and Safety Authority
345 Carlingview Drive
Toronto, Ontario M9W 6N9
Customer Service: 1.877.682.8772
Email: fssubmissions@tssa.org
www.tssa.org

PAYMENT INSTRUCTIONS

TSSA use only	L #	CH #
WO # _____		

If paying by cheque, bank draft, money order, this form must accompany all applications submitted to TSSA. A separate payment form is required for each application. Please refer to our fee schedule posted on our website www.tssa.org. HST Registration No: 891131369.

Payment Options:

☑ **Credit Card - Click link below**

TSSA Service Prepayment Portal
https://forms.tssa.org/Payments/Service-Prepayment-Portal

☐ **Cheque, Bank Draft or Money Order (payable to Technical Standards and Safety Authority)**

Name of Applicant/Organization:
Telephone No:
Email Address:

Cheque/Bank Draft/Money Order #:_____

Mail payment along with a copy of your application to:

Attention: Accounts Receivable
Technical Standards and Safety Authority
345 Carlingview Drive
Toronto, Ontario M9W 6N9

If a copy of the application is not submitted with your payment, this will delay the processing of the application.

Dishonored Payments: A $35 administration fee will apply for each returned item

ENBRIDGE

memo

Date: June 21, 2024

Re: **St. Laurent Pipeline (SLP) Conditional Fitness-for-Service Assessment**

Purpose:

The purpose of this memo is to clarify the effectiveness of current temporary mitigation actions on the SLP. While these actions conditionally and temporarily reduce risks, they are not adequate in the long term and do not constitute a permanent mitigation strategy.

Background:

- Following the OEB decision to deny the 2021 Leave-to-Construct (LTC) Application, the Integrity team initiated a "Targeted Integrity Program" to comprehensively assess the SLP's condition and risks.
- The program aimed to determine the operability of the SLP from a safety and reliability perspective, including defining any required immediate mitigations to ensure the pipeline's current safe operation.
- This memo outlines why the pipeline remains conditionally fit to operate on a temporary basis, based on the need for immediate repairs and the practical requirement to implement a timely permanent risk mitigation.

1. SLP Assessment and Mitigation Timeline

- **March 2021** – Enbridge Gas Distribution and Storage (GDS) filed SLP LTC application
- **May 2022** – OEB denied LTC application
- **June 2022** – GDS initiated EOC to evaluate SLP conditions and address risks
- **June 2022** – Additional surveys and mitigations implemented
- **Nov 2022** – EOC established to mitigate 80%+ metal loss feature in a sensitive location
- **May 2023** – Quantitative Risk Assessment completed
- **May 2023** – Temporary Third-party damage risk mitigations implemented
- **May 2023** – GDS SteerCo decision to move forward with updated SLP LTC application independent of the mitigation type (based on the need for mitigation)
- **June 2024** – GDS filed updated SLP LTC application[1]

[1] St. Laurent Replacement Project (SLPRP) LTC application (EB-2024-0200) was filed with the OEB on June 17th, 2024.

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2. Actions Taken Since Initial Denial to Ensure Safe Operation

Table 1 - Inspections / Surveys and Remedial Actions

Inspections / Surveys	Immediate Remediation Actions
In-Line Inspections (ILIs) using axial MFL technology to identify corrosion defects on the pipeline	Emergency mitigation of significant features identified by ILI including one metal loss with a depth estimated greater than 80% of NWT[2], multiple metal loss features with depths estimated greater than 50% of NWT[2], significant dents >= 2% of OD[3], and dents with possible gouging.
In-line inspections (ILIs) using MFL technology to identify gouges on the pipeline	Enhanced Third-Party Damage (TPD) Prevention barriers[4] implemented in 2023, following the results of the QRA: ▪ Installed additional pipeline markers ▪ Established ongoing ROW patrols on a daily frequency ▪ Added the SLP to Vital Main Standby Program ▪ Initiated a targeted public awareness campaign
In-line inspections (ILIs) using LDS technology to identify deformations on the pipeline	
Depth of Cover survey	
CP Surveys, such as Direct Current Voltage Gradient (DCVG) and Close-Interval Potential Surveys (CIPS).	CP team investigated and increased rectifier outputs to improve levels of cathodic protection
Accelerated Leak detection from once every four years to twice a year and carried out enhanced leak surveys through a specialized vendor.	Identification and remediation of a pinhole leak on a Line-Stopper Fitting

- These **efforts have temporarily reduced, but not eliminated, SLP's high risks** until a permanent solution can be implemented as soon as practicable. The pipeline's threats have been mitigated

[2] Nominal Wall Thickness
[3] Outer Pipe Wall Diameter
[4] See Decision Record for the assessment of most effective mitigation actions (St. Laurent Pipeline Third-Party Damage Threat – Temporary Mitigation Plan – May 2023)

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to a level where it can be **considered fit-for-service on an ALARP basis[5] in the short-term contingent on the fact that the permanent solution is implemented as soon as practicable.**

- However, **significant integrity actions will be required if the replacement project is not initiated** as soon as practicable, which currently stands as 2025 for the Tremblay Lateral and 2026 for the St. Laurent and Sandridge sections.
- The current fitness-for-service assessment of the pipeline is detailed in the latest SLP Integrity Plan attached to this memo, which is effective from January 1st, 2024.

3. Permanent Risk Mitigation Strategy and Timelines

The SLP pipeline is deemed conditionally fit-for-service until the soonest practicable date for permanent mitigation, following the immediate actions described above. The revised LTC application has been completed on an expedited basis despite its scope and complexity while maintaining temporary risk mitigations and demonstrating due diligence. Below are the key elements influencing the mitigation strategy and timelines.

Priority and Schedule:

- The replacement project was developed with priority placed on replacing the highest-risk segments. As such, the Tremblay Lateral segment, the highest risk segment for corrosion and third-party damage, is scheduled for replacement with a planned in-service date of 2025. The remainder of the pipeline is planned to be replaced with an in-service date of 2026.
- Despite the accelerated development of the replacement LTC application, additional time was required due to heightened OEB requirements. These requirements necessitated extraordinary additional efforts and the adoption of innovative methods to evaluate risks, review alternatives using advanced probabilistic financial models, and build scenarios to assess the pipeline's projected useful life.

Temporary Mitigation Approach and Effectiveness:

- The mitigation strategy for the SLP aligns with approaches used for mitigating identified "High Risks" in other Integrity programs. For example, "High Risks" identified through the quarterly system-wide risk evaluations for all GDS transmission assets are assigned practical and risk-appropriate mitigation actions until a permanent mitigation strategy is developed. Some examples include scheduling EMAT inspections for high risks driven by SCC as soon as practicable or installing pipeline markers for high risks driven by TPD to reduce risk to ALARP, when adequate.

[5] ALARP (As Low As Reasonably Practicable) in pipeline risk assessments refers to reducing risks to a level that is as low as reasonably achievable, taking into account the costs, benefits, and practicality of further risk reduction measures.

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- Starting construction in 2025 will significantly reduce the risk of TPD. GDS's substantial presence in the area of the SLP while planning and executing the replacement project ensures constant oversight and immediate detection of any construction activities near the existing main. Additionally, once GDS obtains the necessary permits and construction is initiated, it will be more challenging for other third parties to secure the permits needed to begin work, which would minimize the TPD risks[6] identified in the risk assessment.
- If the replacement is not approved with an in-service year of 2025 and 2026, the following Integrity-driven actions will need to be initiated as soon as practicable to reduce the pipeline risks, as detailed in the SLPRP LTC application[1]:
    - Additional integrity digs meeting the EDIMP Dig Criteria or exceeding reliability targets will need to be completed on the inspected portion of the SLP.
    - Retrofits and inspections will need to be conducted on 4.6km of uninspected portions of the pipeline, with an uncertain number and location of resulting digs.
    - Installation of mechanical protection barriers and targeted replacements to mitigate the significant TPD threat.
    - Repair of anomalies on the SLP bridge crossing
- The heightened risks of the pipeline expose the company to an accumulation of risk if the status quo remains for multiple years. Maintaining high levels of risk when permanent risk mitigation strategies are practicable does not align with GDS's commitment to safety and operational reliability.

Impacts of extending permanent mitigation timeline:

- Unlike deterministic assessments that yield binary results (e.g., safe or unsafe), risk assessments provide a range of possible outcomes with various uncertainties. The risk assessment on the SLP demonstrates that the corresponding risks exceed multiple industry and company risk or reliability thresholds.
- Current mitigation actions conditionally reduce the risks temporarily but do not bring them to acceptable levels on a longer-term basis. This necessitates assigning appropriate risk mitigation strategies to reduce risks to as low as reasonably practicable, in line with industry and company best practices.
- The replacement project is the most effective and most practicable risk mitigation strategy from a safety, risk mitigation, and financial perspective. While the risk assessment does not prescribe a specific replacement date since the risk thresholds have already been exceeded, it is essential for GDS to demonstrate that it has exerted all practicable efforts to reduce the risk to acceptable

[6] The high TPD risks on the SLP are driven by high levels of observed hits from ILI data, very low material toughness as measured through lab testing, areas with low depth of cover, and the consequences of damage failures in an urban setting.

