DECOMMISSIONING TECHNICAL REPORT

1.1. Preface

As part of the Line 10 Westover Segment Replacement Project , Enbridge proposes to design and construct a replacement pipeline extending from Westover Terminal to Nanticoke Junction in Ontario. Enbridge is applying to replace an approximately 32 km segment of the 143 km Line 10, running from Enbridge's Westover Terminal to its Nanticoke Junction Facility in Hamilton, Ontario.

The existing segment of Line 10 to be decommissioned is an NPS 12 crude oil pipeline, in service since 1962. Enbridge proposes to decommission an approximately 32 km segment of Line 10 in place once the replacement segment is in service.

This Report discusses the technical aspects associated with the decommissioning process, and presents details on how Enbridge proposes to decommission the 32 km segment of Line 10 in place. A brief summary of the decommissioning scope activities is as follows.

1. Remove the product from the replaced segment of Line 10.
2. Clean the replaced segment of Line 10 to protect the environment.
3. Physically separate the replaced segment of Line 10 pipeline at Westover Terminal and Nanticoke Junction to permanently prevent oil from reentering the pipeline.
4. Segment the replaced portion of Line 10 by capping, plugging, or otherwise effectively sealing this portion of pipeline to prevent the creation of water conduits.
5. Continue to apply CP and monitor the existing ROW in perpetuity to identify, assess, and mitigate any potential future issues with the decommissioned segment of Line 10.

1.2. Introduction

This section describes the engineering details for the proposed decommissioning of the replaced 32 km segment of Line 10. Enbridge's decommissioning strategy is based upon an engineering assessment which considered the risks to the environment, the public and industrial users such as railway companies and utilities. This assessment included a detailed literature review, stakeholder consultation, application of mitigation strategies to risk items identified, and validation of the decommissioning plan by modeling and assessing current and expected future pipeline conditions. Revisions and refinements to the strategy are expected as additional data is collected, assessed, and integrated during detailed engineering. The proposed decommissioning strategy for the replaced segment of Line 10 will build on, and incorporate lessons learned from Enbridge's ongoing detailed engineering, testing and development programs for decommissioned pipelines.

Key areas for development in detailed engineering are summarized here and are more fully described below in the balance of this section. They include the following:

- Finalizing the logistics and field preparation activities for the displacement of crude oil shipped on the replaced Line 10 and cleaning of the pipeline.
- Identify locations for pipeline segmentation.
- Developing the ROW monitoring proposal for King's Highway and active railways.

Enbridge intends to file supplemental materials in the event that detailed engineering activities result in updates or modifications to the decommissioning plan as presented in this Application.

1.3. Decommissioning In Place

Ensuring public safety, minimizing environmental impacts and maintaining asset security is paramount to this decommissioning effort. After reviewing industry literature on decommissioning and completing additional assessments, which are described in greater detail below, Enbridge has determined that decommissioning the 32 km replaced segment of Line 10 in place is the most suitable approach from a technical and environmental perspective.

The decommissioned segment of Line 10 is expected to have a very long remaining life as a load bearing structure for supporting soil and surface loads. The results presented in the "Structural Integrity and Subsidence" section of this report indicate the replaced Line 10, once decommissioned, is predicted to maintain structural integrity for 500 years or more depending on site-specific conditions and the assumptions applied. This issue, along with others identified during the development of the decommissioning plan, is discussed throughout this section.

1.4. Decommissioning versus Abandonment

NEB-regulated pipelines must either be decommissioned or abandoned to permanently remove them from operation. The OPR define decommissioning as the permanent cessation of the operation of a pipeline, without a discontinuance of service. Conversely, abandonment involves cessation of operation of the pipeline resulting in the discontinuance of service. In this instance, and in accordance with the OPR, Enbridge is applying to decommission the 32 km replaced segment of Line 10 since that segment will be replaced and there will be no termination of service to Enbridge's customers as a result of removing the replaced segment of Line 10 from operation. As stated above, the replaced segment of Line 10 will not be returned to service after decommissioning. Should conditions arise the permanent cessation of the operation of the decommissioned segment of Line 10 is the best approach for the segment, Enbridge will apply for leave to abandon the segment pursuant to section 74 of the *National Energy Board Act*.

1.5. Guiding Industry Literature

While the retirement of the replaced segment of Line 10 comprises a decommissioning from a Regulatory perspective, it should be noted that a majority of industry guidance generally refers to pipeline “abandonment” rather than “decommissioning,” and the references and citations that follow use the terminology accordingly. Enbridge has also relied on this literature because, from a physical perspective, the activities associated with abandonment and decommissioning are the same. As part of the decommissioning plan for the replaced segment of Line 10, Enbridge will continue the application of CP to reduce the rate of corrosion degradation and will continue to monitor the pipeline ROW as per Enbridge’s ongoing operations and maintenance programs described in the “On-going Monitoring” Section of this report.

CSA, CEPA and the NEB recognize abandonment in place or through removal as viable options for retiring pipelines, and recommend a site-specific assessment for determining the appropriate plan.[1, 3, 4, 5, 6]

Enbridge considers ensuring public safety, minimizing environmental impacts, minimizing impact to the public generally and to landowners specifically, and maintaining asset security to be paramount factors to effectively decommission the replaced segment of Line 10. Both CEPA and the NEB have identified current and future land use as a key factor that must be considered in determining the most appropriate method for decommissioning.[1,3] CEPA developed the Pipeline Abandonment Matrix to provide the industry with guidance for making decisions relevant to abandoning pipelines in place or by removal. The Pipeline Abandonment Matrix provides a recommendation for pipeline abandonment based on the diameter of the pipeline, and both the existing and potential future land use considerations, broken down into 10 usage categories. The Pipeline Abandonment Matrix classifies pipelines with a diameter of 324 mm or less as “small.” A summary of the Pipeline Abandonment Matrix for small diameter pipelines, which is applicable to the existing 324 mm diameter Line 10, is provided in **Table 1** below.

Table 1
Pipeline Abandonment Matrix

Land Use		Primary Option for Abandonment Pipe Diameter 324 mm (12 inches) or less
Agricultural	Cultivated	Abandon in place
	Cultivated with special features* (depth of cover considerations)	Remove
	Non Cultivated (Native Prairie, Rangeland, Pasture)	Abandon in place
Non-Agricultural	Existing Developed Lands (Commercial, Industrial, Residential)	Abandon in place
	Prospective future development (Commercial, Industrial, Residential)	Remove
	No future development anticipated (e.g., Forest Areas)	Abandon in place
Other Areas	Environmentally Sensitive Areas (Including Wetlands)	Abandon in place
	Roads & Railways	Abandon in place with special treatment to prevent potential ground subsidence
	Water Crossings	Abandon in place
	Other Crossings (Utilities)	Abandon in place

*For example, tree farms or deep tillage operations
(Reproduced from the 2007 CEPA Report, Tables 1 and 2)

In the Pipeline Abandonment Matrix, removal is the preferred abandonment option only in limited circumstances as follows: for specific cultivated locations where depth of cover is of special concern (e.g., tree farms, and deep-tilling operations); or where there is the potential for prospective future development. CEPA states for areas of future land development that the preferable option is to abandon the pipeline in place until the land is developed, as this practice lessens the overall impact to the area.[1] It is also recognized that site specific conditions may override any of the primary options presented. As part of the Project, Enbridge proposes to decommission the entire length of the 32 km replaced segment in place.

1.6. Risks Associated with Pipe Removal

There are many public and worker safety concerns, as well as environmental risks, associated with removing a pipeline. CEPA and the NEB recommend abandonment in place for the following land uses because the disturbance caused by pipe removal would adversely affect sensitive areas or existing infrastructure:

- Environmentally sensitive areas (parks, wetlands, natural areas, species at risk habitat);

- Water crossings (streams, rivers, lakes, canals);
- Non-agricultural lands such as:
  - forested lands, and
  - existing developed lands (commercial, industrial, residential);
- Non-cultivated lands (native prairie, range land);
- Roads and railways;
- Other crossings (utilities, other pipelines); and
- Cultivated (including those that are irrigated).[1, 3]

Environmental hazards associated with pipe removal are related to the disturbance of the soil and groundwater, the potential impacts to natural wildlife and vegetation, and the chance of a release caused by a line strike during construction activities. An additional concern is soil stability during and after excavation, which can lead to increased localized erosion and destabilized slopes. These hazards may cause considerable disruption to ongoing and future land management activities. Further explanation and assessment of the environmental risks associated with removal of the decommissioned segment of Line 10 are addressed in the Environmental and Socio-Economic Assessment of this Application.

Excavation and removal of the decommissioned segment of Line 10 will cause additional and unnecessary disruption to landowners and the general public. Construction activities would restrict access to the ROW and adjacent works areas. Removal operations at crossings would not only cause traffic interruptions and restrictions but also may contribute to soil stability issues caused by pipe removal. These issues may have detrimental effects on existing infrastructure such as roadways, railways, and other utilities.

CEPA recognizes that pipelines abandoned in place present a potential hindrance to ongoing land management, due to future construction or areas with special depth of cover ("DOC") concerns.[1] The on-going monitoring discussed in the "On-Going Monitoring" Section of this report is considered to adequately address these risks.

One of the greatest risks of removing a decommissioned pipeline is the risk of damaging adjacent pipelines or infrastructure, which can lead to significant public, environment, and operational issues. The existing Line 10 shares a ROW with an adjacent 20-inch Enbridge pipeline, typically at a distance of approximately 3 m center to center.

1.7. Proposed Approach

Enbridge is proposing to decommission the replaced segment of Line 10 in place for all land use categories, based upon employing a risk-based approach. This strategy aligns with CEPA guidance which states that a risk-based assessment may provide justification to validate or override the primary options recommended in the Pipeline Abandonment Matrix[1]. CEPA recognized that as part of the site-specific assessment, there may be specific risk-based decisions or legal considerations that may change the preferred abandonment option[1].

The risk of possible soil subsidence due to pipe collapse or soil infill was identified by CEPA, NEB, Pipeline Technology Alliance of Canada ("PTAC"), and DNV GL.[1,6,13] It should be noted that the NEB discussion paper indicates that of the 17,000 km of abandoned or discontinued pipe in Alberta (as of 1994), there have been no documented cases of ground subsidence due to pipeline structural failure.[3] Regardless, in an effort to justify decommissioning in place as the preferred option, the analysis presented in this Application was performed to assess the possible failure modes that could lead to ground subsidence, and estimate the associated consequence associated with a decommissioned 12-inch pipe. The results of this assessment are detailed in the "Structural Integrity and Subsidence" section of this report.

CEPA's Pipeline Abandonment Matrix was developed with the assumption that CP will be discontinued for the abandoned pipeline[1]. Continuing application of CP on the decommissioned Line 10 can reduce the rate of general corrosion degradation and increase the remaining life of decommissioned Line 10 as a load bearing structure as detailed in "Structural Integrity and Subsidence" section of this report.

CEPA also assumes that the ROW will be abandoned and no future monitoring or maintenance activities will occur. Enbridge is committed to monitoring and remediating any issues that impact public safety, land use or the environment related to the decommissioned pipeline in perpetuity. As per CSA Z662-15 requirements, the safety of the general public will be ensured by regular monitoring ("On-Going Monitoring" section of this report) in accordance with Enbridge O&MMs including:

- Inspecting the pipeline ROW via pipeline patrols,
- Assessing areas of potential geotechnical threats,
- Maintaining pipeline signage,
- Performing depth of cover surveys,
- Maintain the cathodic protection system and continue to monitor the replaced section of the pipeline in perpetuity.
- Continued maintenance of the ROW, and
- Enhanced monitoring using void detection at King's Highway and active railways.

1.8. Risk Model

Enbridge previously conducted a risk assessment to determine the technical risks associated with decommissioning a pipeline in place; this risk assessment was done in consultation with Enbridge internal stakeholders. The assessment consisted of:

- Collecting risk data from a cross-section of Enbridge's subject matter experts;
- Quantifying the risks according to Enbridge Liquid Pipelines Risk Assessment Matrix (Dec 2013);
- Classifying the risks;
- Developing risk reduction and mitigation strategies for high risk scenarios; and
- Re-assessing the high risks (post-action) to assess the value of the reduction and mitigation strategies.

The critical areas used to classify the risks were selected based on industry literature related to decommissioning and abandonment of pipelines including CSA Z662-15,[4] the 2007 CEPA Report[1], and the 2010 DNV GL Study.[6] The literature review identified that the following areas are the most critical for decommissioned pipelines:

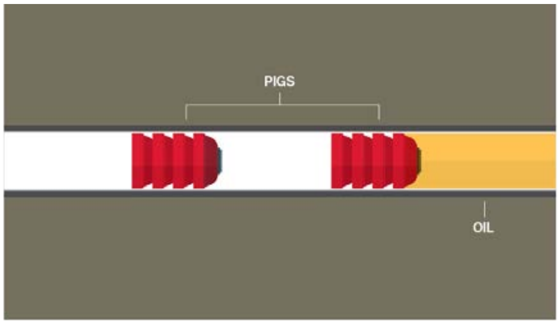
- Erosion;
- Soil contamination;
- Water contamination;
- Subsidence; and
- Water conduits.

The above areas highlighted by this assessment along with supporting engineering justification and further discussion on the mitigation strategies are in the following sections of this Application.

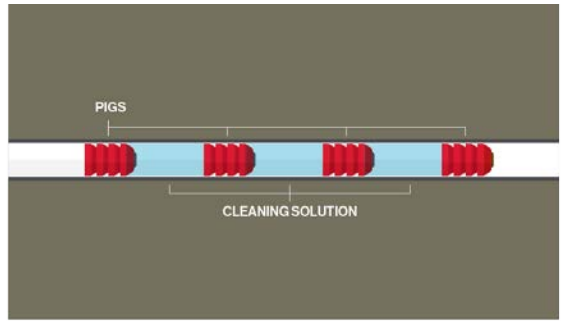
The risk model was originally conducted for an NPS 34 pipeline, however the primary findings can be considered applicable or conservative for the NPS 12 Line 10. It should be noted that certain risks identified in the assessment of the NPS 34 pipeline, are expected to be a lower likelihood and consequence for the smaller diameter Line 10.

1.9. Engineering Decommissioning Design Details and Justification

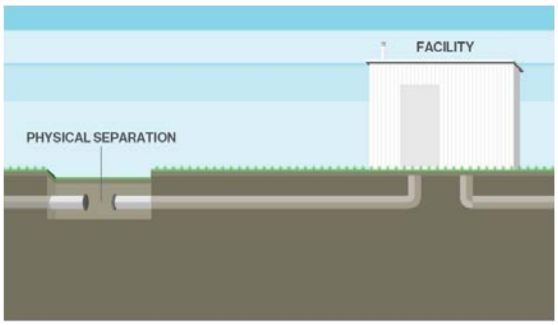
The decommissioning of the replaced segment of Line 10 will follow the basic steps shown in **Figure 1** and summarized below.



1. **Remove the vast majority of the oil** using specially designed cleaning instruments.



