FLOW
FOR LOVE OF WATER

Protecting the Common Waters of the Great Lakes Basin
Through Public Trust Solutions

November 2, 2017

Governor Rick Snyder P.O. Box 30013 Lansing, Michigan 48909	Executive Director Valerie Brader Michigan Agency for Energy P.O. Box 30013 Lansing, Michigan 48909-7958
Attorney General Bill Schuette G. Mennen Williams Building, 7th Floor 525 West Ottawa Street P.O. Box 30212 Lansing, Michigan 48909	Director Keith Creagh Michigan Department of Natural Resources Executive Division P.O. Box 30028 Lansing, Michigan 48909
Director Heidi Grether Michigan Department of Environmental Quality P.O. Box 30458 Lansing, Michigan 48909-7958	

VIA EMAIL SUBMISSION

Dear Governor Snyder, Attorney General Schuette, Director of Michigan Department of Environmental Quality, Director of Michigan Department of Natural Resources, and Director of Michigan Agency for Energy:

As you know, For Love of Water ("FLOW") is a Michigan nonprofit corporation dedicated to researching, evaluating, and providing sound law, science, and policy to protect the waters of Michigan and the Great Lakes, their bottomlands, aquatic resources, and the public trust in these lands, waters, and their protected public trust uses. With respect to crude oil pipeline transport in the Great Lakes, FLOW has submitted numerous legal and technical reports on the high risks associated with Line 5, including the segment in the Straits of Mackinac, over the past three years.

FLOW is gravely troubled by Enbridge's recent acknowledgement of bare spots being caused by anchor supports, which have been installed along the pipeline since 2003, and further troubled by the fact that Enbridge detected the bare steel three years ago in 2014 and only disclosed the information to the State of Michigan last week. Enbridge has lost credibility and trust from state leaders and Michiganders alike. In a letter dated November 1, 2017 to Enbridge, Representative Fred Upton called Enbridge's response and lack of transparency "absolutely unacceptable."

Following last week's news, FLOW is submitting a supplemental technical paper from our technical advisor, Gary Street, a retired Dow Chemical engineer who has spent several years studying and documenting his technical concerns related to Enbridge Line 5. Mr. Street's enclosed technical paper, entitled "*Zebra and Quagga Mussels and their Impact on Bare Steel*," concludes that the twin pipelines in the Straits may have experienced pitting corrosion at the various "holiday" locations, which may have diminished the wall thickness by almost 50 percent.

Enbridge's current reliance on remote underwater video and smart pig inspection are inadequate tools to study and evaluate pitting corrosion caused by invasive mussels encrusting the Line 5 pipelines. Because pitting corrosion is more difficult to detect, predict, and design against, there could be many more damaged areas that occurred years ago and since then have been overgrown by mussels and other biologic growth and not identified by underwater video.

This technical paper's findings, combined with Enbridge's June disclosures of bends in the lines and concealed attempts to address the failure in design, conflicts of interest, and now the recent disclosure of known bare metal spots on the pipeline for a minimum of three years, elevate the risk of a catastrophic oil spill beyond any prudent or acceptable level. We therefore urge the State of Michigan to exercise its powers and take the following immediate actions:

(1) Require Enbridge to conduct an immediate investigation on the impact of zebra and quagga mussels on bare steel. FLOW and our independent technical advisors (Gary Street, Ed Timm and Rick Kane) are available to meet with the State of Michigan for a meeting to discuss these concerns in further detail;

(2) Revoke the 1953 easement or its use based on the imprudence of continued use of the lines because of the non-curable failures of the line and violations of the 1953 easement, which present an unreasonable threat to public and private property, the public trust in and public use of these highly valued waters and bottomlands; and

(3) Require Enbridge, as part of the pending application for anchor supports under the GLSLA, MCL 324.32501 et seq., to obtain authorization for occupancy and permits for the continued use of the lines and new or added structures. This must include (a) a showing that the lines and supplemental structures in their entirety will not endanger or impair the public trust, safety, or health and welfare of the public; and (b) a showing that there is no feasible and prudent alternative to Line 5 and/or the lines in the Straits taking into account the entire Enbridge and related system through the Great Lakes basin and Michigan.

It is our hope that as leaders of the State you will take these actions and place the responsibility where it belongs—on Enbridge. We submit that this is the only reasonable and lawful means that will eliminate the imprudent and unacceptable risk of catastrophic harm to the Great Lakes, property owners, businesses, communities, and the public threatened and endangered by the transport of crude oil in the twin pipelines in the Straits' segment of Line 5.

Nothing less than Michigan's heritage, legacy, and future are at stake. Thank you.