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levels as soon as practicable, as a demonstration of due diligence and in line with its value of safety. Therefore, any delay in initiating the project would fail to meet this requirement.

4. Conclusions

By taking several comprehensive measures since the date of the OEB denial in May 2022 and increasing the monitoring of the asset, GDS has ensured that the pipeline is fit for operation on a conditional and temporary basis. The comprehensive approach, which implements both temporary and long-term mitigations, demonstrates the company's due diligence and its commitment to safety and operational reliability. As part of its unrelenting focus on safety and reliability, **GDS categorically supports implementing a permanent solution that reduces the risk to acceptable levels as soon as practicable**. Based on a comprehensive assessment of alternatives, which considers risks and costs, the **most effective solution for the SLP system is to replace the pipeline on a prioritized basis as soon as practicable, as reflected in the SLPRP LTC application[1].**

Task	Name, Title	Date
Prepared by:	Miaad Safari, Technical Manager, Integrity	June 21, 2024
Reviewed by:	Ryan Werenich, Manager, Integrity Programs - Pipelines	June 21, 2024
Approved by:	Mohamed Chebaro, Director, Integrity and Risk	June 26, 2024
Recipient:	Tracey Teed Martin, VP Engineering & Integrity	June 26, 2024
Recipient:	Heidi Bredenholler-Prasad, VP & Chief Customer Officer	June 26, 2024
Recipient:	Jim Sanders, SVP Enterprise and Utility Integration	June 26, 2024

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Attachment #1 –
SLP Integrity Plan

NPS 12/16 St. Laurent Pipeline Integrity Plan

Level: Level IV

Pipeline Region: Eastern

Effective Date:

January 1, 2024

Expiry Date:

December 31, 2025

Report

—

Company: Gas Distribution and Storage

Owned by: EDIMP

Controlled Location: EDIMP Teamsite

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Contents

NPS 12/16 St. Laurent Pipeline Integrity Plan

Purpose

This document evaluates if the NPS 12/16 St. Laurent pipeline is fit to continue operating at its established Maximum Operating Pressure (MOP) of 275 psig based on the findings of the condition monitoring and Integrity digs. This report will also determine the timeframe for which the Fitness for Service assessment of this report is valid and will describe the future Integrity Plan for the subject pipeline.

Scope

This Integrity Plan is a short and medium term forecast of the fitness for service of the pipeline, focusing on the integrity activities required to maintain the pipeline's fitness for service.

This report does not evaluate the fitness of the pipeline to supply sufficient gas to meet customer demand. This report also assumes that regular maintenance and operational activities such as right of way surveys and CP monitoring are being conducted as per company standards, and therefore does not provide recommendations on the continuation of these standard activities.

Background

The St. Laurent Pipeline is part of the Enbridge Gas Inc. natural gas distribution system for the City of Ottawa and Gatineau and consists of steel mains primarily installed in 1958. The main pipeline characteristics are summarized in the table below. Specific pipe details are referring to the majority of pipe assets that make up the pipeline and may not be the properties for the entire pipeline.

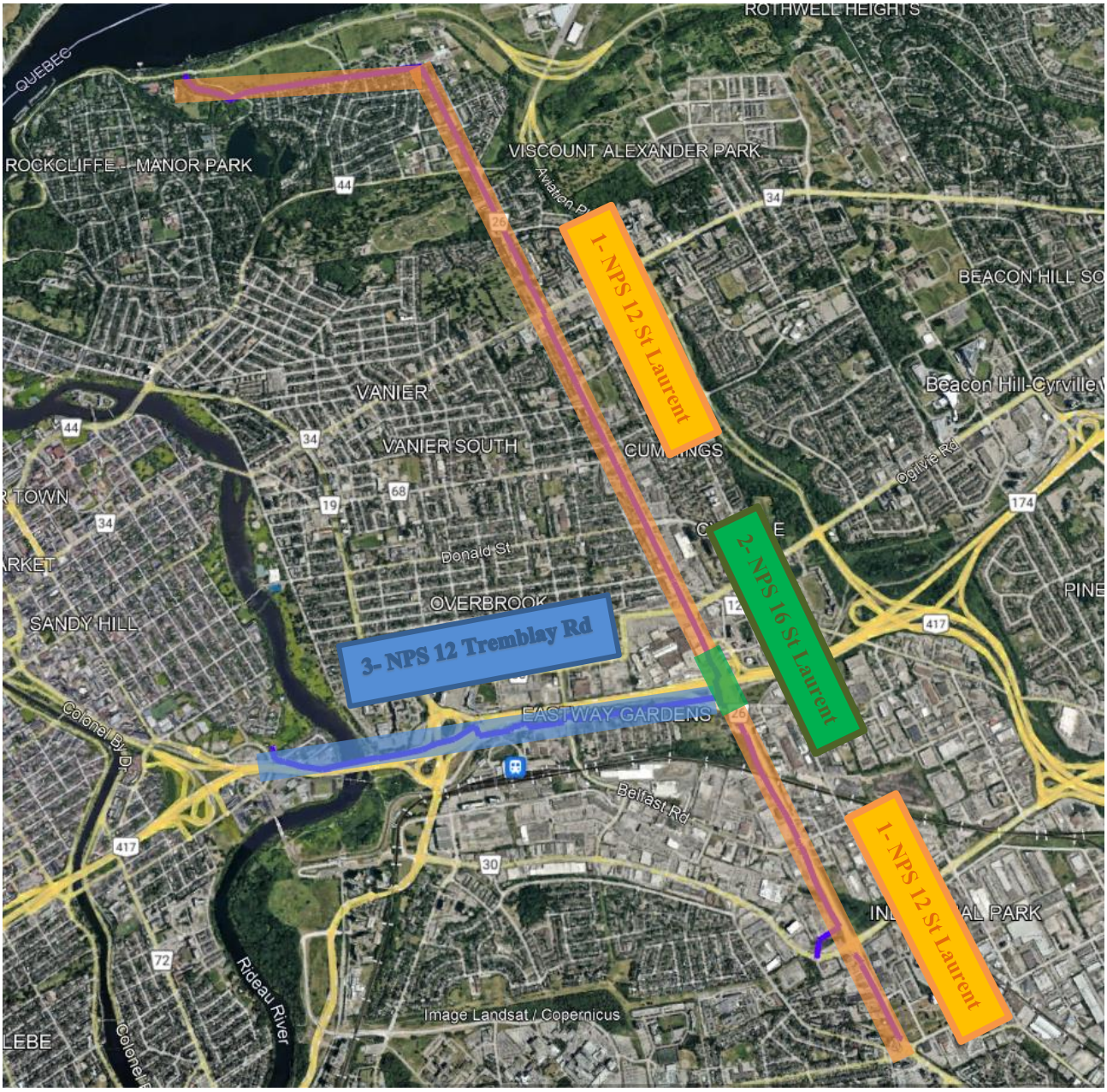
Table 1: Pipeline Summary

Attributes	Details on Record	Assumed Values	Comments
Region	Eastern		
Install Year	1958		Comprised of 363 m installed in 1985 of NPS 16
NPS	12/16		3.4 % NPS 16 96.6 % NPS 12
Pipe Grade		207 MPa	Records indicating pipe grade are unavailable for the original pipeline installation, therefore, a grade of 207 MPa is assumed based on pipe vintage and the company's historical purchasing practices.
Wall Thickness	6.35 mm		
Pressure Class	XHP		
Length	11,113 m		Based on asset lengths provided in the GIS attribute data
MOP	1900 kPa/ 275 psi		
Operating Pressure	1900 kPa/ 275 psi		
Max. % SMYS		23%	Based on the assumed grade
Coating Type	Coal tar		
Seam Type	ERW		
Corrosion Protection (CP) Type	Rectifier/ Anode		96% Rectifier 4% Anode

Table 2: Pipeline Section Summary

Pipeline Section Number	Pipeline Section Type	Length (km)	Comments
1	T (Trunk)	8.0	NPS 12 St. Laurent
2	T (Trunk)	0.4	NPS 16 St. Laurent
3	B (Branch)	2.7	NPS 12 Tremblay Rd. Lateral

Figure 1: Pipeline Route



Crossings

The following crossings are present along the St. Laurent pipeline.

