Report to the State of Michigan

Alternatives for replacing Enbridge's dual Line 5 pipelines crossing the Straits of Mackinac

June 15, 2018

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Executive Summary

The Purpose of This Report

On November 27, 2017, the State of Michigan and Enbridge signed a wide-ranging agreement setting out a plan to improve coordination between Enbridge and the State for the operation and maintenance of the Line 5 pipeline located in Michigan, while also providing enhanced transparency to the citizens of Michigan.

In Section F of that agreement, Enbridge committed to assessing the feasibility of three alternatives to replace the dual, 20-inch Line 5 pipelines across the Straits of Mackinac (the Straits) with a new pipeline that is either:

i. placed in an underground tunnel below the Straits;

ii. installed across the Straits using an open-cut method that includes secondary containment*; or

iii. installed below the Straits using the horizontal directional drilling (HDD) method.

Enbridge also committed to report on its findings by June 15, 2018, and include in its report:

iv. the costs and engineering considerations associated with each alternative;

v. the potential environmental impacts that may result from the construction, operation and maintenance of the alternatives; and

vi. the approvals or authorizations that would be necessary to construct, operate and/or maintain each alternative.

This report summarizes the findings of Enbridge's feasibility assessment of the three alternatives, as well as the associated costs, engineering considerations, potential environmental impacts and mitigation measures, and permits and approvals.

Summary of Key Conclusions

Enbridge engaged three Lead Engineering Consultants—prominent engineering companies that specialize in tunneling, offshore pipelines and horizontal directional drilling—to assess and report on the technical feasibility of each alternative. Then, three separate teams of independent expert Engineering Consultants and three separate teams of expert Constructibility Reviewers assessed and verified the Lead Engineering Consultants' conclusions regarding feasibility and construction approach.

Simultaneous to the three feasibility studies, Enbridge engaged two respected Environmental Consulting firms—one as the Lead Consultant and another as an Independent Reviewer—to assess and verify the potential environmental impacts and mitigation measures related to each alternative. Enbridge also evaluated the U.S. regulatory and environmental permits and approvals that would be required.

* A secondary containment system provides another line of defense in the unlikely event of a failure of the primary product pipeline. The system provides containment of discharged product until the appropriate actions are taken to abate the source of the discharge and remove oil from areas where it has accumulated to prevent it from reaching navigable waters or adjoining shorelines.

Out of that process, Enbridge has concluded that the technical feasibility of the three alternatives is as follows:

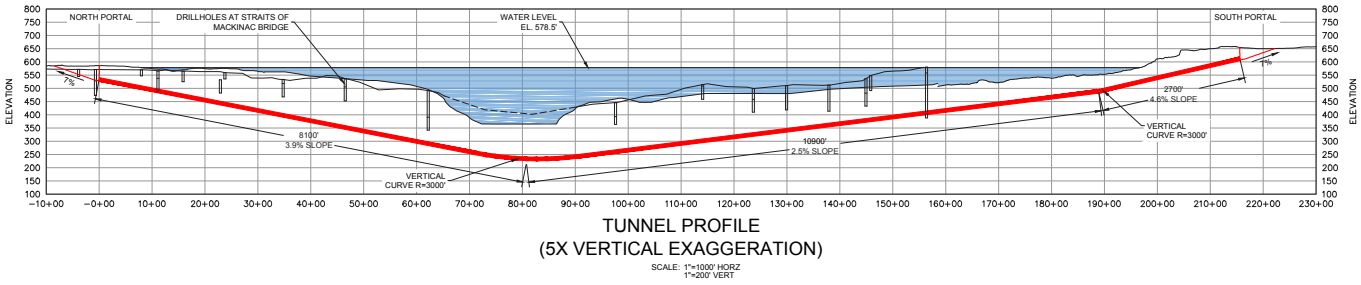
Alternative	Technical Feasibility
Tunnel	Feasible
Open cut with secondary containment	Feasible
Horizontal directional drilling	Not feasible

To view an animation and graphic illustrating the construction of the proposed Straits of Mackinac tunnel, please visit **enbridge.com/L5Alt**