2. **Clean and wipe** the segment of replaced pipeline with cleaning instruments and solution.



3. **Disconnect the segment of replaced pipeline,** sealing it off from active facilities like pump stations, to prevent oil from re-entering the decommissioned segment.

4. **Segment the pipeline**, by capping, plugging, or otherwise effectively sealing the pipeline to prevent the creation of water conduits.

5. **Monitor the segment of decommissioned pipeline,** by maintaining cathodic protection, regular patrols, exact location signs, depth-of-cover surveys and Click Before You Dig program information.

Figure 1: The Five Basic Stages of Decommissioning

1.9.1. Pre-Displacement Activities

The 12-inch section of Line 10 from Enbridge's Westover Terminal to its Nanticoke Junction Facility continues to operate at a flow rate that prevents accumulation of water and sediment.

No internal corrosion mitigation program is presently required. The line operation will continue to be monitored while it is in service, and changes will be made to the internal corrosion mitigation program as necessary to address future changes in operation.

1.9.2. Displacement Activities

As part of the decommissioning of the replaced segment of Line 10, the product will be displaced and the segment will be cleaned. Displacement and cleaning activities will be executed from Westover Terminal to Nanticoke Junction. The segment of pipeline will be displaced and then cleaned as separate activities.

The product within the segment of pipeline will be removed by a pig designed for product displacement. The pig selection will be based on the characteristics of the final product shipped by the segment of pipeline. The planned displacement/cleaning program will be performed using cleaning fluid stages between pigs as a separate train as shown below in **Figure 2**, below.

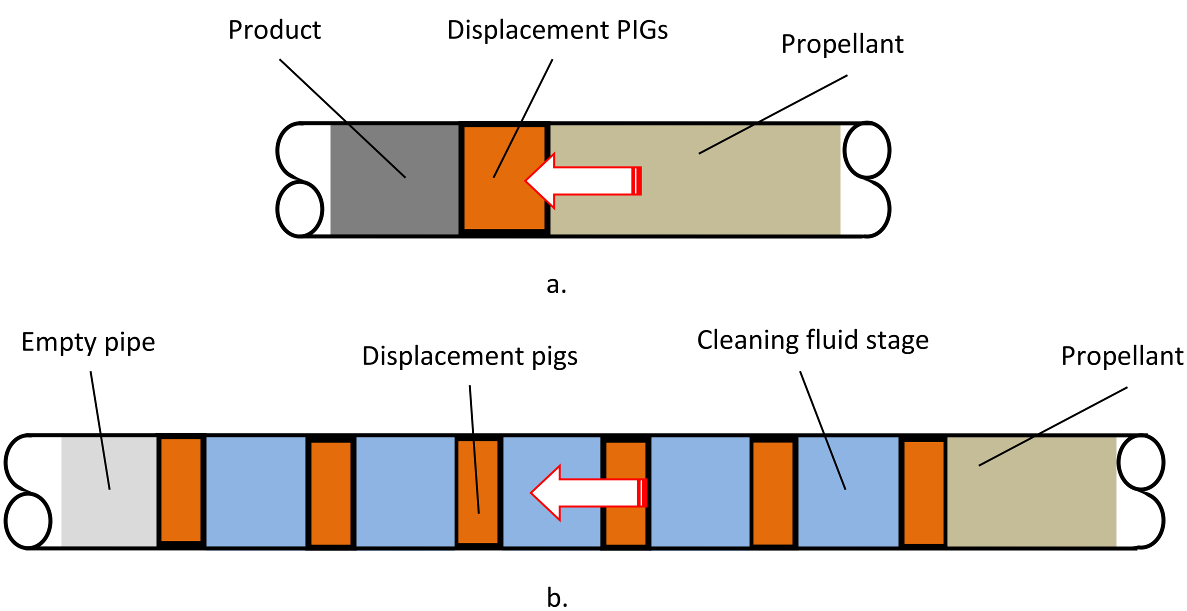


Figure 2: Schematic of displacement and cleaning programs
(a) separate displacement of crude oil from the replaced segment of pipeline and;
(b) separate cleaning program.

Nitrogen is the initially proposed propellant for all displacement and cleaning activities.

1.9.3. Pipeline Cleaning

Establishment of Cleanliness Level

The NEB and CEPA posed the question of "How Clean is Clean?" as a guide for industry to consider both the condition inside an abandoned pipeline and the potential for migration of any materials out of an abandoned pipeline.[1,3] Currently, there are no published standards that define cleanliness for decommissioned or abandoned pipelines.

A cleaning program is presently being developed through Enbridge's Decommissioning Program field trials to establish and test a prudent cleaning criterion.

Enbridge Plan for Cleaning

The cleaning phase will use a multistage pig and cleaning solution column as shown in Figure 2. The column will consist of a number of pigs separated by cleaning solution stages. The cleaning pigs may include brushes to improve mixing efficiencies. Each water stage will be sized specific to the segment.

The first pig will be launched by injecting a cleaning solution stage behind it. Subsequent pigs and cleaning solution stages will be injected until all pigs and cleaning stages are in the replaced segment of pipeline. The final pig will be launched using a propellant medium.

All waste cleaning solution from the cleaning process will be disposed of according to applicable laws, regulations and standards. Cleanliness guidelines will be established during this research and development program in conjunction with review of published literature.

Enbridge's Decommissioning Program is undertaking field trials to establish and test a prudent cleaning criterion. Enbridge's Line 10 Westover Segment Replacement Project will follow the criteria established.

Items to be determined during detailed engineering include:

- Separate displacement and cleaning programs;
- Size, number, and composition of the cleaning solution stages;
- The type and concentration of cleaning agent to be added to the cleaning solution stages;
- Type of pigs and whether towed or integral wire brushes will be used on the pigs to increase mechanical agitation to improve the mixing efficiency of the cleaning solution stages
- Possible benefits of using biocides or inhibitors to minimize likelihood of microbially-induced corrosion ("MIC"); and

- Benefits of drying the pipeline after cleaning process through use of drying pig or air movers.

1.9.4. Pipeline Isolation

As per CSA Z662-15, the decommissioned segment of pipeline will be physically separated from in-service piping to prevent the reintroduction of product into the decommissioned segment. Additionally, equipment and instrumentation on the decommissioned segment of pipeline will be de-electrified for safety reasons.

The pressure-containing side of any isolation location (as applicable) will be designed and installed according to all applicable industry and Enbridge standards. Facilities will be isolated from the decommissioned segment of pipeline as detailed below:

1. **Westover Terminal:** Isolation will be achieved by physically cutting the replaced segment of pipeline below the base of the existing sending trap, removing a short piece of pipe, and welding a plate to the pipe at each side of the trap as determined appropriate in detailed engineering.

2. **Nanticoke Junction:** Isolation will be achieved by physically cutting the replaced segment of pipeline below the base of the existing NPS 20 sending trap to tie the new NPS 20 pipeline into the existing NPS 20 pipeline.

3. **MLBV:** One manual mainline block valve (“MLBV”) exists on the replaced segment of Line 10. The valve does not require physical separation from active associated piping but it will be used for engineering segmentation. As it is stand-alone it will be removed to a depth of 1 m below surface grade or to the top of the valve body, whichever is less, and the ROW will be restored.

4. **Electrical and Instrumentation:** Electrical connections will be de-energized and rendered safe as determined during detailed engineering. Any electrical or instrumentation infrastructure required for the on-going application of the CP system will be maintained.

Additionally, an assessment will be completed during detailed engineering to ensure continuity and reliability of the CP system at any location where the replaced segment of pipeline is physically separated.

1.9.5. Pipeline Segmentation

Segmentation is carried out to avoid or reduce the potential for the replaced segment of pipeline to act as a water conduit. CEPA recommends that a decommissioned pipeline be capped, plugged, or otherwise effectively sealed to protect against the creation of water conduits (2007 CEPA Report, Section 3.3 Environmental Considerations).[1] The replaced segment of Line 10 will be segmented by installing a full containment plug at environmentally sensitive locations, as defined by the ESA, and by closing, permanently disabling, the MLBV along Line 10. Westover Terminal and Nanticoke Junction will be physically isolated by cut and plate, providing a segmentation location even though their function is to provide physical separation from active assets.

The Environmental Decommissioning Technical Report provides an environmental assessment of the existing Line 10 pipeline to identify segmentation location in the "Decommissioning Treatment – Environmental Evaluation" section of that report.

At segmentation locations identified in the ESA, a plug will be installed by filling a section of the pipe with sufficient engineered fill to create an impermeable barrier to water flow. A minimal disturbance method is planned for installing the plugs, whereby pneumatic or hydraulic excavation from the surface will uncover small sections of the pipeline sufficient in size to drill or cut into the pipe from the surface and allow for installation of the containment bulkheads.

Enbridge is presently conducting Field Trials to evaluate a minimally invasive procedure for segmentation of decommissioned pipelines. If the field trials determine that the planned segmentation method is not viable, segmentation will be accomplished by conventional excavation, and cut and plate methods.

Additionally, as CP will continue to be applied to the decommissioned segment of Line 10, the segmentation procedure will include a method for continued electrical continuity along Line 10, such as through bonding cables across segmented locations.

1.9.6. Structural Integrity and Subsidence

The risk of ground subsidence has been identified by CEPA, PTAC, and the NEB, as a possible concern for the decommissioning in place of a pipeline.[1, 3, 13] It is recognized that the long-term degradation of a decommissioned pipeline may eventually lead to a measureable amount of ground subsidence; however, the extent of that subsidence is not well defined and must be assessed.[6] A geotechnical study prepared for the NEB indicates that possible subsidence magnitude related to a 12-inch pipeline, such as the replaced segment of Line 10, is negligible, based on a review of multiple subsidence calculation methods presented for DOC of 0.6 m or greater. Additionally, published literature reviewed during the development of this decommissioning plan substantiates the assessment that possible subsidence magnitudes related to a 12-inch pipeline, such as the replaced segment of Line 10 are expected to be minimal or negligible. [1,3,613]

Therefore, it is expected that the magnitude of soil subsidence associated with possible collapse of the decommissioned segment of Line 10 will be negligible. However, it is also noted that in order to responsibly decommission a pipeline, an operator must consider the risks of ground subsidence, the possible consequences associated with these risks, and develop a plan to address them. In an effort to confirm the previous research, and provide a prediction of the expected long term structural integrity, assessments were performed considering corrosion, structural integrity, and geotechnical effects.

This section provides details of the assessments of subsidence and structural integrity performed as part of developing the Line 10 Decommissioning Program to predict the short and long-term risks of ground subsidence. It should be noted that subsidence as a general term is used in relation to both natural and artificial hazards, such as growth faults, flood or groundwater withdrawal, and mining operations. However, reference to ground subsidence within this Application is used solely with respect to possible subsidence concerns related to pipeline decommissioning.

Enbridge performed a thorough review of the possible risks associated with ground subsidence with respect to pipeline decommissioning, considering industry guidance from the 2007 CEPA Report,[1] the NEB Background and Discussion Papers,[3,5] the PTAC Report,[13] the 2010 DNV GL Report,[6] and additional Enbridge work summarized in this Application. The review identified the following potential consequences related to ground subsidence with respect to pipeline decommissioning.

- Public Safety:
  - hazards to agricultural equipment;
  - road subsidence at a King's Highway;
  - track bed subsidence at railway crossings; and
  - hazards to people, machinery, or livestock.

- Environmental Impact and Land use:
  - water channeling and subsequent erosion;
  - loss of topsoil; and
  - long-term impact on land aesthetics.

1.10. Subsidence Failure Modes

Ground subsidence can occur where a void is created within the ground, generally at the pipe depth, allowing the soil above to collapse into the void, and creating a disturbance at the surface. This may occur due to a combination of corrosion degradation, and loss of structural integrity of the pipe wall. Subsidence due to corrosion can be either partial, considering soil infill into large localized perforations in a decommissioned pipe, or total, considering significant overall general wall loss and total infill of soil. Structural integrity, in the case of a decommissioned pipeline, is defined by the ability of the pipeline to resist collapse due to external loading, rather than internal product and pressure containment. DNV GL recognized that an abandoned pipeline sufficiently degraded by corrosion such that structural integrity is compromised could, in theory, collapse due to the weight of the soil and any potential surface loads present.[6,13] However, the subsidence magnitude associated with a 12-inch diameter pipeline such as Line 10, is considered to be minimal or negligible based on multiple published assessments.

In 2013, the PTAC commissioned DNV GL to prepare a study entitled “Understanding the Mechanisms of Corrosion and their Effects on Abandoned Pipeline”.[13] The PTAC report presents a conservative methodology proposed by DNV GL for estimating time to loss of structural support for an abandoned pipeline. This assessment considers a worst case condition, assuming no coating (or 100% loss of coating) and no CP applied. These assumptions are not applicable to the replaced segment of Line 10 since CP will continue to be applied to the decommissioned segment; thus, the corrosion progression is predicted to be localized perforations due to external corrosion and not general wall thinning. Similarly, the conditions for internal corrosion, on the replaced segment of Line 10, are not consistent with the data used to formulate the corrosion aspect of the PTAC model. It is presented here as reference; however, to provide a conservative estimate for long-term corrosion progression of the replaced segment of Line 10.

1.11. Corrosion Degradation

The structural integrity of a pipeline in a load bearing capacity is subject to decrease with corrosion degradation. The specific rate of corrosion due to exposure to the environment depends on a number of factors, including the condition of the pipeline coating, soil aeration, types and homogeneity of soils, soil moisture, internal atmosphere, and electrical factors which create the potential differences for a corrosion cell to be established.[43]

Line 10 has been in operation since 1962 (i.e. 53 years of operation) and over the life of the pipeline, several sections have been replaced with new pipeline sections. To approximate the historical external corrosion progression of the pipeline section from MP 1863.24 (Westover) to MP 1883.52 (Nanticoke), In-Line Inspection (“ILI”) data collected in 2006 and 2012 were analyzed. These data sets were selected because the same ILI technology was used (UltraScan® WM) and cathodic protection data was available between the years 2009 and 2014. Localized pitting and uniform corrosion, both external and internal, are the two general forms of corrosion that have been considered with respect to decommissioning the 32 km segment of Line 10 and the contribution to subsidence.

1.12. Effects of Coating and Cathodic Protection on Corrosion

External corrosion control is generally achieved on underground pipelines by a combination of corrosion resistant coatings and CP systems. Corrosion resistant coatings are designed to provide high dielectric strength, and low moisture permeability. The coating, where intact, provides a barrier to moisture, which is necessary to support the corrosion reactions. However, all coatings contain defects, or ‘holidays’ where corrosion can occur, and can degrade with time increasing the extent of bare pipe surface susceptible to corrosion.