Water Crossings:

There is a single water crossing at Rideau River along Highway 417.

Bridge Crossings:

There is a single bridge crossing along St. Laurent Blvd at Highway 417. The inspection conducted in 2020 recommended the mitigation of disbonded coating of 3.77 m long starting from the south end of the pipe which is demonstrated in Figure 2. Another inspection of the bridge crossing completed in 2022 did not identify any visible signs of corrosion. The only observation identified as part of this inspection was misaligned alignment guides and fiber-reinforced polymer pads. During the 2023 scheduled repair, numerous corrosion anomalies were found along the bridge crossing. The Enhanced Distribution Integrity Management Program (EDIMP) department and Pipeline Engineering were consulted to complete an assessment of the pipeline. The results of the assessment indicated that repairs to the pipeline could be safely delayed until 2027, considering the broader remediation actions planned for this system.
Additionally, there is a crossing over the LRT north of Tremblay Rd and Pickering Pl.

Figure 2: Bridge crossing disbonded coating

Rail Crossings:

There is a single rail crossing with the Canadian Pacific Railway along St. Laurent Blvd between Tremblay Rd and Belfast Rd. There are no currently available inspection details of the rail crossing.

Highway Crossings:

The St. Laurent pipeline crosses HWY 417 at two points, one crossing at St. Laurent Blvd and the second at Pont Max Keeping pedestrian bridge along Tremblay Rd.

Aerial Crossings:

There are no aerial crossings.

Alternating Current (AC) Crossings:

There are three AC crossings along St. Laurent. The first one is north of Highway 50, the second one is at Industrial Ave., and the third one is at Tremblay Rd and Belfast Rd. intersection.

Direct Current (DC) Crossings:

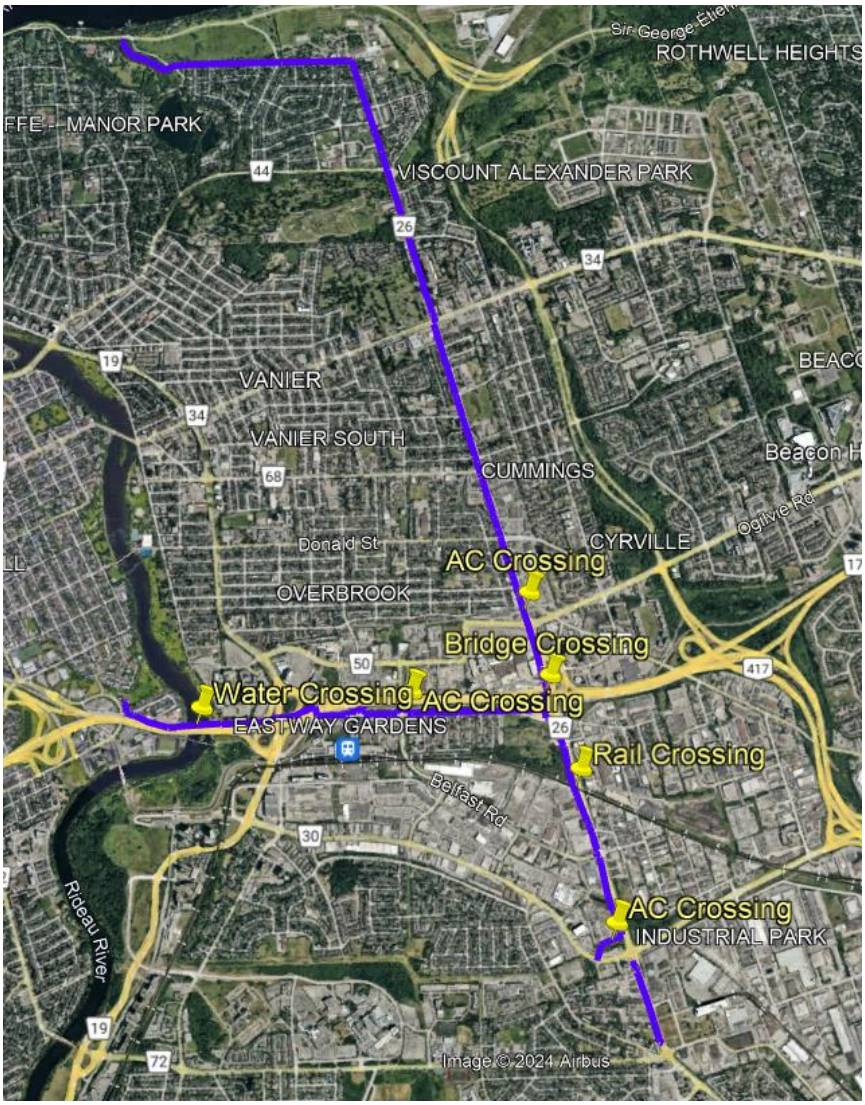
The CIPS/DCVG survey done on the NPS 12 St. Laurent displayed significant fluctuations due to stray current influence from the Ottawa Light Rail Transit (LRT). The area between Rideau River (Ch. 637.0 m) and the off-ramp at Highway 417 (Ch. 2792.4 m), was the area most significantly impacted by the high level of stray current.

Exposed Piping:

There is no exposed piping reported along the St. Laurent pipeline. The only pipe exposed to atmospheric conditions is at the bridge crossing north of Hwy 417 along St. Laurent Blvd, but it is specifically designed, coated, maintained, and inspected as such.

The controlled version is located on the EDIMP Shared Drive. All copies are uncontrolled. © Enbridge Gas Inc.

Figure 3. Map of St. Laurent Pipeline Crossings



Condition Monitoring History

Table 3 summarizes the available historical reports that were produced to date.

Table 3: Survey Summary

Year	Survey Type	Vendor
2022	2022 CIPS + DCVG Report + Depth of Cover	CSCL
2022	2022 NPS 12 St Laurent Integrity Dig Reports	NDT Group
2022	2022 NPS 16 Bridge Crossing Inspection	Acuren
2020	2020 NPS 16 Bridge Crossing Inspection	Acuren
2017	2017 Depth of Cover Survey	G-Tel Engineering
2014	2014 Integrity Digs Feature Assessment	Acuren
2013	Non-destructive Testing – 12” St. Laurent Pipeline	Acuren

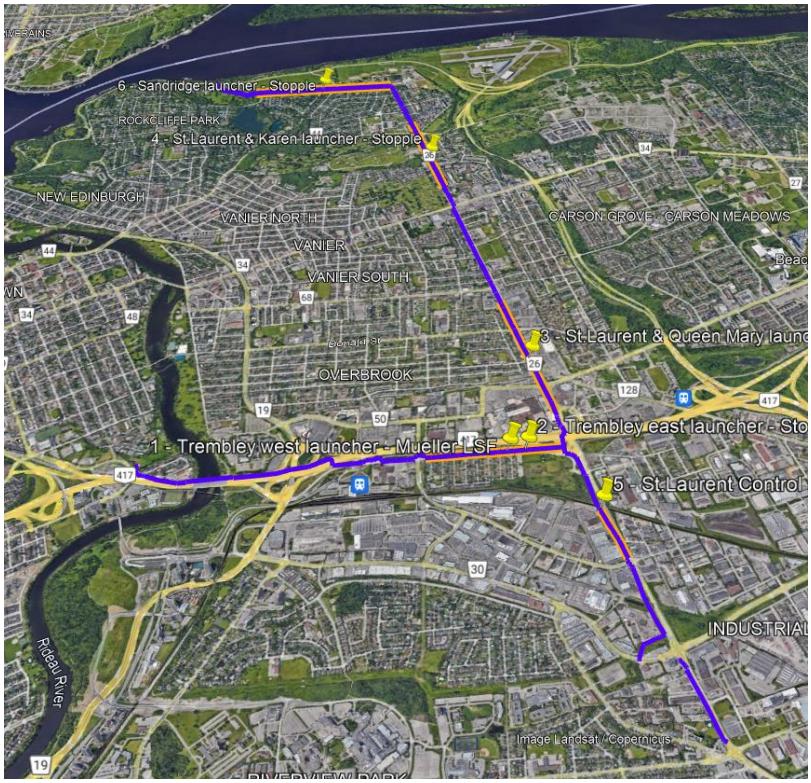
Nine ILI runs across six launch sites were completed. Table 4 summarizes the locations, number of runs, and total distance inspected per launch site. Figure 4 shows the pipeline

sections that were inspected highlighted in orange; the yellow pins identify the launch point locations. The sections inspected were selected based on the following pipeline characteristics: install year, corrosion area, fitting density class, and coating type, to aim for a sample size that is representative of the pipeline, including the non-inspected portions.