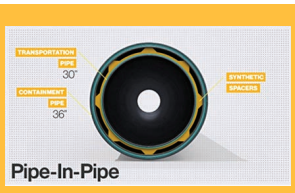
Tunnel highlights *(Figure 1)*

- Enbridge has concluded that tunnel construction under the Straits of Mackinac is feasible and, with proper maintenance and inspection, provides a safe, robust, long-term facility.
- The proposed tunnel would be excavated with a Tunnel Boring Machine (TBM).
- The maximum tunnel depth would be approximately 350 feet below the lake surface and approximately 100 feet beneath the lakebed at its deepest point.
- The completed tunnel would contain one 30-inch hydrocarbon pipeline.
- The proposed tunnel would have a 12-foot outside diameter and a 10-foot inside diameter and would be just over four miles in length, which is well within the size and length range of tunnels constructed around the world.
- Many tunnels have been completed under lakes, rivers and seas; numerous energy pipeline tunnels have been constructed to date, particularly in the last five to 10 years.
- Should this alternative move forward, detailed geotechnical investigations would be carried out to optimize tunnel design and engineering.
- The tunnel would be a portal-to-portal design, meaning tunnel construction would begin from a launch portal located near Enbridge's existing North Straits Station and finish at a reception portal located near Enbridge's Mackinaw Station on the south shore. The exact location of the two portals would be determined during the next phase of design.
- In the unlikely event of a hydrocarbon release from the pipeline, the concrete tunnel would act as a secondary containment system, with two secondary-containment features:
  - The tunnel interior would be lined with precast reinforced concrete lining that incorporates high-strength gaskets.
  - The annulus (the space outside the concrete lining) would be filled with cement grout.
- A reliability assessment of the tunnel alternative demonstrated there is no credible scenario that would result in a release of product from the tunnel into the Straits. The probability of this occurring is estimated to be negligible, which means the probability is considered to be virtually zero.

Figure 1: Profile drawing of a Line 5 Straits tunnel (illustrated with a 5x vertical exaggeration to aid visualization).



- The tunnel would avoid construction impacts to shorelines and the lakebed. It would require 10 to 15 acres of temporary workspace on the north shore entry location and two to eight acres at the south shore exit location.
- Disturbed onshore areas would be reclaimed once construction is completed. The permanent operational footprint would likely be a fenced enclosure of up to one acre for the entry and exit locations.
- The tunnel would require at least 15 state and federal permits. The primary regulators would be the U.S. Army Corps of Engineers, Michigan Department of Environmental Quality, Michigan Department of Natural Resources and Michigan Public Service Commission.
- Several local permits—zoning, building, special use, etc.—would be required from two cities, one county and one township.



Pipe-In-Pipe

To view an animation and graphic illustrating construction of a pipeline across the Straits of Mackinac using the open cut construction method and featuring pipe-in-pipe secondary containment, please visit **enbridge.com/L5AIt**

Open cut highlights *(Figures 2 and 3)*

- Enbridge has concluded that a pipeline using the open cut construction method and featuring secondary containment can be safely installed across the Straits.
- The pipeline would be a pipe-in-pipe system consisting of a 30-inch inner pipe that would carry the hydrocarbon products, and a 36-inch outer pipe that would provide secondary containment.
- The 36-inch outer pipe would include a leak detection system, enabling continuous real-time monitoring of the pipe-in-pipe annulus (the space between the inner and outer pipe) so that any leak from the 30-inch pipe can be identified and immediate action can be taken, including system shut-down.

Figure 2: Proposed pipe-in-pipe system configuration.

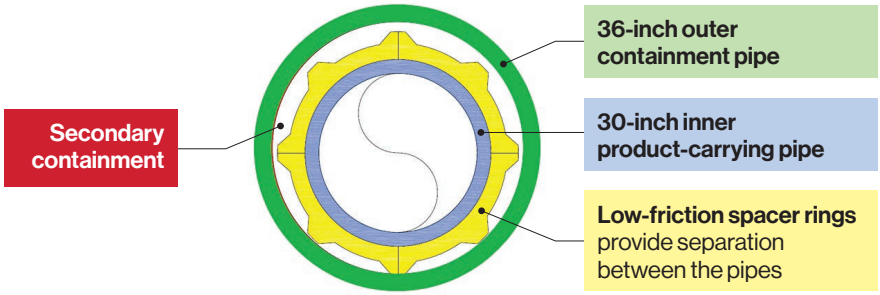
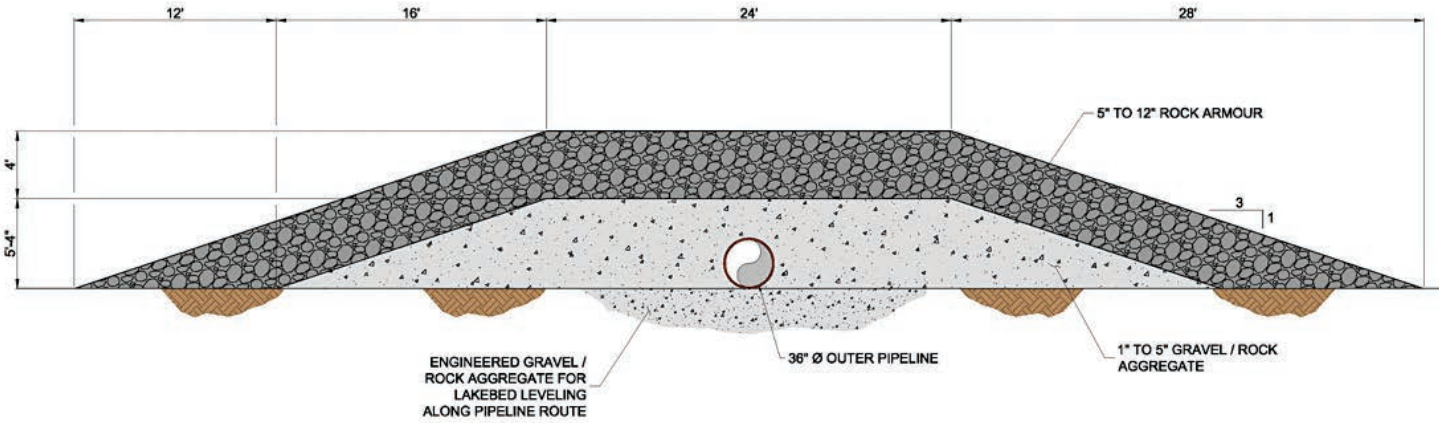


Figure 3: Pipeline covered with engineered protective cover across the lakebed.