Per historical industry experience, and guidance from CEPA and the NEB, it is considered highly unlikely for corrosion to cover the entire circumference of a pipeline over a significant length.[1,3] Thus, it is correspondingly unlikely that a long segment of the pipeline will be potentially susceptible to sudden collapse and subsidence.[1,3] It should be noted that the 2012 in-line inspection data for the proposed decommissioned section of Line 10 revealed that approximately 99% of the inspected pipe joints contained corrosion that was <5% of the pipe's total surface area. This data substantiates the guidance provided by CEPA and the NEB that it is considered highly unlikely for corrosion to cover the entire circumference of a pipeline over a significant length.[1,3]

The decommissioned segment of Line 10 is externally coated with polyethylene tape. A Gas Research Institute ("GRI") report[18] published in 1992 provides information that the most common problems reported by pipeline operators who had used tape coating on their pipeline systems were: poor field application, failure of adhesive, poor resistance to soil stress, and high susceptibility to shielding the current of the CP system.

Data collected from prior direct examinations, conducted on Line 10, was reviewed to provide a baseline for historical metal loss on this line. A total of 110 corrosion related dig reports, based on findings of the inline inspection ("ILI") tool, from 2004 to 2014 were reviewed. External metal loss was found on all but one of these reports, all under wrinkled and disbonded tape. Once the wrinkles form, water is able to seep under the disbonded coating and is carried along the pipeline's steel surface by capillary action. Permeation of the CP current is limited due to the high dielectric strength of the polyethylene tape shielding the current.

1.13. Estimate of Corrosion Rates

A review of historical and conservative theoretical external and internal corrosion rates was undertaken to help establish a predicted time to failure for possible pipeline collapse, and related ground subsidence.

1.13.1. Historical External Corrosion

The maximum external metal loss depth reported by the 2006 ILI inspection was 3.8 mm (61% of the 6.1-mm nominal wall thickness). Assuming external corrosion started since the installation of the line, this corresponds to a linear corrosion rate of 0.09 mm per year (3.5 mils per year or "mpy", mils is the imperial unit for thousands of an inch). A more conservative assumption could be made with respect to the time to external metal loss initiation, considering corrosion starting 10 years after installation. This would translate to a linear corrosion rate of 0.11 mm per year (4.3 mpy).

The depth and orientation of the external metal loss anomalies reported by the 2006 ILI data were aligned with pipe elevation and plotted against the tool odometer, as presented in Figure 3, below.

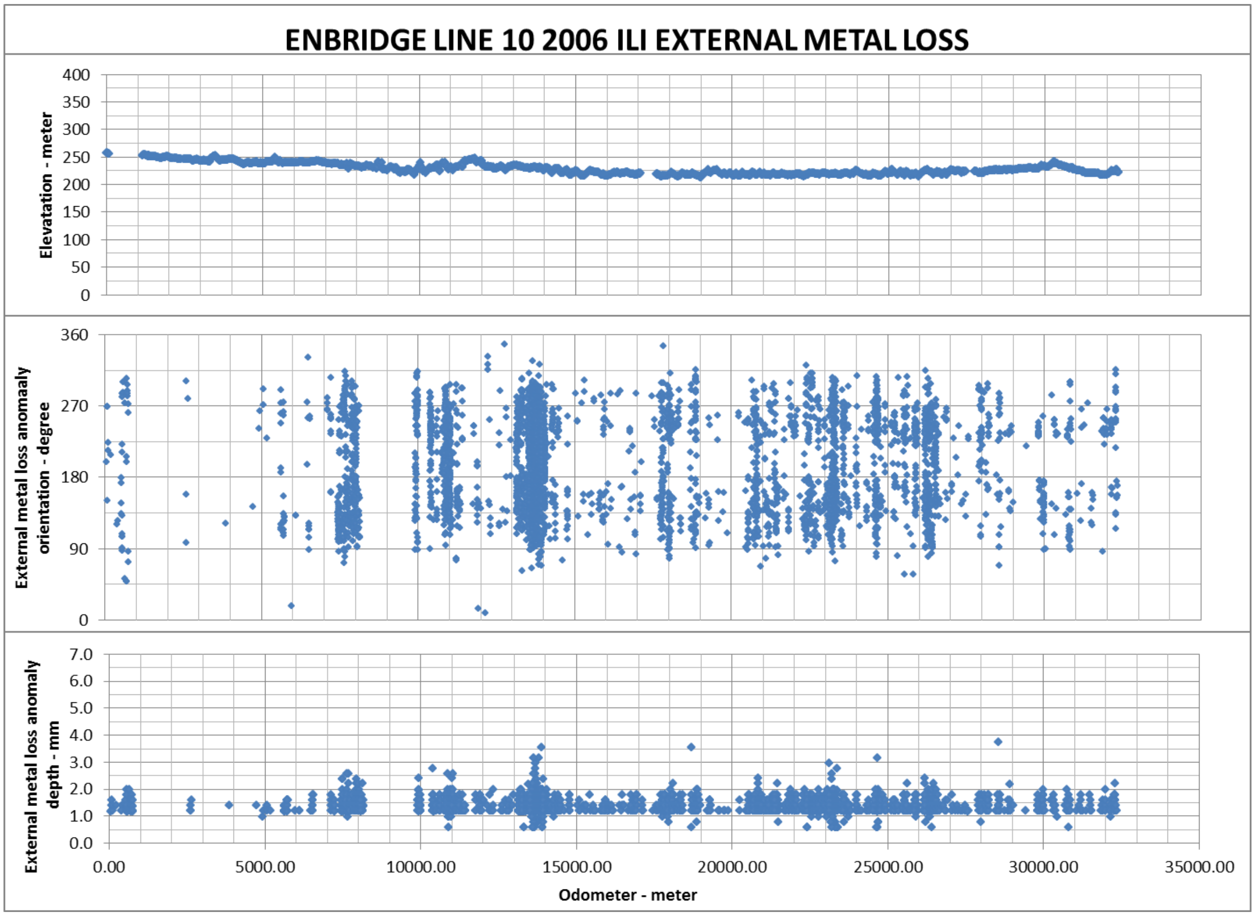


Figure 3: Line 10 2006 ILI External Metal loss Data

The external metal loss anomalies reported by the 2006 ILI inspection appear to be concentrated on the bottom half of the pipe as shown in **Figure 3**. The distribution around the pipeline circumference of the external metal loss anomalies reported by the 2006 ILI inspection is presented in **Figure 4**. There is a preferential location of the external metal loss anomalies around the 4 and 8 o'clock positions. This is most likely attributable to the fact that polyethylene tape coatings, such as that used on Line 10, are susceptible to soil stresses that result in wrinkling and disbondment along the sides of the pipe. Due to the shielding characteristics of the coating, the CP system would not be able to adequately protect the pipe surface under the areas of disbondment. The data presented in this figure indicate that general corrosion of the full circumference over a significant length of Line 10 has not been identified, and there is no evidence to currently suggest that there are segments of Line 10 potentially susceptible to sudden collapse that could lead to abrupt subsidence.

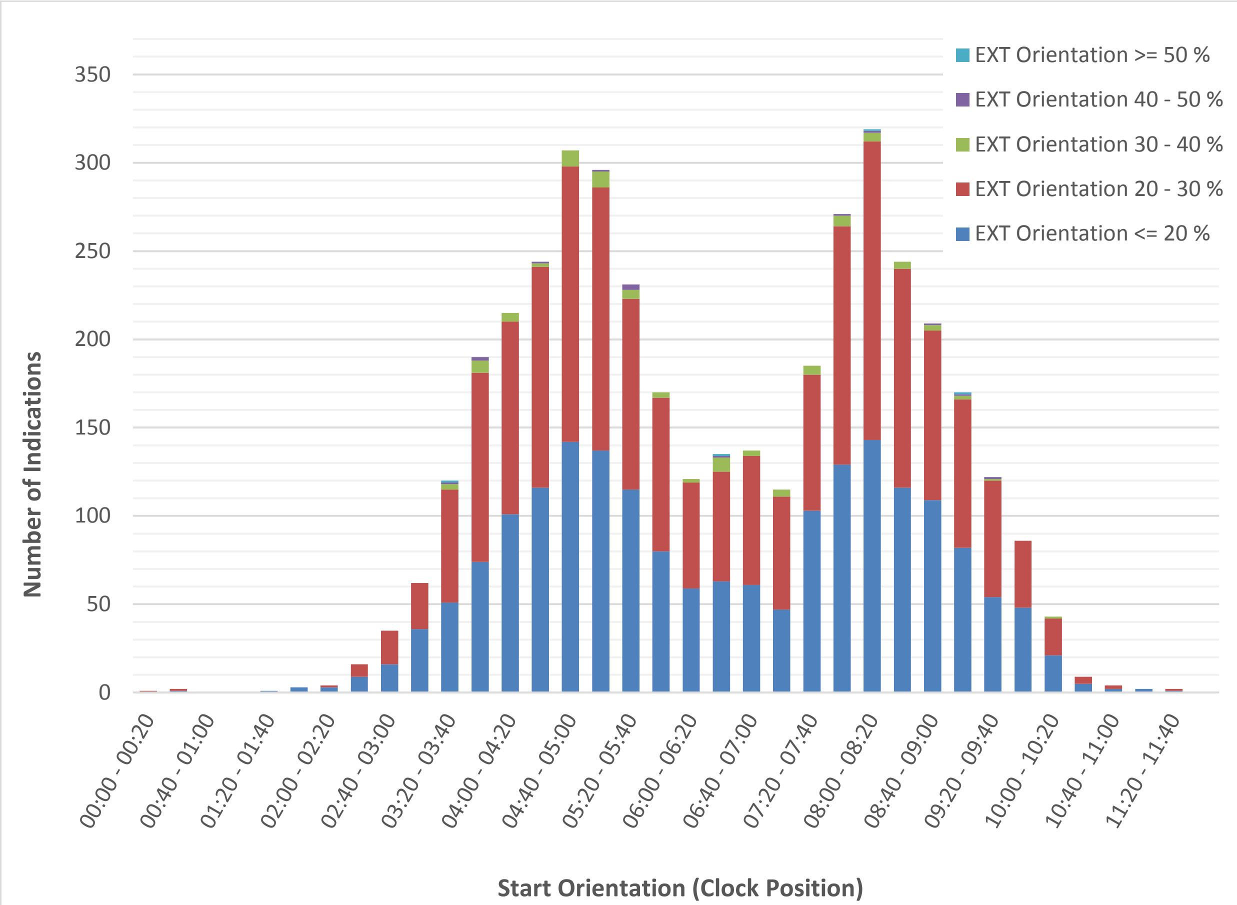


Figure 4: Distribution around the pipe circumference of the external loss anomalies reported by the 2006 ILI inspection

The maximum external metal loss depth reported by the 2012 ILI inspection was 3.16 mm (52% of the nominal 61 -mm wall thickness). Assuming external corrosion started since the installation of the line, corresponds to a linear corrosion rate of 0.06 mm per year (1.5 mpy). A more conservative assumption could be made with respect to the time to external metal loss initiation, considering it started 10 years after being installed, corresponding to a linear corrosion rate of 0.08 mm per year (2.0 mpy).

The depth and orientation of the external metal loss anomalies reported by the 2012 ILI data were aligned with pipe elevation and plotted against the tool odometer. These data is presented in **Figure 5**.

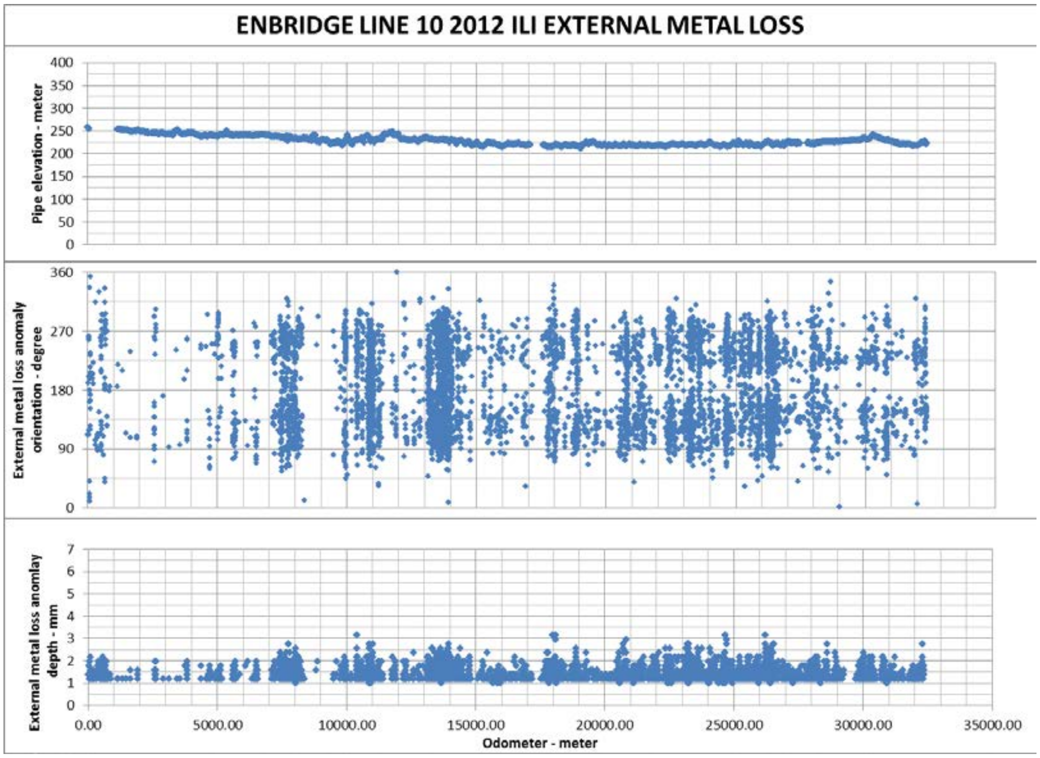


Figure 5: Line 10 2012 ILI External Metal loss Data

The external metal loss anomalies reported by the 2012 ILI inspection follow a similar trend as those reported by the 2006 ILI inspection; as shown in **Figure 6** below there is again a preferential distribution of the external metal loss anomalies around the 4 and 8 o'clock positions.