Table 4. 2022–MFL-Intero Inspection Launch Sites and Inspected Distance

Launch Site	Runs	Distance (m)
1- Tremblay West	1	545
2- Tremblay East	1	315
3- Queen Mary	2	1,116
4- Karen Way	2	953
5- Control Station	1	393
6- Sandridge	2	1,157
Total	9	4,479

Figure 4. 2022–MFL-Intero Inspections Sections



Inline Inspection Results

The ILIs were performed in August 2022, with the Intero NPS 12 crawler inspection tool which uses Magnetic Flux Leakage (MFL) technology to detect metal loss anomalies and a Laser Deformation Sensor (LDS) to detect dents. A video camera was used to determine general pipeline conditions and whether corrosion was internal or external. As part of a cut-out repair, one Phase 1 and two Phase 2 anomalies were remediated. Table 5 describes the summary of the ILI reported clustered metal loss features and Table 6 describes a summary of reported deformations.

Table 5: 2022-MFL-Intero Summary of Results – Metal Loss

Pipeline Segment	ILI Run Length (m)	Clustered Metal Loss Features (% Wall Loss)								
		10% ≤ Depth < 20%	20% ≤ Depth < 30%	30% ≤ Depth < 40%	40 % ≤ Depth < 50%	50 % ≤ Depth < 60%	60% ≤ Depth < 70%	70% ≤ Depth < 80%	≥80%	TOTAL
Tremblay East	315	65	15	11	1	1	0	0	1	94
Tremblay West	545	19	0	0	0	0	0	0	0	19
Queen Mary	1,116	101	8	5	4	1	0	0	0	119
Karen Way	953	13	0	0	0	0	0	0	0	13
Control Station	393	63	8	3	1	0	0	0	0	75
Sandridge	1,157	5	1	1	0	0	0	0	0	7
TOTAL	**4,479**	**266**	**32**	**20**	**6**	**2**	**0**	**0**	**1**	**327**

Table 6: 2022-MFL-Intero Summary of Results – Dent

Pipeline Segment	ILI Run Length (m)	Dents (% of OD)				Dents of Interest		
		<2%	2-4%	>4%	TOTAL	Top Side Dents	Dents With Metal Loss	Sharp Dents
Tremblay East	315	18	2	1	21	14	6	5
Tremblay West	545	57	3	0	60	39	3	6
Queen Mary	1,116	99	4	1	104	76	4	9
Karen Way	953	84	4	0	88	57	0	18
Control Station	393	20	0	0	20	16	1	4
Sandridge	1,157	93	0	0	93	72	0	4
TOTAL	**4,479**	**371**	**13**	**2**	**386**	**274**	**14**	**46**

The ILI results were assessed using the EDIMP ILI Response Standard and a minimum of 12 features were selected for further field investigation as detailed in Table 7 and Table 8.

Table 7: Inline Inspection (ILI) Summary

Year	Inspection Technologies	Vendor	Digs by Phase				Validation Level
			1	2	3	4	
2022	NPS 12 crawler inspection tool using Magnetic Flux Leakage (MFL) Technology	Intero	1	3	0	0	Level 3
2022	NPS 12 crawler inspection tool using Laser Deformation Sensor (LDS) Technology	Intero	0	7	0	1	N/A

Table 8: Anomalies Meeting ILI Response Criteria

Launch Site	FID	Feature Type	Depth (%)	Length (mm)	Width (mm)	Clock Position	Phase	Repair Status
1- Tremblay West	62	Dent	2.7	52	71	00:49	2	Repaired
2- Tremblay East	107	Metal Loss	80+	17	16	07:36	1	Repaired
2- Tremblay East	85	Dent	6.2	183	150	10:00	2	Repaired
3- Queen Mary	172	Metal Loss on LSW*	33	22	77	03:22	2	Pending
3- Queen Mary	238	Metal Loss	52	30	130	06:26	2	Pending
3- Queen Mary	454	Metal Loss on LSW*	30	27	31	01:25	2	Pending
3- Queen Mary	515	Dent	4.9	107	161	02:18	2	Pending
3- Queen Mary	608/618	Dent	2.4/2.1	129/94	107/81	03:51/00:06	2	Pending
3- Queen Mary	724	Dent	2.0	102	86	09:55	2	Pending
3- Queen Mary	329	Dent	2.7	135	82	05:28	4	Pending
4- Karen Way	274	Dent	2.0	65	92	11:56	2	Pending
4- Karen Way	362/363	Dent	2.0/2.5	82/106	87/104	11:38/11:37	2	Pending

*Long Seam Weld (LSW)

Note: Additional Phase 4 features may be identified as a result of field findings, as described below:

- Additional corrosion features near the depth acceptance limits may require further investigation due to possible tool under-calling biases.
- Dents reported with metal loss may require investigation if the tool is deemed to not reliably differentiate between corrosion and gouging.

Integrity Dig Summary

The integrity dig summary shows the occurrences of hazards found during integrity digs. Individual digs may be counted more than once if multiple hazards were found. Detailed dig and hazard information is included in the Hazard Assessment.

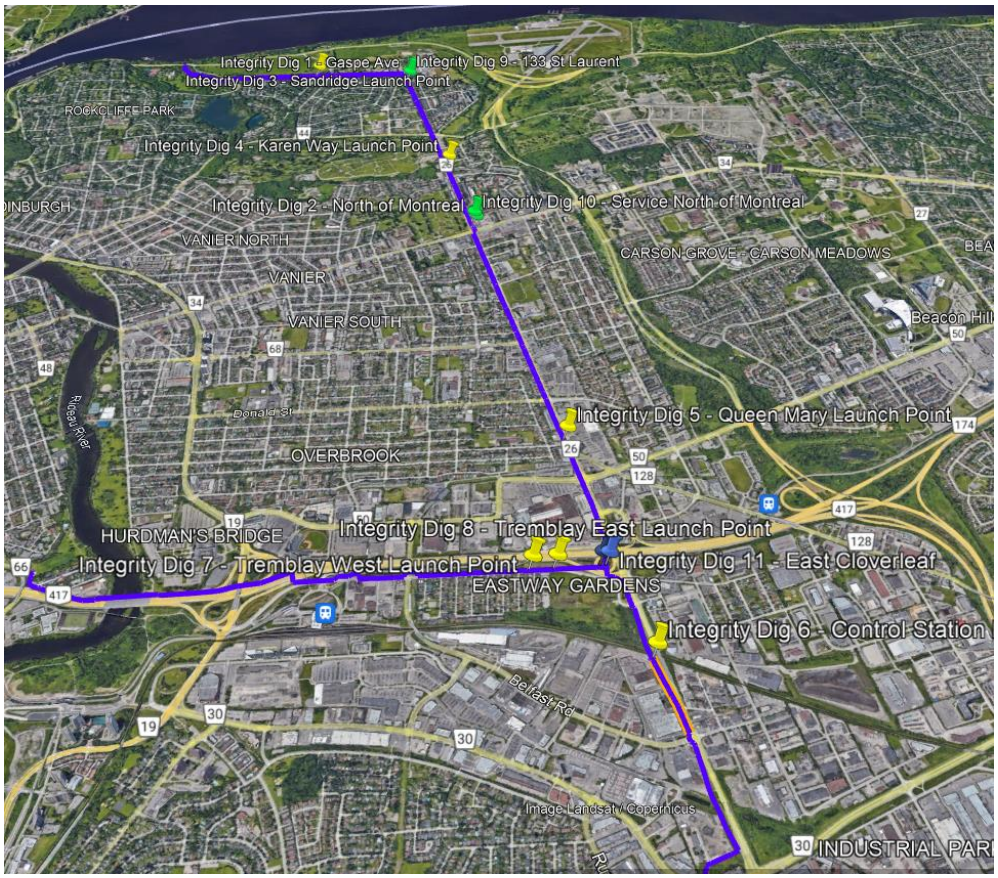
A total of 13 integrity digs were performed in 2022- 2023 including at each ILI launch site.

In March 2023, an integrity dig was completed on the line near Rockcliffe Control Station. The dig was executed as part of a leak repair on the pipeline. After the leak was remediated, an investigation of the pipeline directly where initial readings were recorded was conducted. A coating assessment, X-ray, and Non-Destructive Examination (NDE) were conducted. This integrity dig is identified as Dig Site 13.

In addition to those features, the NDE reported one scab on the ERW long seam, three OD connected linear indications in the long seam with a maximum depth of 6% of the actual wall thickness, and one girth weld defect.

Figure 5 identifies the location of the integrity digs. Yellow pins represent launch sites, green and blue pins represent digs at points of interest.