- The pipeline would be trenched to 30 feet of water depth (approximately one-half mile offshore) and then laid on the lakebed.
- To protect the pipe-in-pipe system against damage from anchor strikes or other dropped objects, the system would be covered with engineered protective cover made of gravel and cobble, which is rock ranging in size from approximately one to 12 inches. From the top of the pipe, the engineered protective cover would be six- to eight-feet thick.
- Should this alternative move forward, lakebed geotechnical data would be gathered to optimize design and engineering of the open cut route and the height of the engineered protective cover.
- A reliability assessment of the open cut alternative demonstrated the probability of a release into the Straits is reduced significantly by the secondary containment feature of the outer pipe. The release probability is estimated to be 2.43×10^{-7}.
- The open cut method would have an impact on the shorelines and lakebed and would permanently alter the lakebed surface resulting from the placement of the engineered protective cobble cover over the pipeline.
- Onshore workspaces six to eight acres in size on the north shore and one to two acres on the south shore would be required. Disturbed onshore areas would be reclaimed once construction is completed. There are no new significant above-ground permanent facilities anticipated.
- The open cut method would require at least 15 state and federal permits. The primary regulators would be the U.S. Army Corps of Engineers, Michigan Department of Environmental Quality, Michigan Department of Natural Resources and Michigan Public Service Commission. The scope of the open cut method likely would be considered by regulators to have the potential for impacts that may not fit the definition of minimal individual and cumulative adverse environmental effects. This means an Individual Permit likely would be required and that could prolong the permitting process.
- Several local permits—zoning, building, special use, etc.—would be required from two cities, one county and one township.

Horizontal directional drilling

- Several HDD options were considered but all were determined to be not technically feasible, so the HDD alternative was withdrawn from consideration. Reasons included: the 30-inch diameter of the pipe required; the hard characteristics of the subsurface rock (dolomite and limestone); and the length of the drill required, which would be more than double any comparable crossing that has been completed to date.

Summary Comparison of the Two Feasible Alternatives

	Tunnel	Open cut with secondary containment
Enbridge's opinion	Feasible	Feasible
Lead Engineering Consultant's opinion	Feasible	Feasible
Independent Consultant's opinion	Feasible	Feasible
Constructibility Reviewer's opinion	Constructible	Constructible
Estimated cost	$350 – 500 million	$250 – 300 million
Project timeline (including planning, design, permitting and construction)	5 to 6 years	4 to 5* years * Schedule would be sensitive to seasonality.
Pipeline location	A 30-inch pipeline located within a concrete-lined tunnel and mounted on pipe supports within the tunnel. The tunnel would be located approximately 350 feet below the lake surface and approximately 100 feet beneath the lakebed at its deepest point.	Trenched to 30 feet of water depth (approximately one-half mile offshore); remaining length laid on the lakebed and covered in engineered protective cover. From the top of the pipe, the protective cover would be six- to eight-feet thick.
Secondary containment feature	Tunnel would be lined with precast concrete tunnel lining that incorporates high-strength gaskets. The annulus outside the lining would be filled with cement grout.	Pipe-in-pipe system with the 30-inch product pipe contained within a 36-inch outer secondary containment pipe.
Risk of product release into the Straits	Negligible—considered virtually zero.	The secondary containment design of the pipe-in-pipe system combined with the engineered protective cover reduces the probability of a release into the Straits to an extremely low value.
Potential environmental impacts	**Construction:** No impact to shorelines and lakebed; onshore work space would be 10 to 15 acres on the north shore and two to eight on the south shore. Marine work just for geotechnical investigation program—one summer season. **Operations:** Disturbed onshore areas would be reclaimed after construction; new operational footprint of up to a one-acre fenced-in area with an above-ground structure over the portal entrances on each shore.	**Construction:** Impact to shorelines likely to be considered minimal; impact to lakebed may not fit the regulators definition of having minimal effects—likely would require an Individual Permit. Onshore workspaces six to eight acres in size on the north shore and one to two acres on the south shore would be required. Marine work for two consecutive summer seasons; plus one summer season for geotechnical investigation/surveys. **Operations:** Disturbed onshore areas would be reclaimed after construction; no new significant above-ground permanent facilities anticipated.
Incident prevention	24/7/365 monitoring and regular inspections.	24/7/365 monitoring and regular inspections of both the internal product pipe and the engineered protective cover.
Pipeline accessibility and maintenance	Tunnel would be open and accessible, and the pipeline would be supported within the tunnel, providing sufficient space for pipeline inspection and maintenance.	If the pipeline needs to be accessed at any location, the engineered protective cover can be removed by subsea construction equipment and divers. If repairs are required, they would be challenging due to depth of water and the pipe-in-pipe system.