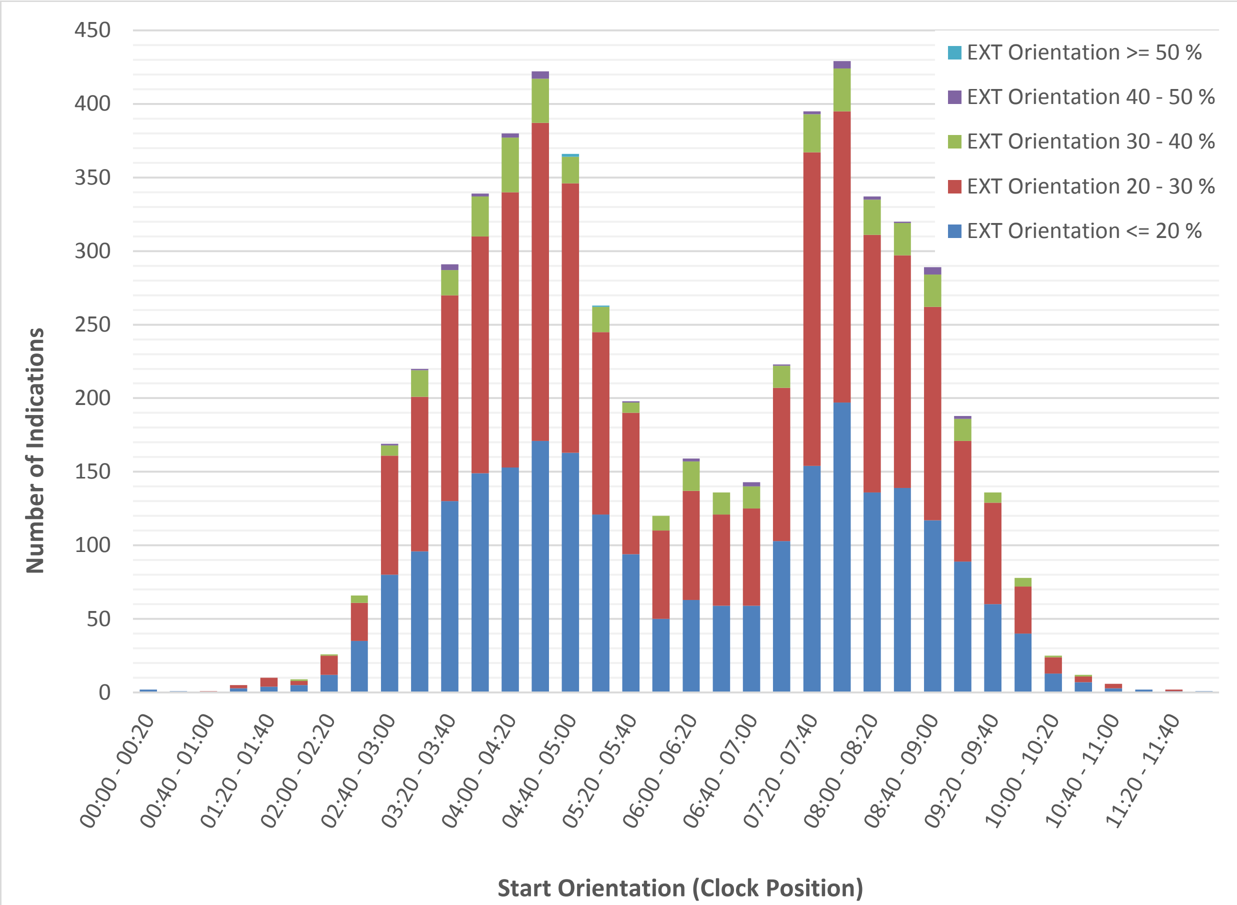


Figure 6: Distribution around the pipe circumference of the external loss anomalies reported by the 2012 ILI inspection

The number of external metal loss anomalies reported by the two ILI tool runs increased from 4,094 in 2006, to 5,769 in 2012, an increase of 41%. The distribution of the external metal loss anomaly depths reported by the ILI in years 2006 and 2012 were analyzed to further define the severity of the external corrosion reported by the two inspections. **Table 2** presents the maximum reported metal loss depths, as well as the 90th, 99th, and 100th percentile reported metal loss depths for both 2006 and 2012.

Table 2
2006 and 2012 ILI External Metal Loss (EML) Depth Distributions

Year	2006	2012
Percentile	Maximum EML Depth (% of nominal wall thickness)	Maximum EML Depth (% of nominal wall thickness)
90th	31%	35%
99th	47%	50%
100th	61%	65%

1.13.2. PTAC Estimated Rates

The PTAC published a report that provides a corrosion model to determine the extent of localized corrosion damage to a pipeline as a function of soil environment and time. This approach is suitable to predict Line 10 corrosion progression based on the historical corrosion behavior reviewed in "Historical External Corrosion" section (preceding section). Based on the PTAC model, upper and lower bound corrosion progression rates were developed for comparison with the results of the ILI data analyzed and estimate time to perforation through wall due to pitting and time to collapse due to uniform corrosion.

The external metal loss maximum depth distributions calculated from the 2012 ILI inspection data were plotted together with PTAC lower and upper bounds corrosion growth rates. In addition, NACE standard SP0502 default conservative linear corrosion rates of 0.4 mm/yr (16 mpy) where no details are known and 0.3 mm/year (12 mpy) considering CP is being applied were included for comparison.

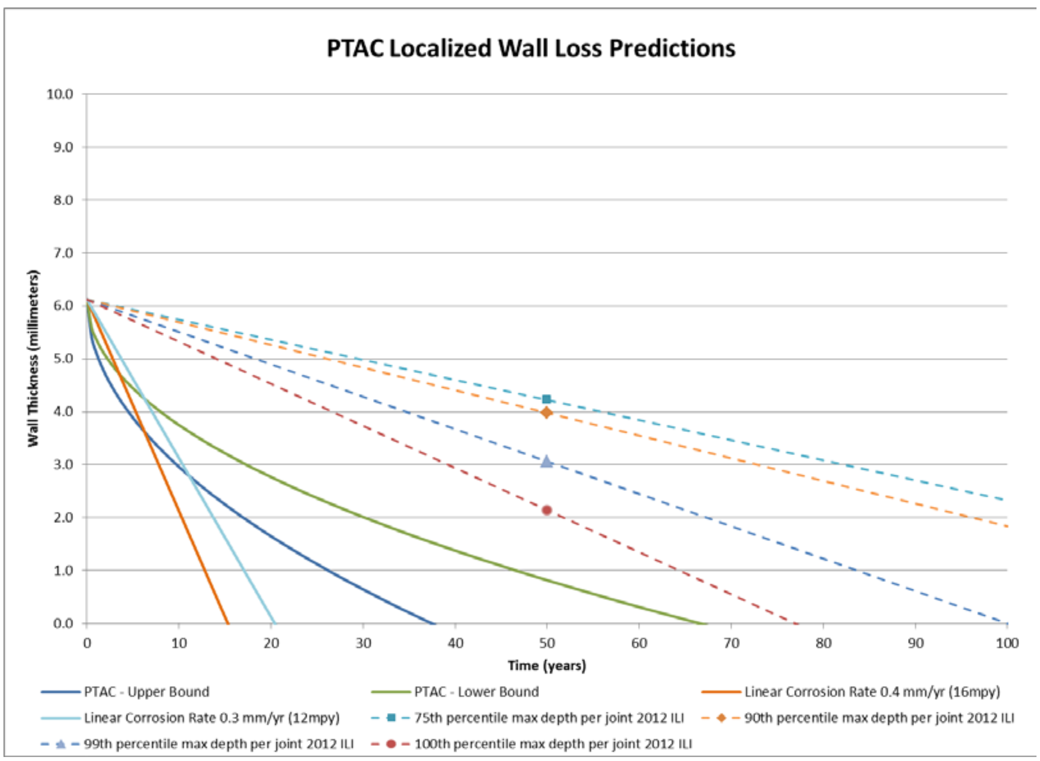


Figure 7: Localized corrosion progression based on historical ILI data and PTAC report

Based on the data presented in Figure 7 the external metal loss present on Line 10 appears to be consistent with the PTAC Lower Bound model. This conservative rate estimates 100% through wall perforation in 66 years after the installation of the pipeline, corresponding to the year 2028. Considering the 100th percentile maximum depth reported by the 2012 ILI, as shown in Figure 7 as the worst case corrosion depth, shifting the PTAC Upper Bound corrosion rate curve along the x-axis accordingly to estimate progression from 2012, indicates approximately 22 years to through wall perforation from 2012, corresponding to 2034.

It should be noted that the rate of future corrosion progression is dependent on many variables, and will vary along the length of the replaced segment of line. The estimates provided here are in attempt to determine a conservative rate used for determining a minimum time to collapse for the decommissioned segment.

1.14. Predicted Internal Corrosion Progression

Historical ILI data and dig reports for Line 10 indicate that internal corrosion ("IC") has been limited for the proposed decommission segment of Line 10. Additionally, no specific indications were noted during the data review process that would suggest any concerns of MIC for this segment. However, it is prudent to ensure proper treatment of the decommissioned segment of Line 10 to reduce the likelihood or rate of IC.

The predicted internal corrosion progression assumes the pipe has been cleaned, and residual moisture levels are as proposed in the cleaning program ("Pipeline Cleaning" section of this report). It is also assumed that corrosion due to MIC is negligible. Limiting the residual water after the cleaning process will reduce the magnitude of MIC if bacteria are present.

The following is written assuming that the replaced segment of pipe has been completely cleaned and dried, and there are no deposits or water left in the segment.

1. Internal corrosion is expected to be minimal until large enough perforations occur to allow moisture or soil to enter the pipe.

    (a) With no product in the segment and assuming the segment is sufficiently cleaned and dried, the research performed by DNV and NGA/NYSEARCH related to casing corrosion is applicable.19 In this study, bench, small-scale, and field tests were performed for a variety of casing environments. Field testing of corrosion coupons in carrier pipe with a dry, vented annular environment showed no pitting and very low corrosion rates (maximum of 0.002 mm/yr [0.08 mpy]) at all pipe positions except for 6 o'clock. At the 6 o'clock position, an average corrosion rate of 0.05 mm/yr [2.01 mpy] was observed. Although the annular environment was reportedly dry, the vent may have allowed for ingress of moisture and oxygen; therefore, these results may be considered as a somewhat conservative estimate of what may happen inside a clean, dry, sealed pipe.

2. After the first perforations form, the segment of replaced pipe will start to corrode internally.

    (a) When the segment becomes perforated due to external corrosion, the internal surface will be exposed to moisture and possibly soil. In the DNV and NGA/NYSEARCH study, small-scale testing of bare carrier pipe exposed to air and a static level of brackish water (half-filled annular space) showed an average corrosion rate of 0.22 mm/yr [8.61 mpy] and an average pitting rate of 0.45 mm/yr [18.1 mpy]. These rates were observed at the water/air interface, which was located at the 3 o'clock and 9 o'clock positions in this experiment. Other pipe positions showed relatively low corrosion rates (maximum of 0.055 mm/yr [2.20 mpy]) and no pitting. Considering only water ingress, the internal area of replaced segment of Line 10 that is expected to corrode will be dependent on the volume of water that enters that segment.

(b) b. If soil enters the segment, there is the possibility of these deposits causing localized areas of corrosion, which would be expected to occur at or near the 6 o'clock position where the soil is likely to settle. This internal surface has essentially become analogous to a bare external surface, and the external rates presented in "Historical External Corrosion" section of this report are applicable for reference.

1.15. Effects of CP

It is expected that given sufficient time, a pipeline that is not maintained, has poor or no coating, and no CP, will eventually degrade due to corrosion.[6] Estimates of this timeframe have been provided in industry references and vary from decades at the low end to thousands of years on the high end.[1,3,6,13] The NEB recognizes that maintaining abandoned pipelines while continuing CP cannot completely eliminate the risk of pipeline degradation or collapse; however, it can be expected to significantly retard the corrosion process.

It is recognized, however, that polyethylene tape coatings are subject to disbondment, and locations where coating has disbonded will be dielectrically shielded from CP.[39] Enbridge will continue to monitor the decommissioned segment of Line 10 as part of its ongoing Operations and Maintenance programs as described in the "On-Going Monitoring" section of this report and will continue the application of CP. Continuing the application and monitoring of CP will help to minimize the corrosion at coating holidays. However, corrosion may continue at locations of disbonded coating where water may contact with the pipe surface, and the coating dielectrically shields CP.

1.16. Structural Integrity and Subsidence

The PTAC model[13] for pipe collapse presents a conservative methodology for estimating time to collapse, defined as time to loss of structural integrity, of an abandoned pipeline. The PTAC assessment considers uniform wall loss scenarios, considering no coating (or 100% loss of coating) and no CP. This is considered to be conservative for the case of the decommissioned segment of Line 10.

The primary loads to consider acting on a decommissioned pipeline that may contribute to structural collapse are loads imposed by soil cover, and any surface loads transferred to the pipe from forces acting at the ground surface, such as vehicular or equipment loads. The load acting directly at the pipe, or the "effective live load", is generally much less than the loads at the surface, as the loads are dissipated through the soil as they are transferred to the pipe. The degree of this dissipation is dependent on the depth of soil cover.

The PTAC report[13] provides calculations and summary tables of typical effective live loads for various American Society of Civil Engineers ("ASCE") load and impact factors.[20] The effects of surface live loads on a decommissioned pipeline are considered more significant than the loads associated with depth of cover alone. [3,13] If sufficient enough to exceed the structural capacity of a decommissioned pipeline, the pressures transferred to the pipe will lead to ovalization. If the loads are sufficient to progress, the pipe may fail through either plastic collapse or elastic buckling, as depicted in 0 and as per the PTAC Report[13] and the American Life Alliance *Guidelines for the Design of Buried Steel Pipe.*[20]

Plastic collapse occurs when bending stress on the pipe walls exceeds the yield strength of the pipe steel. The wall plastically yields, and collapses under the loads on the pipe. Elastic collapse, or buckling, occurs when the elastic energy in the pipe wall exceeds the critical buckling limit. Both failure modes need to be considered in development of collapse assessments.[13] The critical load acting on the pipe to cause this collapse is considered the load bearing capacity of the pipeline.

The PTAC model presents a methodology to assess the load bearing capacity of a pipeline as a function of wall thickness, considering both plastic and elastic collapse. An example plot is presented in Figure 8, where the blue curve represents the load bearing capacity as limited by plastic collapse, and the red curve represents the load bearing capacity as limited by elastic collapse. It should be noted that the load bearing capacity is not directly decreasing with the decrease in wall thickness. As the pipe wall becomes thinner, the stiffness of the pipe wall decreases. The decreased stiffness increases resistance to plastic collapse, until the point where elastic buckling is the controlling failure mode as described within the PTAC report.