Figure 5. Map of St. Laurent Pipeline Integrity Digs

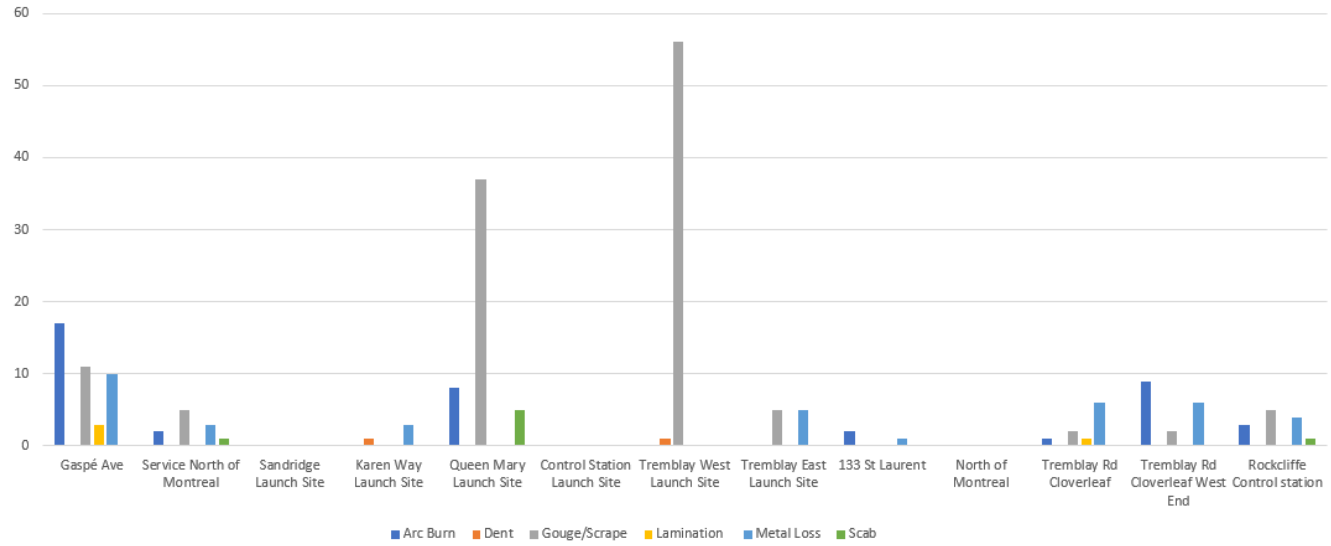


NDT Group Inc. performed the field direct assessments at the thirteen integrity dig sites. Table 9 and Figure 6 summarize the features discovered at those digs.

Table 9. Summary of Integrity Dig Findings

Dig Number	Row Labels	Arc Burn	Dent	Gouge/ Scrape	Lamination	Corrosion	Scab	Total
1	Gaspé Ave	17		11	3	10		41
2	Service North of Montreal	2		5		3	1	11
3	Sandridge Launch Site							0
4	Karen Way Launch Site		1			3		4
5	Queen Mary Launch Site	8		37			5	50
6	Control Station Launch Site							0
7	Tremblay West Launch Site		1	56				57
8	Tremblay East Launch Site			5		2		10
9	133 St Laurent	2				1		3
10	North of Montreal	No NDE Assessment was completed						
11	Tremblay Rd Cloverleaf	1		2	1	5		10
12	Tremblay Rd Cloverleaf West End	9		2		6		17
13	Rockcliffe Control station	4		5		4	1	13
TOTAL		43	2	123	4	34	7	213

Figure 6. Integrity Dig Summary by Hazard



All defects were assessed for repair as per the Gas Distribution and Storage (GDS) Distribution Steel Pipeline Repair Standard. For details on repairs executed refer to the NDE report.

Failure History

The Historical Failure Data files have been utilized to determine failures, damages, and potential hazards on the pipeline. The Failure and Repair History is shown in Table 10 which includes the summary of 24 repairs between 2007 and 2023. Reporting of failures started in 2007, therefore any previous failure reports on this pipeline are unavailable.

Nine (9) repairs were due to Leaks and fifteen (15) repairs were due to Damage/Potential Hazard. Table 10 contains descriptions of each failure or repair: one leak in the pipe body, three leaks in Service Line Connections, five leaks in Valve stems, and fifteen Damages/Potential Hazards.

Table 10: Failure and Repair Summary

Date	Description	Hazard/Anomaly Category	Failure Type
Feb 23, 2007	Sleeve welded on corroded section of pipe on St Laurent south of Tremblay Rd.	External corrosion	Potential Hazard
Jun 11, 2012	Sleeve welded over dent on the main on Tremblay Rd	External Interference	Damage
Sept 25, 2013	Corrosion Class A Leak on the main on Tremblay Rd asset 77857	External corrosion	Failure Incident (Leak)
Nov 10, 2013	Sleeve welded over damaged main asset 3577741 on Hwy 417	External Interference	Damage
Nov 18, 2013	Repaired damaged main asset 76852 on Tremblay Rd and Hwy 417	External Interference	Damage
Mar 28, 2014	Three sleeves welded on dents with corrosion on the main at St Laurent NPS 16 Hwy crossing	External Interference	Damage
Mar 12, 2016	Leak on valve stem on asset 499271	Equipment Malfunction	Failure Incident (Leak)

Feb 23, 2017	Leak on valve stem on asset 499283	Equipment Malfunction	Failure Incident (Leak)
Apr 12, 2017	Class A Leak at CVT on Tremblay Rd asset 751388	Equipment failure	Failure Incident (Leak)
Aug 23, 2017	St Laurent and Cote Rd, coating repaired after 3rd Party Damage	External interference	Damage
May 29, 2019	Leak on valve stem on asset 8519960	Equipment Malfunction	Failure Incident (Leak)
Apr 22, 2020	Leak on valve stem on asset 1417068	Equipment Malfunction	Failure Incident (Leak)
May 18, 2022	Leak at CVT service connection on main asset M119218349	Equipment Malfunction	Failure Incident (Leak)
May 05, 2022	Leak on valve stem on asset 501309	Equipment Malfunction	Failure Incident (Leak)
May 19, 2022	Leak at CVT service connection on main asset 101782	Equipment Malfunction	Failure Incident (Leak)
Sep 24, 2022	Dig #1: Cut-out replacement for remediation	External corrosion/ External Interference/Construction/ Manufacturing	Potential Hazard
Oct 30, 2022	Dig #2: Grind repairs were performed on reported anomalies	External corrosion/ External Interference/Construction/ Manufacturing	Potential Hazard
Aug 22, 2022	Dig #4: Sleeve was used for the repair	External corrosion/ External Interference	Potential Hazard
Sep 12, 2022	Dig #5: Grind and sleeve repairs were performed on reported anomalies	External Interference/Construction/ Manufacturing	Potential Hazard
Aug 15, 2022	Dig #7: Cut-out replacement for remediation	External Interference	Potential Hazard
Oct 4, 2022	Dig #8: Grind and Sleeve repairs were performed on reported anomalies	External corrosion/ External Interference	Potential Hazard
Aug 17, 2022	Dig #9: Grind repairs were performed on reported anomalies	External corrosion/Construction	Potential Hazard
Nov 2, 2022	Dig #11: Grind, Sleeve repair and Cut-out replacement were performed on reported anomalies	External corrosion/ External Interference/Construction/ Manufacturing	Potential Hazard
Nov 18, 2022	Dig #12: Cut-out replacement for remediation (removing one Phase 1 and two Phase 2 anomalies)	External corrosion/ External Interference/Construction	Potential Hazard
March 13, 2023	Class C Leak at Line Stopper Fitting (LSF) south of Rockcliffe Station	Equipment Malfunction	Failure Incident (Leak)
March 30, 2023	Dig #13: Grind and Sleeve repairs were performed on reported anomalies	External corrosion/ External Interference/Construction/ Manufacturing	Potential Hazard

Changes from the Previous Integrity Plan

This is the second Integrity Plan for this pipeline. The first Integrity Plan was created to document the assessment work completed in 2022 before the ILI and was valid until December 31, 2023. This integrity plan is based on new ILI data completed in 2022 which was not included in the previous version. This Integrity Plan replaces the previous version with an effective date of January 1, 2024, when the previous version expired.

Hazard Assessment

This hazard assessment evaluates the failure susceptibility of the subject pipeline to the hazards that have been identified in the EDIMP Hazard Inventory. The hazard susceptibility is based on the Enbridge Risk Matrix failure likelihood classification levels. Refer to the Hazard Assessment document for the complete discussions of the individual hazards and details of the Enbridge Risk Matrix.

Table 11: Hazard Summary from Hazard Assessment Document

Hazard	Sub-hazard	Susceptibility
External Corrosion	General corrosion	High
	Interference corrosion	Likely
	Microbiologically induced corrosion	Remote
	Selective seam corrosion	Likely
Internal Corrosion	General corrosion	Remote
	Interference corrosion	Remote
	Microbiologically induced corrosion	Remote
	Selective seam corrosion	Likely
Internal Erosion	Particulate Erosion	Extremely Remote
Environmentally Assisted Cracking	Hydrogen Induced Cracking	Low
External Interference	Company contractor	High
	Company employee	High
	Collision Damage	Low
	Excavation damage	High
	Heavy machinery crossing	Remote
	Horizontal directional drilling damage	Intermediate
	Vandalism	Low
	Latent damage	High
Manufacturing	Pipe body defects	Likely
	Pipe seam defects	High
Construction	Branch connection/joint	Intermediate
	Circumferential weld defects	High
	Installation practices	Intermediate
	Overbending	Low
Hydrotechnical Hazards	Encroachment	Remote
	Scour	Remote
	Bank Erosion	Remote
Geotechnical	Frost Heave	Likely
	Soil subsidence/slope movement	Low
Weather	Lightning	Remote
Wildlife and Vegetation	Tree Root Encroachment	Intermediate

Hazard	Sub-hazard	Susceptibility
	Wild fire	Extremely Remote
Equipment Failure	Mechanical Fitting Malfunction	High
Incorrect Operation	Human error	Remote

Risk and Reliability

A risk assessment utilizing a defense-in-depth approach was conducted to evaluate the reliability and risk of the St. Laurent pipeline considering all applicable threats to pipeline integrity. Failure rates were calculated based on historical information and best practice reliability models and were compared to industry benchmarks.

The assessment supports the following conclusions:

- 3.6 km of the 11.2 km pipeline (32%) is assessed to have a small leak failure rate that is above the 1E-3 LLS limit described by CSA Z662 - Annex O.
- 7.0 km of the 11.2 km pipeline (62%) is assessed to have a large leak or rupture failure rate that is above the 5.8E-5 ULS limit described by CSA Z662 – Annex O for a NPS 12 pipeline at 275 psi MOP in a Class 3 (urban) location.
- Integrating the LLS and ULS approaches, 8.8 km of the 11.2 km pipeline (79%) fails one or both reliability limits.

In addition to benchmarking with industry standard CSA Z662 thresholds, an assessment was performed to compare the estimated significant incident rates on the St. Laurent pipeline to significant incident rates observed on typical distribution pipelines. This assessment concluded that the pipeline-specific significant incident rates for St. Laurent are orders of magnitude higher than the historical per km average observed in the industry.

To take into account the overall risks of a failure of the pipeline system, the quantitative reliability assessment was supplemented with consequences of various outcomes and mapped to the Enbridge Standard Operational Risk Assessment Matrix. This exercise concluded that various risk scenarios meet the Enbridge Operational Risk Matrix definitions of “High Risk” or “Very High Risk”.

Based on the combination of the three evaluation methods described, it is determined that remedial action is required to improve the reliability of 8.8 km of the St. Laurent pipeline system to meet industry benchmarks and the Enbridge enterprise's acceptable risk levels. This length is non-continuous and does not consider practical considerations of any possible remedial actions.

Lastly, a sensitivity analysis was completed to determine the impact various inputs or key assumptions would have on the results of the three approaches in which the pipeline condition was evaluated against absolute thresholds. The results of the sensitivity analysis showed that the recommendation made will not substantially change by applying unconservative assumptions/inputs into the various models.

Recommendation

It is recommended to continue with the following additional temporary mitigations that are already in place until permanent mitigation actions are completed. These actions are alleviating the pipeline's threats to a level where it can be considered fit for service on an As Low As Reasonably Practicable (ALARP) basis in the short term contingent on the fact that the permanent solution is implemented as soon as practicable.

- Increased CP system output
- Daily damage prevention patrols and vital main standby
- Semi-annual leak surveys
- Enhanced Public Awareness Campaign
- Additional pipeline markers

Fitness for Service Assessment

The fitness-for-service determination is based on the integration of the deterministic program-level condition assessments and probabilistic risk assessments. As per the Quantitative Risk Assessment (QRA), this pipeline requires immediate mitigation actions to bring the risks to tolerable levels. While the mitigation actions are being finalized (i.e., planned replacement), the following practical temporary mitigation measures are required to remain in place:

- Increased rectifier output to improve cathodic protection along the pipeline (addressing corrosion threat)
- Weekly damage prevention patrols and vital main standby (addressing third-party damage threat)
- Semi-annual leak surveys (addressing corrosion threat)
- Enhanced Public Awareness Campaign (addressing third-party damage threat)
- Additional pipeline markers (addressing third-party damage threat)

If the planned replacement is not approved with an in-service year of 2025 and 2026, the following Integrity mitigations must be completed by the end of 2025:

- the uninspected portions of vintage pipe are required to be inspected and further assessed based on inspection findings.
- a total of 19 excavations are required to be completed based on inspection findings, the EDIMP ILI response standard, and the risk evaluation criteria applied to the pipeline (8 EDIMP Phase 2, 1 EDIMP Phase 4, 10 Reliability-driven).

And the following mitigation must be completed by the end of 2027:

- the bridge crossing anomalies are required to be repaired.

The current EDIMP ILI Response Standard requires the excavations to happen by the end of 2024. However, based on the thorough risk evaluation, such limited remedial action would not reduce the full line's residual risk to an acceptable level. Therefore, in line with the risk assessment, the fitness for service is extended until the end of 2025 based on Enbridge's position for permanent remedial action options to replace the pipeline. The temporary mitigation measures in place which reduce the pipeline's risk to an ALARP level temporarily, do not change the need for the full replacement.

The pipeline is temporarily fit for service to operate at the current MOP on an ALARP basis with the additional temporary mitigations in place subject to the permanent solution implementation as soon as practicable (i.e., by 2025/2026 depending on the segment). This fitness for service assessment concurs with the Quantitative Risk Assessment dated April 24, 2023, and approved by the Director of Integrity and Senior Vice President of Operations and is valid until the end of 2025 or when new information is received warranting a re-assessment.

Revision History

Date	Summary of Changes	Prepared by:	Reviewed by:	Approved by:
June 21, 2024	Second Version- New template, additional information post-ILI and Digs	Azadeh Vatani Engineering Analyst-EDIMP	Arvind Chhabra Supervisor-EDIMP Miaad Safari Technical Manager-Integrity	Ryan Werenich Manager-Integrity Programs, Transmission and Enhanced Distribution
July 7, 2022	Initial Version	David Shaw Specialist- Integrity Safety Case	Fred Butrico Supervisor-DIMP	

References*

1- Quantitative Risk Assessment (QRA)-St. Laurent North Pipeline, April 24, 2023.

2- St. Laurent Integrity Actions Report by the Distribution Integrity Management Program (DIMP), May 5, 2023.

3- Bridge Crossing Inspection Report, October 5, 2020.

4- Visual Bridge Crossing Inspection Form, June 2, 2022.

5- Integrity Digs NDE Reports.

6- 2022 CIPS+DCVG Report, November 17, 2022.

7- EDIMP ILI Response Standard, May 2024.

*All references are confidential internal company documents.

Attachment #2 –

TPD Temporary Mitigation Decision Record

St. Laurent Pipeline Third-Party Damage Threat Temporary Mitigation Plan

Introduction

The St. Laurent Pipeline Quantitative Risk Assessment (QRA) has concluded that various sections of the pipeline have a reliability level that exceed the Annex O thresholds, primarily due to the Third-Party Damage (TPD) Threat. The Tremblay Lateral section is the primary segment of the pipeline above the thresholds, as shown in Table 1.

Table 1 - Average TPD Reliability by Section

Section	Length (km)	Large Leak Rate (/km.yr)	ULS (/km.yr)	Limit (/km.yr)	% of Limit
St. Laurent Boulevard	6.73	2.1E-03	4.5E-05	5.80E-05	78%
Sandridge Rd. Lateral	1.62	1.4E-03	3.0E-05	5.80E-05	52%
Tremblay Rd. Lateral	2.84	6.5E-03	1.4E-04	5.80E-05	241%

Additional actions can be taken as temporary measures to reduce the risk on the pipeline by implementing additional barriers to prevent third-party damage. The effectiveness of the additional barriers has been quantified by applying the C-FER TPD model[1], and its embedded barrier effectiveness ratings. This model is well established in the pipeline analytics industry and is the most widely used quantitative approach to assess TPD risks. A map of the pipeline sections is shown in Figure 1.