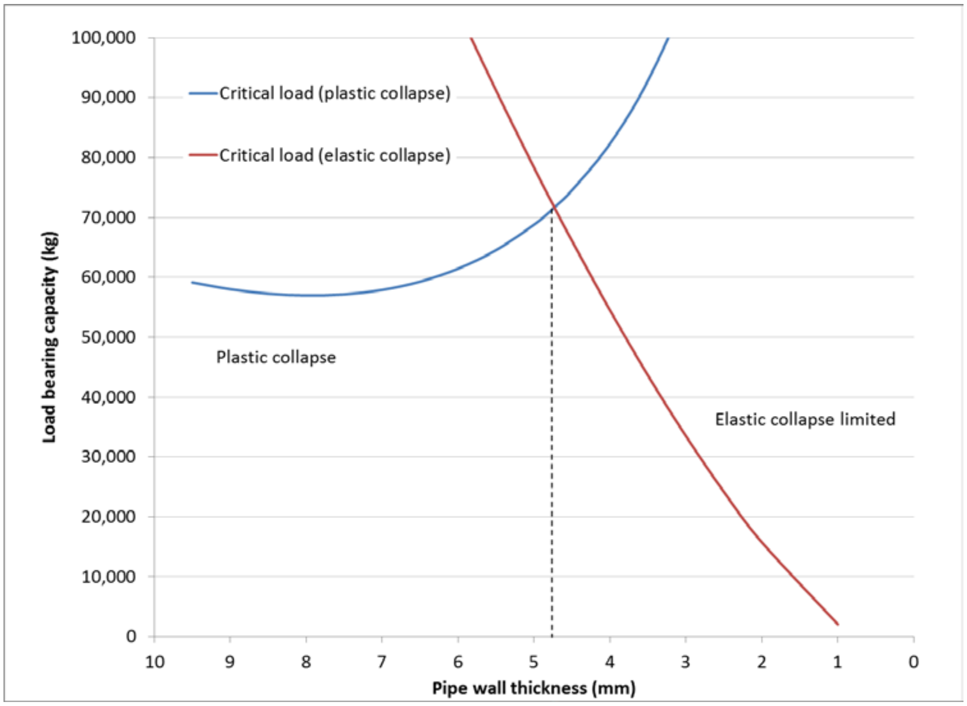


Figure 8: Example plot of load bearing capacity as a function of pipe wall thickness
(Reproduced from PTAC)[13]

1.17. Pipe Collapse Due to Generalized Corrosion

Structural integrity models presented by PTAC ("PTAC Model") were analyzed to assess the load bearing capacity of the decommissioned segment of Line 10 as a function of corrosion damage. As the decommissioned segment of pipeline corrodes, the load bearing capacity will be reduced to some extent. Analyses were performed to estimate the critical surface load necessary to cause pipe collapse, the corresponding soil subsidence geometry, and the pipe stresses associated with various surface loading scenarios.

The load bearing capacity of a 12-inch pipeline, comparable to the decommissioned segment of Line 10 was analyzed using the combined PTAC model for plastic and elastic collapse. It should be noted that the PTAC model is considered a conservative estimate, as it assume generalized corrosion, no coating, and no CP, which are not representative of conditions on the decommissioned segment of Line 10. However, it may be used to establish a conservative lower bound estimate. The following input assumptions were used, as required, based on known or approximated conditions along decommissioned segment of Line 10:

- Max Soil Density = 2000 kg/m^3
- X52 Pipe (52,000 psi = 359 MPa)
- 12-inc Diameter (304 mm)

- Young's Modulus (E = 205 GPa)
- Soil Modulus (E') = 6.9 MPa
- Bedding factor = 0.1
- Lag factor = 1.5
- Stress Intensity Factor = 3
- Impact factor = 1.75

Figure 9 presents the estimated surface load bearing capacity as calculated by the PTAC model for a 304 mm (12 inch) pipeline as a function of remaining or effective wall thickness. The surface load bearing capacity curve considers both plastic collapse and elastic buckling, as indicated in Figure 9. The surface loads represented in Figure 9 consider a point load acting at the ground surface in kilograms, and is generally conservative as surface loading will be distributed over a given area. The data is presented, however, to demonstrate the effect of depth of cover with respect to the surface load bearing capacity of a decommissioned pipeline.

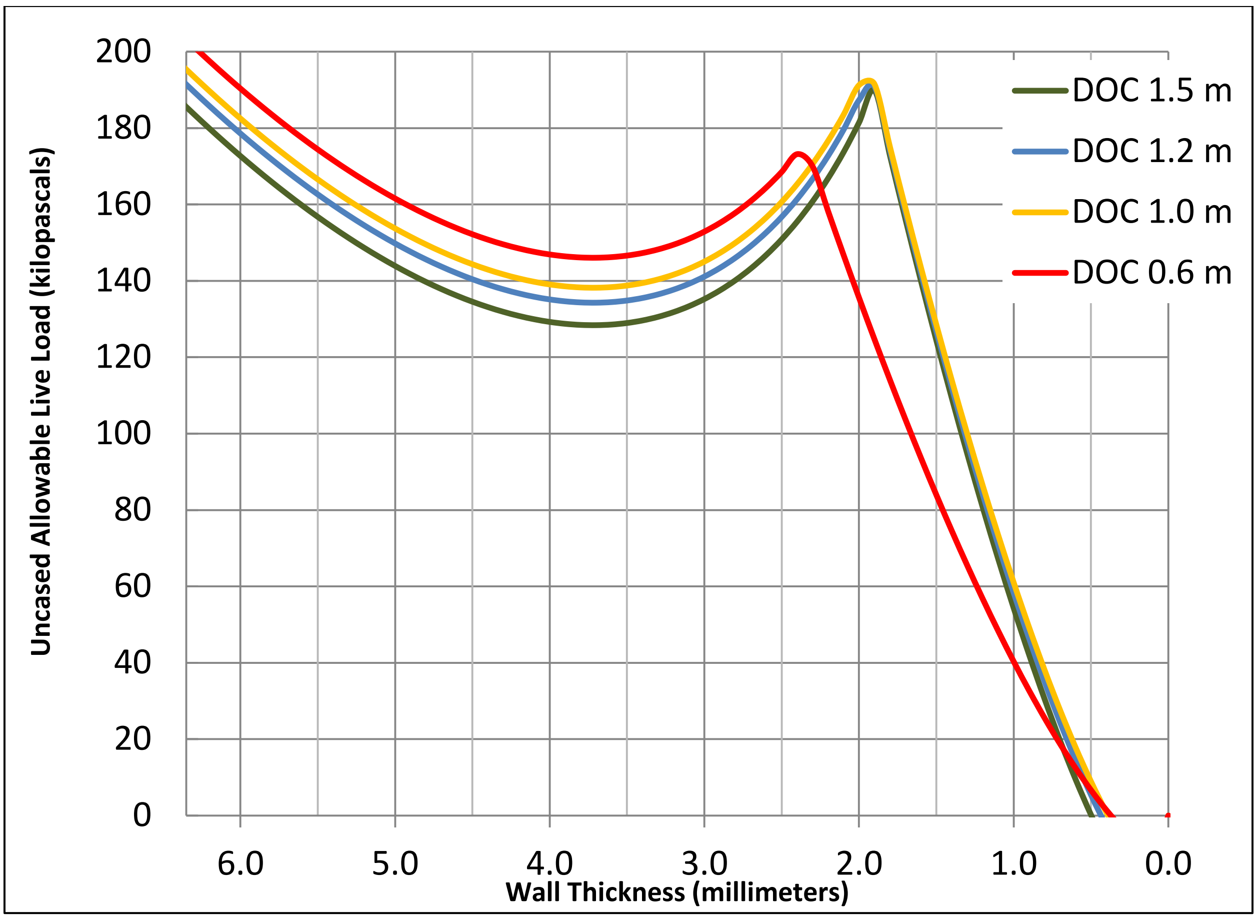


Figure 7: Uncased Load Bearing Capacity versus wall thickness as a function of depth of cover

Figure 9 and **Figure 10** below present the effective live load capacity, for an uncased pipe at both 1.0 and 0.6 m DOC, as calculated as above. The effective live load, due to various surface load conditions, is presented for comparison. An HS-20 load simulates a 20-tonne truck traffic load as defined by ASCE.[20] The maximum agricultural load presented is based on Enbridge's agricultural loading tool, representing the maximum load allowed to cross the active ROW. The minimum wall thickness necessary to resist collapse for a given load is found where the horizontal load lines intersect the corresponding DOC curve, as represented by the vertical dashed lines. For example, considering the maximum agricultural load scenario, at 0.6 m DOC, the minimal wall thickness to resist collapse is found where the red curve representing the 0.6 m DOC intersects the horizontal live load line for the maximum agricultural load at 1.6 mm for this example. Meaning the pipe wall would need to lose approximately 75% of the wall material to corrosion degradation before losing structural integrity under this surface load.

It should be noted that the effective live loads presented in **Figure 9** represent the live load acting directly at the pipe, considering allowable contribution from surface loading. The live load capacity decreases slightly with depth of cover, as the contribution from soil loads will be greater at depth. Comparing of Figure 10 and Figure 11 indicates that the added load from soil is minor in comparison to the benefits of depth of cover, however. For comparison, considering an HS-20 load at the ground surface, the effective live load at the pipe for a relatively shallow depth of cover of 0.6 m is two times greater than the effective live load considering a 1.2 m depth of cover, while the load capacity is only reduced approximately 8% due to soil loading.

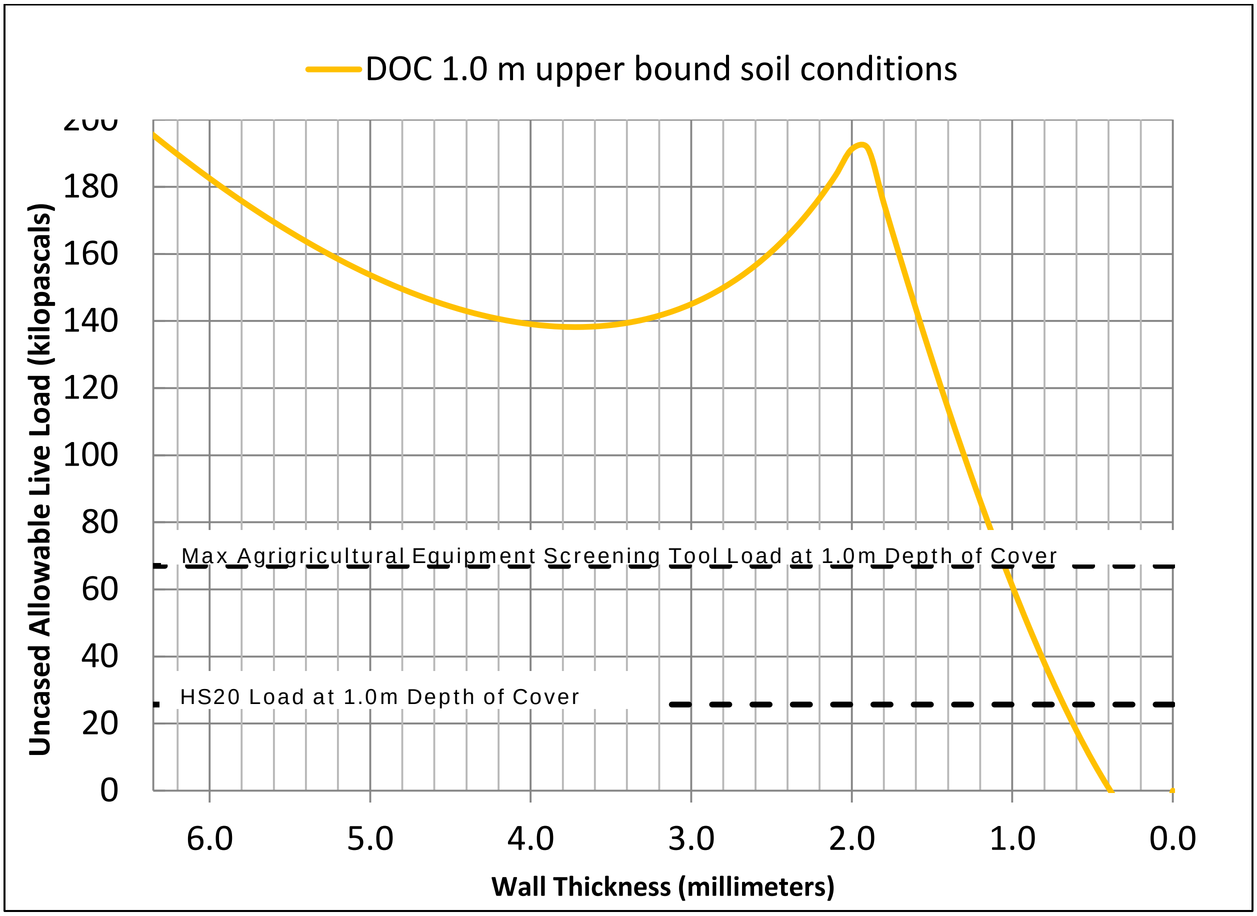


Figure 8: Uncased Effective Load Bearing Capacity versus wall thickness

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Line 10 Westover Segment Replacement Project

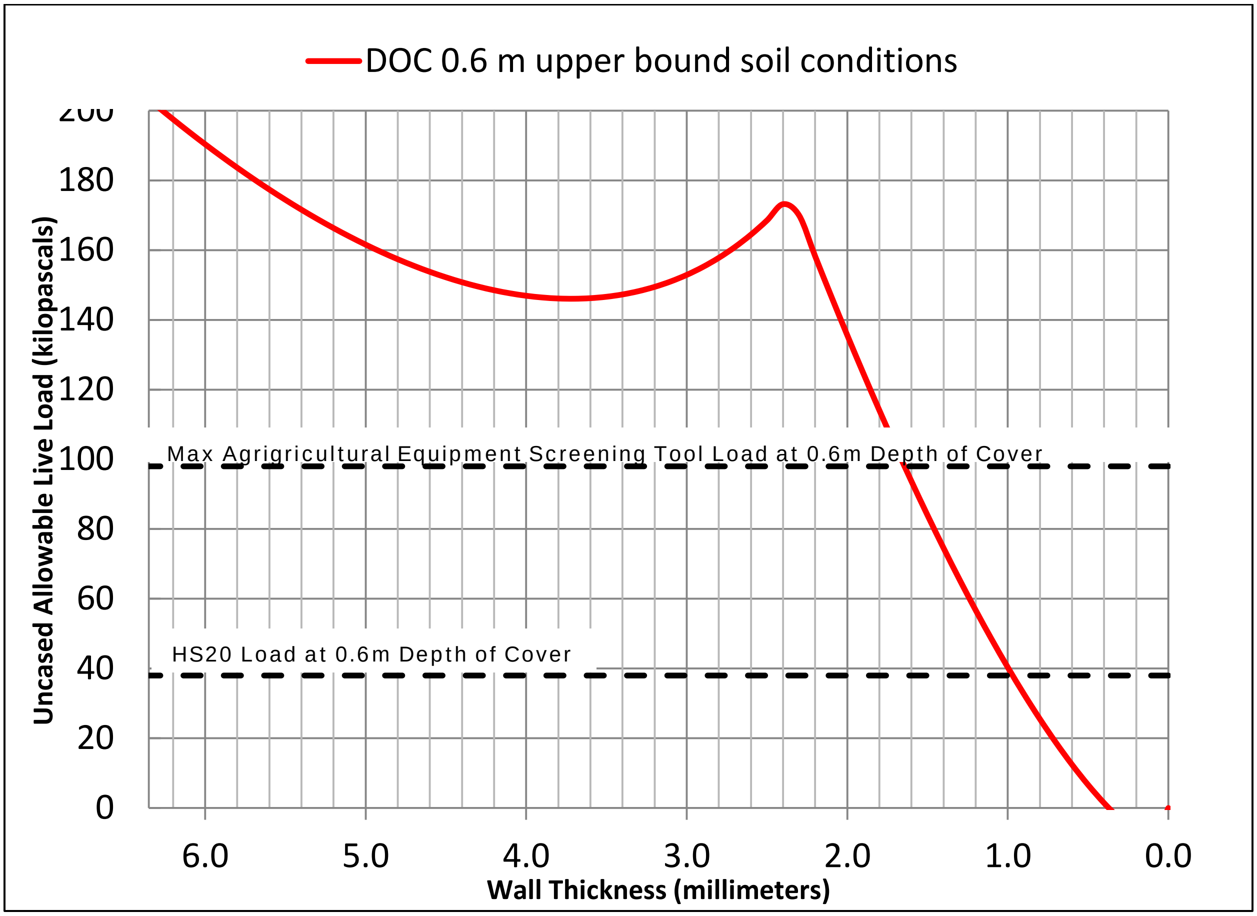

Figure 9: Uncased Effective Load Bearing Capacity versus wall thickness

Table 3 summarizes the minimum effective wall thicknesses, necessary for the decommissioned segment of Line 10 to resist collapse at various depths of cover and considering the two loading scenarios: 20-tonne truck load, and the maximum agricultural load. The assumed depths of cover in **Table 3** are based on the following:

- 0.6 m is approximately the minimum measured depth of cover in the 2007 depth of cover survey completed on Line 10; and
- 1.2 m is the typical depth of cover as measured in the 2007 depth of cover survey completed on Line 10;

Table 3:
Minimum Allowable Uncased Wall Thickness Capable of Withstanding the Maximum Agricultural and Highway Loads

DOC (m)	Minimum Allowable Wall Thickness (mm)	
	Max. Ag. Load	HS-20
0.6	1.6	1.0
1.2	1.0	0.7
1.5	0.9	0.6

Table 4 illustrates that the predicted time to failure under the maximum agricultural load assuming uniform wall loss (i.e. the pipe wall has thinned to the extent that it can no longer support the live load under a highway or railway) varies from approximately 500 years to greater than 1,000 years depending upon the assumed soil classification and drainage.