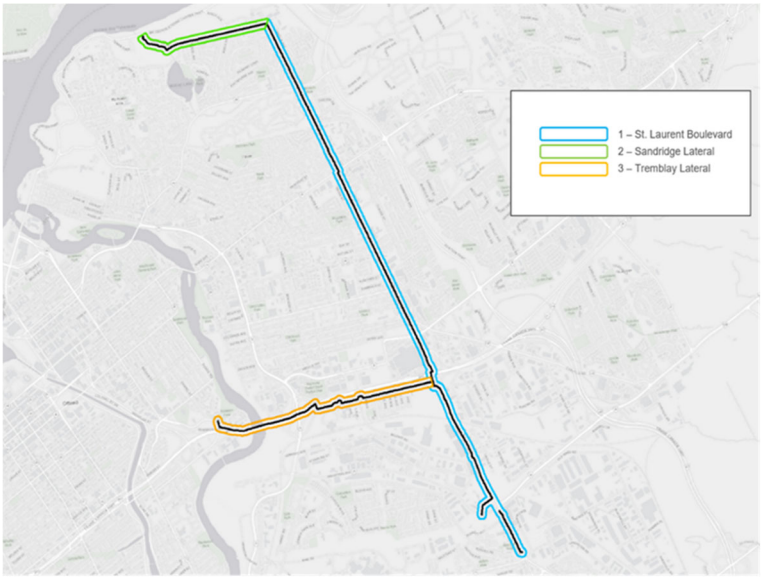


Figure 1 - Map of St. Laurent Pipeline Sections

[1] Q. Chen and M. Nessim, "Reliability-Based Prevention of Mechanical Damage," in Proceedings of the EPRG/PRCI 12th Biennial Joint Technical Meeting on Pipeline Research, Cambridge, UK, 1999

Assessment

There are two important factors that play a role in the effectiveness of a barrier:

1) the location of the barrier in the fault tree (i.e. factors that impact the fault tree at its ends have less impact on the TPD risk)
2) the effectiveness of other barriers in the same branch of the tree (e.g. if there are already strong public awareness barriers, additional public awareness activities will have diminished returns)

Given that the effectiveness of the barrier changes depending on other barriers, this assessment looks at the best barriers to implement in a stepped manner to select the proposed actions that with yield the most value.

Table 2 - Step 1 Barrier Effectiveness

TPD Barrier	Baseline E10	New E10	% Reduction
Daily ROW Patrols	0.2538	0.19256	24.1%
Increased Pipeline Markers	0.2538	0.2476	2.4%
Enhanced Public Awareness Campaign	0.2538	0.2292	9.7%
On-site Supervision (i.e., Vital Main Standby)	0.2538	0.2299	9.4%

Table 3 - Step 2 Barrier Effectiveness

TPD Barrier	Baseline E10	New E10	% Reduction
Assume Daily ROW Patrols in place			
Increased Pipeline Markers	0.19256	0.18926	1.7%
Enhanced Public Awareness Campaign	0.19256	0.1852	3.8%
On-site Supervision (i.e., Vital Main Standby)	0.19256	0.1668	13.4%

Table 4 - Step 3 Barrier Effectiveness

TPD Barrier	Baseline	New	% Reduction
Assume Daily ROW Patrols in place			
Increased Pipeline Markers	0.1668	0.1634	2.0%
Enhanced Public Awareness Campaign	0.1668	0.1592	4.6%
Assume On-site Supervision (i.e., Vital Main Standby)			

Table 5 - Step 4 Barrier Effectiveness

TPD Barrier	Baseline	New	% Reduction
Assume Daily ROW Patrols in place			
Increased Pipeline Markers	0.1592	0.15776	0.9%
Assume Enhanced Public Awareness Campaign			
Assume On-site Supervision (i.e., Vital Main Standby)			

As shown in Tables 2 to 5, the following barriers present the highest impact to reducing the TPD risk (in order of effectiveness):

- Daily ROW Patrols
- On-Site Supervision (i.e., Vital Main Standby)
- Enhanced Public Awareness Campaign

Based on the TOD fault tree and C-FER effectiveness ratings, increasing pipeline markers will have less impact to reducing the third-party damage risk. However, it would still be beneficial to install pipeline markers strategically where there is low measured depth of cover, where it is not cost prohibitive.

Residual Risk

The implementation of the four additional barriers described above will result in a reduction of the failure frequency of the pipeline by 38%. Table 6 outlines the residual risk of the system with the additional barriers in place.

Table 6 - Residual Risk/Reliability

Section	Length (km)	ULS (/km.yr)	Limit (/km.yr)	% of Limit	Reduction Factor	New Reliability
St. Laurent Boulevard	6.73	4.5E-05	5.80E-05	78%	37.8%	2.8E-05
Sandridge Rd. Lateral	1.62	3.0E-05	5.80E-05	52%	37.8%	1.9E-05
Tremblay Rd. Lateral	2.84	1.4E-04	5.80E-05	241%	37.8%	8.7E-05

Recommendation

It is recommended to implement immediate additional barriers or enhance existing barriers on the St. Laurent pipeline system to lower the risk of TPD. The recommended actions are to designate the pipeline as a "Vital Main" and implement the following enhanced TPD prevention barriers:

- Daily ROW Patrols
- On-Site Supervision (i.e., Vital Main Standby)
- Enhanced Public Awareness Campaign
- Increase Pipeline Markers

These actions are practicable in the short term and will reduce the risks associated with TPD by 38%; however, sections of the pipeline will still operate close or above the threshold. As such, a permanent mitigation such as replacement is still required in the long term to bring the TPD risk to an acceptable level. The temporary TPD risk mitigation actions will stay in place until construction on the line is initiated (pending approvals), however, the barriers will be lessened during the winter months where there is substantially less construction activity.

Task	**Name, Title**	**Date**
Recommended by	Miaad Safari, Technical Manager, Integrity	May 24, 2023
Reviewed by	Jean-Benoit Trahan, Director, Eastern Region Operations & Gazifere	May 24, 2023
Approved by	Michael McGivery, Director, Distribution Protection	May 24, 2023
Approved by	Mohamed Chebaro, Director, Integrity	May 26, 2023

ENBRIDGE GAS INC.

Answer to Undertaking from
Pollution Probe (PP)

Undertaking:

Tr: 103

To provide the live version of excel formulas related to the present value calculations.

Response:

The spreadsheets provided at Exhibit I.2-STAFF-17, Attachment 1 to 3 have been attached to this undertaking as Attachments 1 to 3. These versions of the spreadsheets include the live formulas to calculate present value.

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Please see Exhibit JT2.20_Attachment 1.xlsx on the OEB's RDS.

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Please see Exhibit JT2.20_Attachment 2.xlsx on the OEB's RDS.

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Please see Exhibit JT2.20_Attachment 3.xlsx on the OEB's RDS.

ENBRIDGE GAS INC.

Answer to Undertaking from
Pollution Probe (PP)

Undertaking:

Tr: 112

To provide a breakdown of the 2027 capital incurred costs.

Response:

Please refer to Table 1 for a breakdown of 2027 forecasted capital costs for the Full Replacement alternative, compared to the total overall project costs for each cost category. Indirect overheads and interest during construction have not been included.

Table 1

Item No.	Description	2027 Costs ($)	Total Costs ($)
1.0	Material Costs	145,782	4,341,774
2.0	Labour Costs	4,264,752	108,233,238
3.0	External Permitting, Land	78,812	1,705,250
4.0	Outside Services	1,116,949	14,396,581
5.0	Direct Overheads	697,298	3,139,152
6.0	Contingency Costs	931,671	20,686,962
7.0	Project Capital Cost	7,235,265	152,502,958
	Abandonment	7,384,529	8,886,878
	Total Project Cost including Abandonment	14,619,794	161,389,836

The 2027 project capital cost of $7,235,265 consists of the following tasks:

- Relay approximately 2 services
- Reconnect approximately 106 services
- Relight approximately 220 customers
- Reconnect to 7 district stations
- Restoration of approximately 5.3 km of sidewalks, roadways and boulevards.

Other activities incorporated in these costs include, but are not limited to, traffic control, non-destructive examination (NDE) costs (i.e., x-ray welds), environmental assessment/protection, temporary workspace, environmental inspection, project

inspectors, records, post construction monitoring reports, hydrovac, permits, and contingency.

The 2027 abandonment costs of $7,384,529 include the abandonment of 8.1 km of NPS 12 & 16 pipeline. Activities included in these costs are the abandonment/sectionalization of the existing pipeline, restoration, internal labour, records, project inspection, hydrovac, traffic control and permits.

ENBRIDGE GAS INC.

Answer to Undertaking from
Pollution Probe (PP)

Undertaking:

Tr: 117

To confirm DNV proposal was attached to contract provided in pollution probe-24, attachment 4.

Response:

Confirmed.

ENBRIDGE GAS INC.

Answer to Undertaking from
Pollution Probe (PP)

Undertaking:

Tr: 126

To consider whether to file the draft report; and if not prepared to file the draft report, to respond accordingly.

Response:

As a policy, DNV generally does not release drafts because they may represent incomplete data or intermediate conclusions. Therefore, Enbridge Gas is declining to provide a draft report, and takes the position that any such prior draft would be irrelevant

ENBRIDGE GAS INC.

Answer to Undertaking from
Ontario Energy Board Staff (STAFF)

Undertaking:

Tr: 133

To report if it had requested a TSSA assessment of fitness for service for other integrity management projects

Response:
As far as Enbridge Gas is currently aware, it has not identified other instances where it requested the TSSA to complete an assessment of fitness for service for other integrity management projects.

The TSSA, however, does carry out cyclical audits on the Integrity Management Program at Enbridge Gas.

ENBRIDGE GAS INC.

Answer to Undertaking from
Ontario Energy Board Staff (STAFF)

Undertaking:

Tr: 142

What is the minimum acceptable Charpy value by the Z662 code?

Response:

For new pipe installations such as the proposed replacement SLP pipeline, the current version of the CSA Z662 Code references CSA Z245.1 for fracture toughness requirements. Category I pipe does not require proven notch toughness properties.[1] Category II pipe must exhibit a minimum absorbed energy of 27 J in the pipe body for diameters smaller than 457 mm, and 40 J for pipe diameters 457 mm or larger.[2]

The proposed replacement pipe for the St. Laurent Project will primarily consist of NPS 12 (CSA Z245.1, Category I) pipe and NPS 16 (CSA Z245.1, Category II) pipe. Therefore, the proposed NPS 16 pipeline must exhibit a minimum absorbed energy of 27 J in the pipe body.

[1] CSA Z662-23, Clause 5.2.2.1.
[2] CSA Z662-23, Table 5.1.

ENBRIDGE GAS INC.

Answer to Undertaking from
Ontario Energy Board Staff (STAFF)

Undertaking:

Tr: 165

To provide, on a best-estimates basis, the timeline for the Rockcliffe route and Rockcliffe station location.

Response:

The proposed Rockcliffe Control Station location on the Ottawa New Edinburgh Club property, on Rue Tennis, was identified by the National Capital Commission (NCC) based on discussions/negotiations with Enbridge Gas. Although this site has been established as a potential location, further public consultation and engagement will be required for the Rockcliffe Control Station location project to fulfill the appropriate application processes with the Ontario Energy Board (OEB), the Canadian Energy Regulator (CER) and the NCC's Federal Land Use, Design and Transaction Approval (FLUDTA).

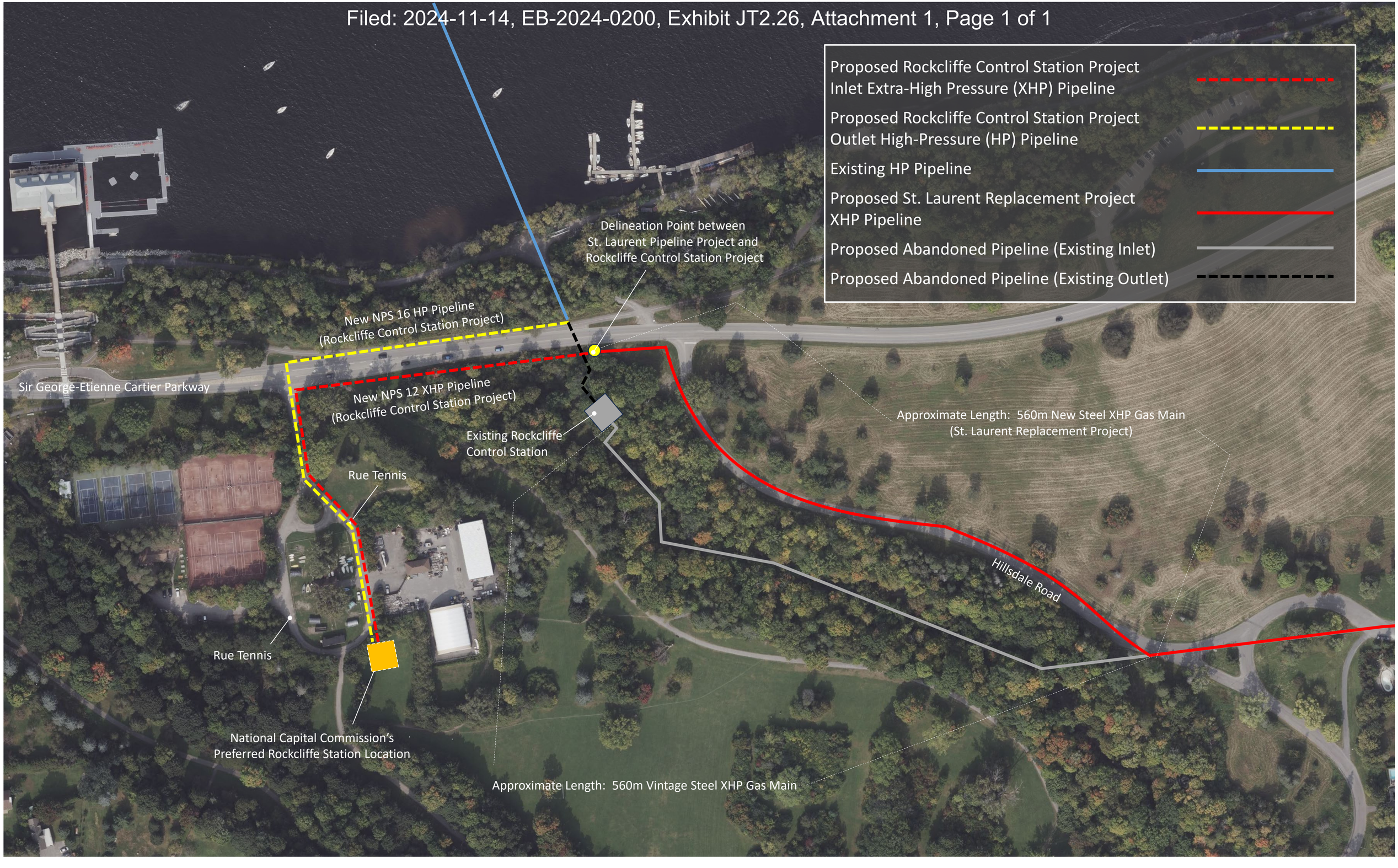
At this time, Enbridge Gas's best available information is that the preferred route for the St. Laurent Pipeline through Rockcliffe Park to serve the proposed Rockcliffe Control Station location is along Hillsdale Road to Sir George-Etienne-Cartier Parkway.[1] This would be the delineation point between the St. Laurent Pipeline Project and any future pipeline installation required as part of the Rockcliffe Control Station project. This route is illustrated in Attachment 1. This route is within the study area of the Environmental Report and has no incremental impact on Project cost.

Finalization of the Rockcliffe Control Station location and associated project details are dependent on the OEB's decision for this Application. If the St. Laurent Pipeline Replacement Project is approved by the OEB, Enbridge Gas will resume planning activities for the Rockcliffe Control Station project, including consultation with the public and other stakeholders, promptly upon OEB approval. Assuming the Rockcliffe Control Station project location does not change from the site identified by the NCC, Enbridge Gas would install the pipeline assets for the St. Laurent Pipeline Replacement Project

[1] TR October 31, p. 164

as described above (and as shown in Attachment 1) in Q4 2026. If the St. Laurent Pipeline Project is denied by the OEB, the Rockcliffe Control Station project will be re-assessed.

The expected execution for the Rockcliffe Control Station project would be Q2 2027 with expected energization in Q4 2027.


Proposed Rockcliffe Control Station Project
Inlet Extra-High Pressure (XHP) Pipeline
Proposed Rockcliffe Control Station Project
Outlet High-Pressure (HP) Pipeline
Existing HP Pipeline
Proposed St. Laurent Replacement Project
XHP Pipeline
Proposed Abandoned Pipeline (Existing Inlet)
Proposed Abandoned Pipeline (Existing Outlet)
Delineation Point between
St. Laurent Pipeline Project and
Rockcliffe Control Station Project
New NPS 16 HP Pipeline
(Rockcliffe Control Station Project)
New NPS 12 XHP Pipeline
(Rockcliffe Control Station Project)
Sir George-Etienne Cartier Parkway
Existing Rockcliffe
Control Station
Approximate Length: 560m New Steel XHP Gas Main
(St. Laurent Replacement Project)
Rue Tennis
Rue Tennis
Hillsdale Road
National Capital Commission's
Preferred Rockcliffe Station Location
Approximate Length: 560m Vintage Steel XHP Gas Main