Table 4:
Time to Critica Wall Loss Estimates Based on Uniform Corrosion and Considering the Maximum Agricultural Load

	Time to Critical Uniform Wall Loss (yrs) Considering Max Ag. Load	
DOC (m)	PTAC Upper Bound Rates	PTAC Lower Bound Rates
0.6	501	8,011
1	642	10,262
1.2	665	10,650
1.5	683	10,921

At the minimum measured depth of cover (0.6 m) the decommissioned Line 10 is capable of resisting collapse due to the maximum agricultural load until sufficient corrosion degradation occurs such that the effective wall thickness is reduced to 1.6 mm, or approximately 75% uniform reduction of the nominal pipe wall thickness for Line 10.

The 2007 depth of cover survey completed on Line 10 indicates that approximately 1% of the line has a depth of cover less than or equal to 0.75 m and approximately 65% of the readings indicate the Line 10 DOC is between 0.9 and 1.25 m. It should be noted that these analyses were performed considering only the strength of the carrier pipe. All King's highway and railway crossings are expected to be cased as per original design recommendations.

1.18. Pipe Collapse Due to Pitting Corrosion

Based on the corrosion growth estimates in Table 4, the expected corrosion progression presented, and the effects of coating and CP, it is considered unlikely that a sufficient length of pipe will corrode uniformly to the point of significant collapse. An alternative scenario to assess, therefore, is to consider randomized perforations growing through wall and outward, resulting in coalescence and larger perforations. As part of Enbridge's previous decommissioning studies, finite element analysis ("FEA") was performed to analyze the strength of a corroded pipeline at various levels of degradation. A finite element ("FE") model was developed to simulate a NPS 34 pipeline subject to localized corrosion and perforation. The model was generated to simulate a top loaded pipe with randomized corrosion localized around the 3 and 9 o'clock positions, which is consistent with the positioning of historical corrosion indications for Line 10, as shown in **Figure 10**.

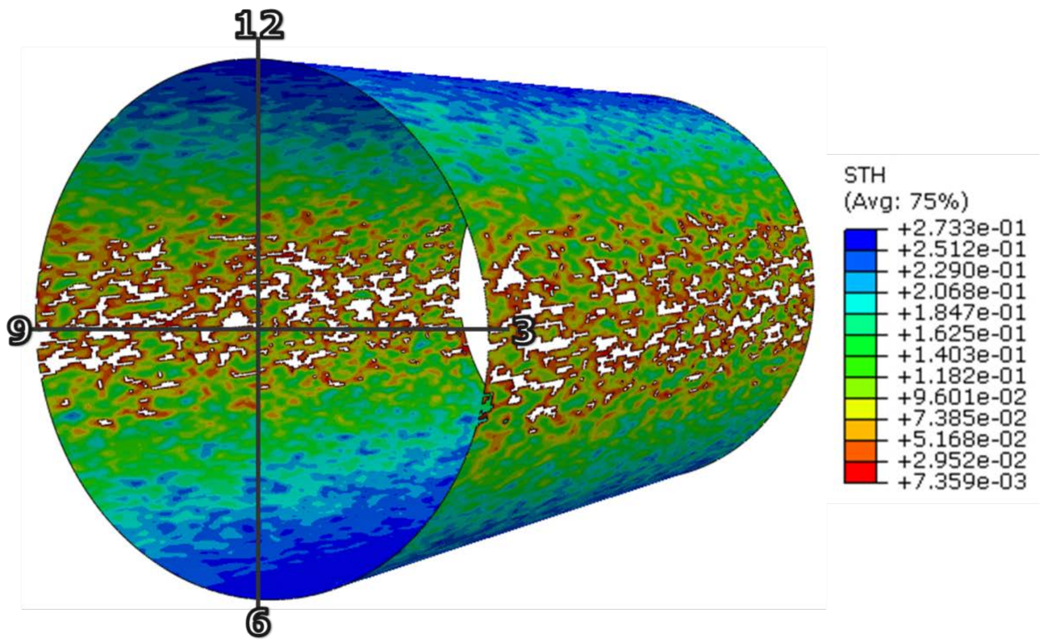

Figure 10:
Finite Element pipe model simulating approximately 75% wall loss along the 3 o'clock and 9 o'clock positions for a NPS 34 pipeline. NOTE: "STH" stans for "Shell Thickness." Elements representing no effective wall thickness have been removed for visual representation.

Multiple scenarios were analyzed considering varying levels of corrosion growth and perforations through the pipe wall due to coalescing. Various surface loading scenarios representative of potential loading conditions along the NPS 34 pipeline were evaluated.

The primary conclusion of the analyses indicated that the decommissioned pipe was expected to retain significant structural integrity, as a load bearing structure, even with significant levels of random localized corrosion.

The detailed FEA modeling results indicated that at corrosion levels representing greater than 75% of wall loss (i.e. less than 25% remaining wall thickness), the NPS34 pipe was expected to retain structural integrity sufficient to support an HS-20 load at a 1.2 meter depth of cover. These results are expected to be conservative for an NPS12 pipe, as the depth to diameter ratio is greater, and there will be less load transferred to the pipe for a given surface load and depth.

Based on historical corrosion performance, and estimated long term corrosion rates, the estimated time to corrode the decommissioned Line 10 to this level of degradation is greater than 1,000 years.

1.19. Historical Ground Subsidence

In 1996 the NEB commissioned a study on corrosion and soil mechanics in an attempt to better understand the connection between pipeline corrosion, structural integrity, and the possible ground subsidence that might be observed. The results of this study indicated that there had been no documented incidents of ground subsidence related to pipeline structural failure and this included the 17,000 km of abandoned or discontinued pipe, as of 1994, in Alberta.[3] The study further stated that ground subsidence associated with the collapse of pipelines is negligible for pipeline diameters up to 323.9 mm (12 inches) in diameter, at typical depths of cover. The 1996 Discussion Paper concluded after significant study that even under the worst conditions of total structural collapse, ground subsidence would be negligible for pipelines with diameters of 12-inches and smaller.

Provided in the following section is a geotechnical analysis that was performed to assess the possible magnitude of subsidence that could be associated with the total collapse or infill of the decommissioned segment of the 324 mm diameter Line 10.

1.20. Predicted Subsidence Profiles

The rate and magnitude of ground subsidence are generally difficult to predict.[3] Subsidence depends on a complex combination of site-specific parameters, pipe degradation, and soil mechanics properties near the pipeline. In 2015 as part of developing the Engineering Basis for the Line 10 Decommissioning Program, Enbridge commissioned DNV GL to provide a geotechnical analysis to determine the possible subsidence levels, and corresponding trough profiles that could occur assuming various levels of pipe infill, up to and including full loss of pipe volume.

Ideally, ground subsidence estimations should consider both total subsidence from pipe collapse at shallow burial depth, and partial subsidence due to excessive ovalization and/or finite soil ingress. Prediction of ground subsidence in the absence of significant external loading can be predicted through analogy with tunneling construction. Extensive field measurements[40,41,42] have shown that the subsidence profile, or settlement trough, during open-face tunneling construction can be well characterized by the Gaussian distribution curve method as shown in **Figure 13**.

Research and field observations have shown that the ground displacement profile predicted by the tunneling approach is applicable to tunnels with DOC greater than four times their diameter. Therefore, this approach is applicable to sections of the decommissioned segment of Line 10 which have DOC greater than four times the pipeline's diameter, or 48 inches (1.2 m).

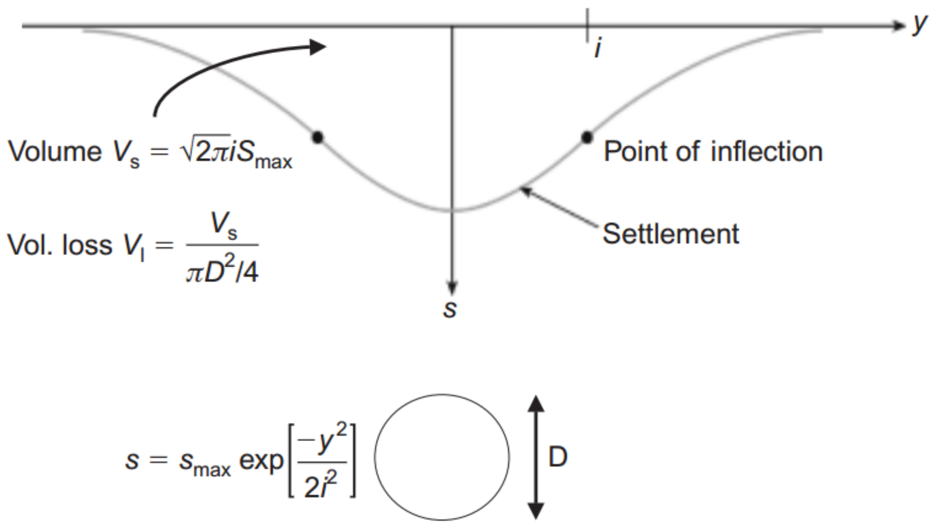

Figure 13: Generic ground settlement trough considering Gaussian Distribution Curve Method

A series of assessments were conducted to predict the ground subsidence profiles considering 25%, 50%, 75% and 100% volume loss at various depths of cover. 100% volume loss represents complete infill of the pipeline, while the 25%, 50% and 75% volume loss estimates represent a partial infill of the pipeline.

Table 5 summarizes the maximum depth of the ground subsidence expected above the centre line of the decommissioned segment of Line 10 for different levels of pipe infill (i.e. 100%, 75%, 50% and 25% infill) and depths of cover (i.e. at 0.6m, 1.0 m, 1.2m). The results of this assessment substantiate the previous publications indicating that the possible magnitude of subsidence associated with the complete collapse of a 12-inch pipeline is negligible. For the decommissioned segment of Line 10 the worst case scenario involving a DOC of 0.6 m and complete infill of the pipe (100% volume loss) would result in a maximum subsidence of approximately 21.5mm (0.8 inches).

Table 5:
Maximum predicted ground displacement for the decommissioned segment of Line 10

Depth of Cover	Volume Loss			
	25%	**50%**	**75%**	**100%**
0.6	5.37mm	10.75mm	16.12mm	21.49mm
1.0m	4.77mm	9.54mm	14.31mm	19.08mm
1.2m	4.52mm	9.03mm	13.55mm	18.06mm

1.21. Limitations

The tunneling approach is primarily used for ground displacement associated with less than 20% volume loss. However, laboratory tests simulating the complete collapse of tunnels showed that the developed displacement profiles are similar to the inverted normal (Gaussian) settlement distribution profile predicted by the tunneling approach.[3] Therefore, it can be assumed that these assessments will give representative magnitudes and displacement profiles associated with the postulated volume loss for Line 10.

The tunneling approach is more appropriate to ground displacement caused by immediate collapse rather than time dependent displacement from infill or compaction of soil. This would therefore be applicable for estimating subsidence due to collapse due to possible overload.

1.22. Crossings

The NEB states "All crossings associated with a pipeline that is being [decommissioned] must be addressed in an appropriate manner. Of particular importance are the terms contained in agreements relating to the crossings of railways, King's Highway, roads, other pipelines, power lines, and communication lines, and the conditions they may place on the [decommissioning] process."1

The specific issues to be addressed with respect to crossings in the development of a program to decommission in place are determining the structural capacity of the pipeline and possible casing.

Predicted subsidence profiles have been shown to be negligible for the decommissioned segment of Line 10. Additionally, it should be noted that the depth of cover at crossings will be generally greater than the 1.2 m average, as installation practices, and design criteria generally require more cover at such locations, and the Line 10 is cased at King's highway and railway crossings. The actual depth of cover associated with the railway crossings on Line 10 will be verified during detailed engineering.

Enbridge proposes the following treatment for specific crossing types. To ensure the safety of the general public, additional monitoring of railroad and King's highway crossings will be done using visual inspection of the roadway as well as void detection technology to inspect for early indications of voids that could result in subsidence.

TABLE 6
Justification for Treatment by Crossing Location

Crossing	Treatment		Justification
	Routine monitoring	Void Detection	
Active Railways	yes	yes	low consequences of subsidence, casing present, currently minimal corrosion indicated
Inactive Railways	yes	no	inactive, currently minimal corrosion
King's Highways	yes	yes	consequences of subsidence, high traffic volumes, casing present, currently minimal corrosion indicated
Municipality Roads	yes	no	lower traffic volumes, smaller loads, and impacts
Landowner drive ways	yes	no	lower traffic volumes, smaller loads, and impacts
Other utility crossings (cable, sewer, etc.)	yes	no	buried utility piping and cable should span voids without issue

1.23. Casings

At the time of construction of Line 10, all King's Highway and railway crossings were intended to be cased by design specifications. The benefits of casings with respect to structural integrity of the pipeline and any cased crossing locations should be noted. Presently, the structural integrity models presented were based solely on the capacity of the carrier pipe, and conservatively ignored any benefits of the casings.

The primary benefit of casings, with respect to structural integrity and loading capacity are that casing pipes, while intact, will provide additional structural support to the decommissioned carrier pipe. Secondly, from a risk perspective, casings will provide a secondary barrier to failure, either by corrosion or structural collapse, meaning that both the casing pipe and the decommissioned carrier pipe would have to fail prior to any substantial ground subsidence at a cased crossing.

1.24. Mitigation strategy

As stated above, subsidence due to pipe or casing corrosion associated with the 324 mm diameter decommissioned segment of Line 10 is expected to be negligible. While the proposed decommission plan involves maintaining CP to extend the life as a load bearing structure, it is recognized that, "…in the long term, any pipeline left in place would eventually degrade to the point that a void exists in the ground".6 The terms, 'long-term' and 'eventually', cited here were intentionally vague, as they refer to site specific conditions. The analyses presented have shown that this 'long-term' may be in the order of centuries or more.

To address the risks associated with long-term corrosion and possible subsidence Enbridge will:

- Continue to monitor the decommissioned segment of Line 10 as part of its ongoing Operations and Maintenance programs;
- Survey, assess, and mitigate the depth of cover over the decommissioned segment of Line 10 in accordance with the Operations and Maintenance Manuals ("OMM") and Enbridge's Pipeline Depth Monitoring Program ("PDMP");
- Monitor and apply the CP in perpetuity in accordance with Enbridge's OMMs;
- Perform ground-truthing to identify and confirm the number and location of crossings; and
- Perform enhanced monitoring of active railroad and King's highway crossings using visual inspection of the roadway/railway as well as void detection survey.

Further details related to Enbridge's monitoring approach are provided in the "On-Going Monitoring" section of this report.

1.25. Summary and Conclusions

The primary conclusions of the analyses provided are as follows:

- Based on the PTAC corrosion rate curves presented, and comparison with historical ILI data for Line 10, the estimated time to through wall penetration was calculated to be between 16 to 22 years from 2012.
- The results of the subsidence magnitude calculations substantiate the previous work indicating that subsidence associated with the decommissioned segment of Line 10 is expected to be negligible (i.e. ≤ 21.5 mm).
- The results of the FEA model considering random perforations indicate the decommissioned segment of Line 10 will maintain the majority of its structural strength until greater than 75% of the pipe's circumference is lost due to coalescing of perforations.

1.26. Special Treatment Areas

Risks not otherwise addressed in the previous sections of this Application which necessitate additional decommissioning scope are covered within this section. The additional risks identified by the Risk Assessment are buoyancy control, erosion, slope stability, and water conduits. The likelihood of each is dependent on numerous variables including depth of cover, soil type, and land use.

To assess the possible Special Treatment Areas the 2007 DOC survey was reviewed to assess the depth of cover along the ROW of the segment of Line 10 proposed to be decommissioned, and identify any potential locations of concern. More than 1,300 survey points were reviewed for the approximately 32 kilometers long segment. The DOC was cross-referenced with the Land Use Type classifications reported by the HM Falcon survey. A histogram of the survey data is shown in Figure 14. The average DOC was calculated as 1.22 m, with a minimum reported DOC of 0.53 m at a single location. A majority of the readings, approximately 65%, indicate the Line 10 DOC between 0.9 and 1.25m. A total of five unique locations with DOC of less 0.75 m were reviewed, and compared to the reported land use categories as shown in **Table 7.**

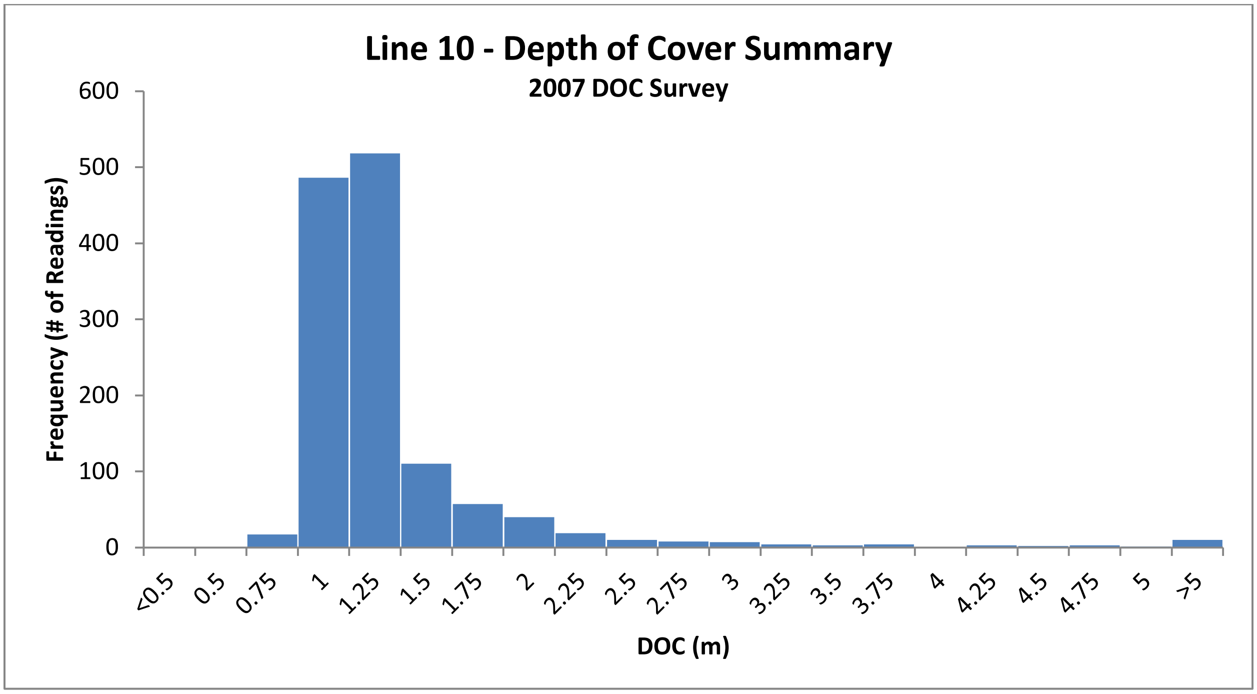

Figure 14: Histogram plot of 2007 Line 10 DOC survey data

Table 7

Line 10 DOC Survey Summary for the proposed to be Decommissioned Segment of Line 10

Location	DOC Range (m)	Land Use	Land Use Type
1	0.73	Agricultural / Unused	Arable / Brush
2	0.70 – 0.71	Arable	Agricultural
3	0.60 – 0.67	Brush	Unused
4	0.53 – 0.74	Landscaped / Arable	Recreational
5	0.69 – 0.73	Arable	Agricultural

1.27. Buoyancy Control Considerations

The 2007 CEPA Report recommends that the probability of a decommissioned pipeline becoming exposed, and the impacts that exposure would entail, should be assessed in high water table areas and at water crossings as part of the decommissioning or abandonment plan.[1]

During operation, the product provides additional weight to keep the pipeline from floating. Once the product has been displaced from the line, pipeline sections without sufficient negative buoyancy could float without mitigation. A preliminary analysis of the soil and depth of cover data along the proposed to be decommissioned segment of Line 10 was conducted to determine areas with potential buoyancy control issues. Land data from Line 10 surveys were compared with DOC to identify potential areas of concern. Only one location along the ROW of the proposed decommissioned segment of Line 10 was identified as “Marsh”, and the corresponding DOC measurements generally range from 1.4 m to 4.5 m at this location. Additional review and comparison with the typical soil type and water table at this location can be completed during the detailed engineering to provide.

Where concerns with buoyancy control exist, mitigation methods may include set-on or bolt-on weights, adding engineered fill to the pipeline, using screw piles with straps, or additional cover (where groundwater is causing buoyancy issues). Areas identified with insufficient negative buoyancy will undergo further assessment during detailed engineering, including the required mitigation methodology.

The ongoing monitoring program will provide further support in identifying any pipe sections exposed by buoyancy.

1.28. Frost Heave Considerations

The DNV GL Scoping Study identified frost heave as a potential geohazard risk for decommissioned pipelines, specifically with respect to the potential for pipeline lifting and eventual exposure. Frost heave is a recognized geohazard for pipelines in operation; however the DNV GL Scoping Study reports that no literature was found related to potential for frost heave on abandoned pipelines[6].

The susceptibility to frost heave is dependent on the local water table, and the frost depth for the region. Pipe lifting due to frost heave is most prevalent considering a frost bulb below the pipeline, contributing to uplifting forces over the affected distance. The proposed decommissioned segment of Line 10 runs through Southern Ontario, where the expected frost line varies between 1.0 to 1.2 m, as shown in Figure 15. It is therefore expected that the ground frost line is typically at or above the top of the pipeline at these depths, and possible ground freeze would not act to lift the pipe.

Additionally, Line 10 shares a ROW in close proximity to one 20-inch active pipeline. Recent literature suggests that the heated zone surrounding a pipeline operating at 20°C may extend for several meters depending on the specific local soil conditions.[45] Based on this premise, it is probable that the adjacent operating pipeline would provide some level of heat transfer to reduce the ground freeze depth for the adjacent Line 10. The decommissioned segment of Line 10 will not contribute to the formation of ice or frost bulbs since it will not transport any product and the pipeline temperature will be equal to that of the surrounding soil.

Additionally, Enbridge's depth of cover surveys will identify locations of soil upheaval, loss of soil coverage, or thaw subsidence areas where decommissioned segment of the pipeline has reduced cover regardless of the cause. Areas with insufficient depth of cover will be assessed and mitigated according to Enbridge's OMMs.

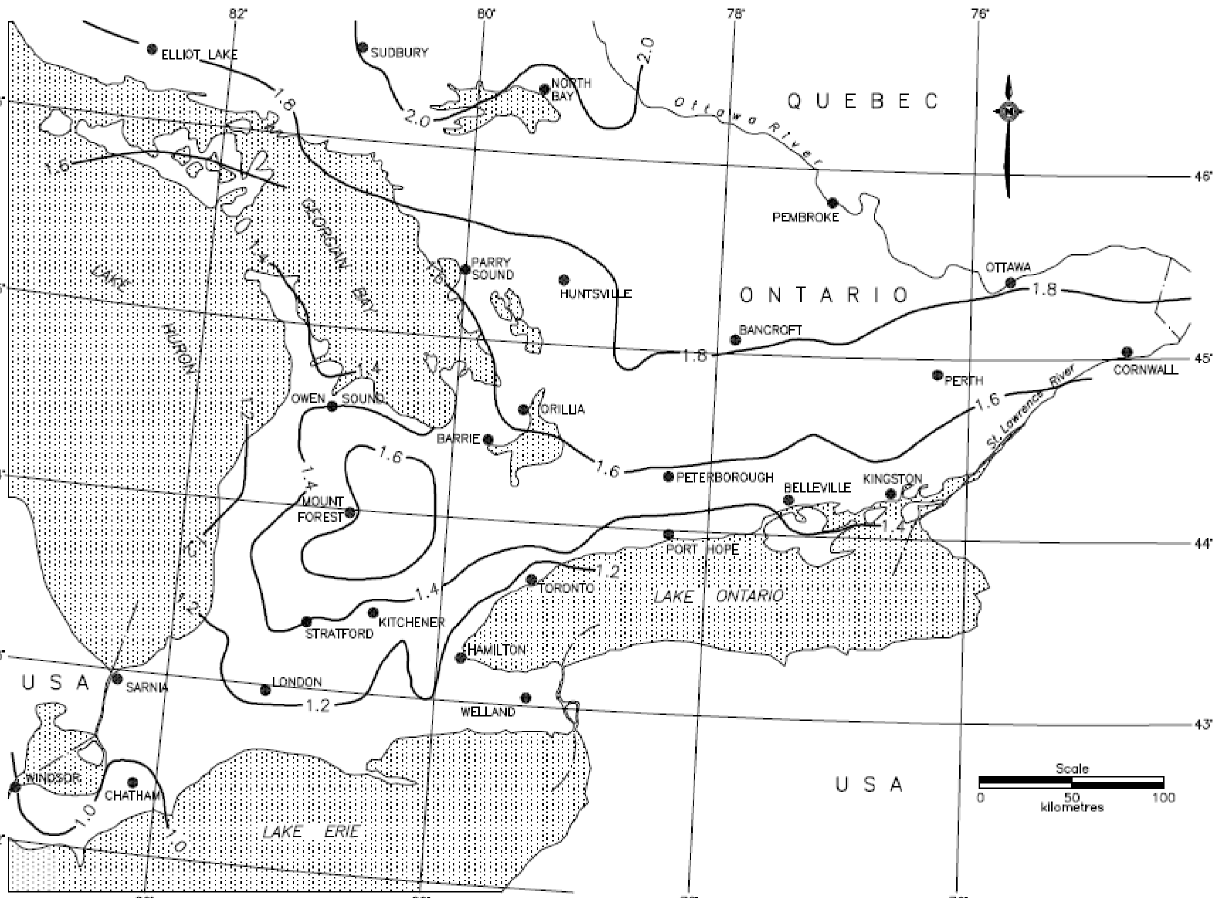

Figure 15: "Foundation, Frost Penetratiion Depths for Southern Ontario (OPSD 3090.101 rev.1" 2010)
(Reproduced from Ontario Ministry of Transportation)

1.29. Erosion

1.29.1. Slope stability

The 2007 CEPA Report (Section 3.7) indicates that the preferred option for sections of the pipeline on a slope is decommissioning in place because over time, the pipeline may play a key role in reinforcing and stabilizing a slope.[1] This may also decrease environmental risk by decreasing or removing the need for protective measures (e.g., berms, ditch plugs, sub-drains, etc.) that are required due to ground disturbance when a pipeline is removed rather than decommissioned in place.

Areas of possible slope instability and their current mitigation strategies will be reviewed during detailed engineering. As part of ongoing monitoring, unstable slopes are identified, regularly monitored, assessed, and remediated, as necessary as described in the ESA "Erosion and Slope Stability" section of that report which forms part of this Project application.

1.29.2. Water Conduits

The risk of an abandoned pipeline acting as a water conduit is acknowledged by the NEB, DNV GL, and CEPA reports. Should a corrosion defect propagate through-wall in the decommissioned segment of Line 10 under a water body/watercourse or high water table area, there is potential for the pipe to act as a water conduit displacing water to another location along the pipeline. To limit the possible impact on water bodies as required by CSA Z662-15,[4] segmentation of the decommissioned segment of Line 10 will be accomplished as described in Section 12.9.5, isolating the identified regions.

At water crossings and locations where soil density is low when saturated, and the water table is high for some or all of the year, e.g., marsh land, there is increased potential for the associated consequences of water transport. This will be mitigated through the pipeline cleaning regimen described in the "Pipeline Cleaning" section of this report and the monitoring program described in the "On-Going Monitoring" section of this report. Pipeline cleaning will ensure that the potential environmental impact of any water transport that may occur will be minimized. Monitoring will allow for identification, assessment and mitigation, if required, of any adverse effects that may arise from water transportation.

Additional affected areas may be developed by the water conduit effect where substances in the soil could adversely affect downslope locations. These risks will be mitigated through monitoring and segmentation. Refer to the ESA and the Environmental Decommissioning Technical Report "Potential for Creation of Water Conduits" for more information.

Segmentation locations and methodology are addressed in the "Pipeline Segmentation" and "Locations For Decommissioning Activities" sections of this report.

1.30. Salvage and Disposal of Ground Facilities, Pipe and Water

As per the Enbridge Waste Management Plan, any removed piping, valves or instrumentation will be salvaged or disposed of at an approved facility. Items which require proper salvage and disposal may include, but are not limited to:

- short sections of pipe removed for the purposes of isolation at Westover Terminal and Nanticoke Junction;

- piping and valve stems removed as part of stand-alone valve site segmentation and restoration;
- electrical or instrumentation items removed at Westover Terminal and Nanticoke Junction; and
- waste or debris produced by decommissioning construction activities.

For displacement, cleaning, and general construction activities all waste water will be treated and/or disposed of according to applicable laws, regulations and Enbridge OMM. Applicable provincial regulations may include but are not limited to the *Ontario Water Resources Act.*

1.31. Reclamation of Areas Disturbed

Decommissioning in place will mitigate many of the issues involved in soil removal, replacement and stabilization that occur with complete removal of the pipeline. It will also decrease the overall impact on environmentally sensitive areas (e.g., wetlands, parks, species-at-risk habitats), water crossings, forested lands, developed areas (e.g., commercial, industrial, residential), non-cultivated lands (native prairie, rangeland), road and rail crossings and cultivated areas. If residual contamination from a historical release is encountered during decommissioning activities, it will be assessed and remediated according to the NEB Remediation Process Guide in accordance with the currently applicable standards.

As per Enbridge standard practices (OMM) and applicable federal and provincial regulations, any ground disturbance caused by decommissioning activities will be remediated through erosion control measures, ditch plugs, soil and slope stabilization, re-vegetation and reforestation as appropriate to the location as discussed in the ESA “Decommissioning Treatment Assessment” section of that report in this Application. Work areas and work scheduling will be selected to minimize impacts to native and migratory species. The full environmental assessment is contained in the Project ESA.

1.32. On-Going Monitoring

Enbridge will continue to monitor the decommissioned segment of Line 10 as part of its ongoing Operations and Maintenance programs. Certain applicable monitoring procedures currently practiced on active pipelines will be extended to the decommissioned pipeline, in order to address the risks identified in Section 1.6. Operations and Maintenance activities to continue include:

- Completing pipeline inspections during patrols;
- Assessing areas of potential geotechnical threats;
- Maintaining pipeline signage;

- Performing depth of cover surveys; and
- Monitoring the CP system in perpetuity.

The decommissioned segment of Line 10 will also remain a part of Enbridge's programs for damage prevention and safe work practices, which include:

- Continuing Enbridge's public awareness program; and
- Ensuring ground disturbance activities by the Company or third parties in the vicinity of the decommissioned segment of Line 10 are done in accordance with Enbridge's construction specifications and OMMs. Typical requirements are:
    - specifying safe work distances during excavation;
    - surface locating and identifying the pipeline;
    - ensuring pipeline is crossed in a safe manner and applying temporary ramps or matting when required; and
    - verifying that construction activities do not negatively impact the structural integrity of the pipeline or its CP system.

As previously discussed in the "Crossings" and "Mitigation strategy" sections of this report, void detection technology will be used to inspect for cavities beneath King's highways and active railways that could potentially result in surface subsidence.

Enbridge periodically reviews and revises its standards and procedures to incorporate regulatory and legislative changes, updated safe work practices and industrial knowledge, and new technology. As such, the on-going monitoring of the decommissioned segment of Line 10 will progress in the same manner as Enbridge's active pipelines.

1.33. Right-Of-Way Patrols, Geotechnical Threat Assessments and Signage

To protect the public in proximity of the pipeline, the environment, and the integrity of the pipeline, the ROW is monitored by:

- Patrolling the entire ROW plus the adjacent land;
- Documenting and assessing abnormal conditions or activities on or adjacent to the ROW;
- Assessing areas of potential geotechnical instability; and
- Inspecting and maintaining ROW signs and markers.

ROW monitoring is completed in accordance with Enbridge OMM.

ROW patrols are completed by qualified individuals to identify abnormal surface conditions or activities on or adjacent to the ROW using methods of walking, driving, flying or other appropriate means, periodically. Any abnormal condition or activity will be recorded. Enbridge will complete additional investigations when warranted. These investigations include documenting the location and condition of exposed pipe, and assessing the effects of unsupported spans, atmospheric corrosion, and third party damage on the pipeline. Remediation activities are planned based on the risk associated with the abnormality. Remediation options include, but are not limited to:

- On-going monitoring;
- Improving community awareness; or
- Providing additional depth of cover, buoyancy control, pipeline protection, cladding, matting, or drainage control.

Warning signs and line markers are located in key areas to promote awareness in the vicinity of the decommissioned segment of Line 10. These signs will be visually inspected during regular patrols and, when required, the key information on the signs will be updated. Signage is also checked annually to ensure signs are not missing, vandalized, or damaged, and are visible from appropriate roadways and railways.

1.34. Pipeline Depth Monitoring Program

Depth-of-cover surveys utilize electromagnetic line locating equipment or equivalent technology to accurately locate and record the depths for each pipeline in the ROW. The depth of cover over the decommissioned segment of Line 10 will be surveyed, assessed, and mitigated in accordance with the OMM. The depth of cover survey program for the decommissioned segment of pipeline will be completed at least once every ten years. The frequency for the depth of cover survey program may be reduced for portions of this segment based on internal risk assessments.

The depth of the pipe will be measured and recorded at predefined intervals down the ROW. Additional measurements will be taken on either side of a location with insufficient depth of cover. Physically probing for pipeline depth will be used to validate non-intrusive depth measurements.

If the measured depth of cover of the decommissioned segment of pipeline does not meet minimum requirements, a risk analysis will be conducted to assess whether mitigative action is required. This risk analysis will consider land use, underground structures in close proximity, and/or adverse conditions that may prevent the maintenance of such cover. The risk assessment will determine if further action is required, such as:

- Adding soil over the pipeline;
- Lowering the pipeline;

- Developing new agreements to restrict land use with the appropriate stakeholders; or
- Installing mechanical protection over the pipeline.

1.35. Cathodic Protection

CP will continue to be applied to reduce corrosion rates of the decommissioned segment of pipeline. An evaluation of the CP system for the decommissioned segment will occur during detailed engineering. Any modifications to the system will be designed in accordance to regulatory requirements, industry standards, and Enbridge design standard D04-101. After decommissioning the segment of Line 10, the CP system will be applied and monitored in accordance with Enbridge OMM. The application of CP to the decommissioned segment in perpetuity will be assessed on a periodic basis.

1.36. Void Detection

To ensure the safety of the general public, enhanced monitoring of active railroad and King's highway crossings will be done using visual inspection of the roadway/railway as well as void detection technology. The frequency of this new monitoring program will be determined during detailed engineering. In the event that a deficiency is found during the monitoring program, a risk assessment will be conducted to determine if remediation activities are required.

1.37. Schedule and Cost of Activities

1.37.1. Cost

The estimated cost for the decommissioning of Line 10 is approximately $5 million, based on the current Scope of Work as outlined in this filing. Per Guide K of the NEB Filing Manual, Enbridge confirms that funding is available to finance the proposed decommissioning Project scope. The costs associated with decommissioning are being financed by United Refining Company.

1.37.2. Schedule

A preliminary milestone schedule for decommissioning the pipeline is provided in **Table 8** below. The schedule will be confirmed and refined during detailed engineering and is subject to Regulatory approval.

Table 8
Project Milestone Schedule

Project Milestones	Year complete
Detailed Engineering	2016
Displacement of Line 10	2018
Cleaning	2018
Isolation Activities	2018
Segmentation Activities	2018
Project Close-Out	2019

1.38. Decommissioning Implementation

The following subsections apply to decommissioning both the segment of pipeline and the associated facilities.

1.39. Resources

The preliminary estimate of the work force required to complete decommissioning is between 30 and 50 people; the work force will consist of Enbridge management, project managers, engineers, and construction related staff. Required resources will be engaged at the time of their applicable phases of the project. Further refinement of the resources required will be determined during the detailed engineering and planning phases.

The preliminary professional and labour resources include the following:

- Enbridge Project Management
  - An Enbridge Project Execution team dedicated to the oversight of the detailed engineering, construction planning including production of Project Execution Plan and Construction Execution Plans, testing activities, and physical activities on-site.
- Detailed Engineering
  - A qualified engineering firm will be contracted to perform the detailed engineering activities
- Displacement
  - Enbridge personnel using qualified contractors will oversee the displacement of product and the cleaning activities.
- Cleaning
  - Enbridge personnel using qualified contractors will oversee the displacement of product and the cleaning activities.
- Isolation

    - Enbridge personnel using qualified contractors will perform the cut and plate operations to physically isolate the decommissioned segment of Line 10 from existing facilities at Westover Terminal and Nanticoke Junction, and the one valve location.
- Segmentation
    - Enbridge personnel using qualified contractors will install the environmental segmentation plugs using the minimal invasive installation techniques proven during the detailed engineering phases.
- Final Clean Up/Restoration
    - Enbridge personnel using qualified contractors will perform final clean-up and restoration of any disturbed sites.

Personnel will require the appropriate qualifications as specified by Enbridge for the work they are responsible for and where applicable will be required to demonstrate those qualifications (e.g., contractors, welders, heavy equipment operators, etc.).

1.40. Logistics

In order to facilitate the proposed scope of work, decommissioning will involve the movement of equipment, materials, and supplies to existing yards and staging areas along the ROW, as well as the use of temporary workspace, as required.

1.41. Inspection

Enbridge will supervise and inspect the decommissioning activities with qualified construction and environmental inspectors to ensure compliance with all applicable regulations, standards and codes.

1.42. Quality

Project Procurement will implement and coordinate quality processes and requirements with the Project Quality Manager. These work processes and requirements will address quality checks during the procurement cycle, including third party inspection at vendor facilities. The processes and requirements will include:

- use of Enbridge pre-qualified vendors;
- quality checks during materials requisitioning and purchasing activities;
- review and approval of quality inspection and testing plans; and
- third-party inspection at vendor facilities.

Quality inspection at vendor facilities will be performed by third-party inspectors. Inspection reports will be submitted for Enbridge's review after each inspection. Project Procurement will coordinate reviews of the inspection reports with the Project Quality Manager and respective discipline leads for acceptance and/or further action. Any materials and equipment received at site or at Enbridge staging facilities that are assessed by Enbridge and its representatives as being non-conforming in any technical aspect will be quarantined and managed in accordance with Enbridge OMMs.

A project specific Quality Management Plan will be developed during detailed engineering.

1.43. Engineering Decommissioning Design Principles

The decommissioning of the 32 km segment of Line 10 will be designed, implemented, and monitored in accordance with CSA Z662-15,[4] the OPR,[29] the NEB *Filing Manual* (2015) Guide B,[30] the NEB Filing Manual (2015) Guide K, Enbridge specifications, standards and procedures, and other applicable industry codes and standards. All other project specific commitments made by Enbridge for the decommissioning of the 32 km segment of Line 10 including commitments made to the NEB by this Application, landowner agreements, third party crossing agreements, the ESA, etc., will be incorporated into the design, execution, and on-going monitoring of the decommissioned pipeline.

1.44. Compliance with Primary Codes and Standards

The CSA Standards listed in **Table 9** will be adhered to in the isolation design and decommissioning activities for the Project.

Table 9
Industry Standards for Pipelines and Facilities

Standard*	Title
CSA Z662-15	Oil and Gas Pipeline Systems
CSA Z245.1-14 (9th edition)	Steel Pipe**
CSA Z245.11-13 (7th edition)	Steel Fittings
CSA Z245.12-13 (7th edition)	Steel Flanges
CSA Z245.15-13 (8th edition)	Steel Valves
CSA Z245.20-10 (6th edition) / Z245.21-10 (5th edition)	Plant-applied External Fusion Bond Epoxy Coating for Steel Pipe / Plant-applied External Polyethylene Coating for Steel Pipe
CSA 22.1	Canadian Electrical Code Part I and 2, Safety Standard for Electrical Installation

Notes:
* The CSA standards in this table, as they may be amended from time to time, often incorporate other CSA standards and publications from other organizations (e.g., American Society of Mechanical

Standard*	Title
Engineers ("ASME"), American Society for Testing and Materials ("ASTM"), American Petroleum Institute ("API"), International Organization for Standardization ("ISO"), Canadian General Best Standards Board, NACE International, Structured Steel Painting Council, and Manufacturers Standardization Society). ** If applicable.	

Additional applicable regulations or industry standards and guidelines may include, however, are not limited to:

- Canada-Wide Standards for Petroleum Hydrocarbons ("PHC") in Soil (CCME 2008);[31]
- Canada-Wide Standards for carcinogenic and other polycyclic aromatic hydrocarbons ("PAHs") (CCME 2010);[32]
- Canadian Soil Quality Guidelines for polychlorinated biphenyls (CCME 1999a);[33]
- Canadian Soil Quality Guidelines for benzene, toluene, ethylbenzene and xylene (BTEX) (CCME 2004);[34]
- Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM) (Health Canada 2000);[9]
- Canadian Water Quality Guidelines for the Protection of Agricultural Water Uses (CCME 1999c);[36] and
- Recreational Water Quality Guidelines and Aesthetics (CCME 1999d).[37]

1.45. Company Standards, Procedures and Specifications

The decommissioning of the 32 km segment of Line 10 will be designed and implemented to meet the requirements contained in Enbridge's standards, procedures and specifications, as listed in the List of Manuals. These documents comply with the OPR and have been previously filed with the NEB. This list may be subject to change as individual specifications and procedures are added, updated or replaced to incorporate legislative and regulatory changes, or advances in technology or industrial knowledge.

Enbridge will employ existing OMM, standards, procedures and specifications which are on file with the Board, for the continued monitoring and maintenance of the decommissioned segment of Line 10 ROW. These manuals will be revised to include any new procedures if required by the Project. The OMM are also periodically reviewed and revised by Enbridge to incorporate legislative and regulatory changes, updated industry best practices, and new technology. OMM topics currently include:

- General reference procedures, including topics such as: regulatory compliance, incident reporting, public awareness, record keeping and training;
- Safety procedures, including safe work practices, hazard assessment, confined space entry, fire protection, lock-out/tag-out, and personal protective equipment;
- Pipeline facility procedures, including: work planning and preparation, environmental protection, ROW maintenance, foreign crossings, pipe repair and testing, and tank maintenance;
- Welding procedures, including welder qualification requirements;
- Petroleum quality and measurement procedures to ensure product quality and custody transfer measurement accuracy;
- Equipment maintenance; and
- Emergency response procedures, including pre-emergency preparedness, emergency response responsibilities and actions, product containment, recovery and cleanup, local release control point mapping and mitigation measures.

1.46. Health, Safety and Environment

All work will be conducted in accordance with applicable federal and provincial legislation, and within the requirements of the Enbridge Health and Safety Management System. Enbridge's applicable Canadian Pipeline Construction Specifications ("CPCS") and LP/MP Safety Manual are listed in the List of Manuals in the Section 7 (Engineering) of this application

For Environmental considerations during pipeline decommissioning, refer to the ESA and project Environmental Protection Plan.

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