Respectfully yours,

Liz Kirkwood
Executive Director

Jim Olson
Founder and President

Zebra and Quagga Mussels and their Impact on Bare Steel

Gary Street, M.S., P.E.
October 27, 2017

Overview:

Enbridge has acknowledged there are several large areas of the pipeline where the protective coating is missing. We know that pseudofeces from zebra mussels and quagga mussels are corrosive to bare steel. However, we do not know for certain what caused the bare spots. Enbridge has said they may have occurred when the new supports were being installed. This may or may not be the case. Making the matter even more uncertain, we do not know how long the various bare spots have been exposed to corrosion by the presence of the zebra mussels.

Given the lack of precise knowledge, and the extreme environmental hazard posed by a rupture of Line 5 at the Straits, the prudent scenario is to assume that damage originally occurred in 2003 when the first of the new supports were installed. That being the case, it is very possible that the Line 5 pipe wall has suffered serious pitting corrosion beginning at that time. Making the matter worse, pitting corrosion is difficult to detect.

Introduction

Recently, it was reported that sections of the coating on Enbridge Line 5 are missing – gone. The sections missing are as large as dinner plates[1] - and larger. Quoting the MLive article:

> *Seven pipeline "holidays," or areas of external anti-corrosion coating loss, are detailed in inspection documents sent to the state on Friday, Sept. 8, and obtained by MLive.*
>
> *Several holidays are larger than the "Band-Aid"-sized areas Enbridge initially described when the gaps were revealed. The largest patch of exposed pipeline metal is 16 inches long and 10 inches wide. Others are narrower but also exceed a foot in length.*
>
> *Also detailed in the reports is a "disturbed" coating area that's more than 3 feet long, a "dislodged" coating area that's 13 feet long and a mysterious 8-inch "white deposit" of unknown origin that Enbridge says "remains under investigation.*

[1] http://www.mlive.com/news/index.ssf/2017/09/line_5_coating_inspection.html#incart_river_home

This news is very disturbing.

Enbridge attributes the bare spots to the installation of pipeline supports. If we accept the Enbridge explanation, we need to remember the first of these supports were installed in 2003[2] – fourteen years ago. As will be discussed later, this length of time is very important.

Impact of Zebra and Quagga Mussels on Bare Steel

The presence of bare steel raises the very real possibility of corrosion of the steel by zebra (and quagga) mussels. While the mussels were not present when Line 5 was constructed in 1953, they are a reality today.

By September of 1991, zebra mussels were found in all five of the Great Lakes.[3]

Numerous sources have documented the corrosive impact of zebra mussels on bare steel.[4,5,6,7,8] Thus, there can be no doubt both zebra mussels and quagga mussels are corrosive to bare steel.

The cause of their corrosiveness is the excrement[9,10,11,12] from the mussels, which is acidic. **An acidic deposit on bare steel leads to corrosion.**

Are all types of corrosion equally harmful? No. Some forms are far worse than others. **Pitting corrosion** is a localized form of corrosion by which cavities or "holes" are produced in the material. While corrosion of bare steel can take many forms, the most insidious, and the one we must be especially concerned with is pitting corrosion. Pitting corrosion is more dangerous

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[2] Letter from Enbridge, dated May 20, 2003, by Adam Erickson, to John Arevalo, Michigan Department of Environmental Quality, titled "Enbridge Energy's Joint Permit Application for Repair Work to be Completed on Crude Oil Transmission Pipelines Located in the Straits of Mackinac. MDEQ Permit Number: 01-24-0046-P.

[3] https://www.oneonta.edu/academics/biofld/PUBS/OP/Biology,%20Invasion,%20and%20Control%20of%20the%20Zebra%20Mussel%20in%20North%20America%20OP%2024.pdf, p. 9

[4] Zebra Mussel Research Technical Notes, Prepared and published by the Zebra Mussel Research Program, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS, 39180-6199, Technical Note ZMR-2-07, and Section 2, Revised January 1998, p. 2.

[5] Zebra mussel migration to inland lakes and reservoirs: A guide for lake managers. Ohio Sea Grant, Published by Ohio State University. Author: Robert Heath, Dept. of Biological Sciences Water Research Institute, Kent State University, 1994, p. 2.

[6] USGS: https://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=5, See "Impact of Introduction", paragraph 1.

[7] U.S. Fish and Wildlife Service, Zebra Mussel (Dreissena polymorpha), Ecological Risk Screening Summary, published February, 2011, Revised July 2015, p. 7.

[8] USGS: Nonindigenous Aquatic Species: Benson, A.J., D. Raikow, J. Larson, A. Fusaro, and A.K. Bogdanoff. 2015. Dreissena polymorpha. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=5 Revision Date: 6/26/2014

[9] https://www.livescience.com/27415-shipwreck-alley-threatened-by-invasive-mussels.html

[10] https://www.michigan.gov/documents/deq/wrd-ais-dreissenids_499881_7.pdf, p. 5.

[11] http://www.aquaticnuisance.org/wordpress/wp-content/uploads/2009/01/FCRPS-foul-release-coating-cost-estimate.pdf, p. 1 – under the heading "Background".

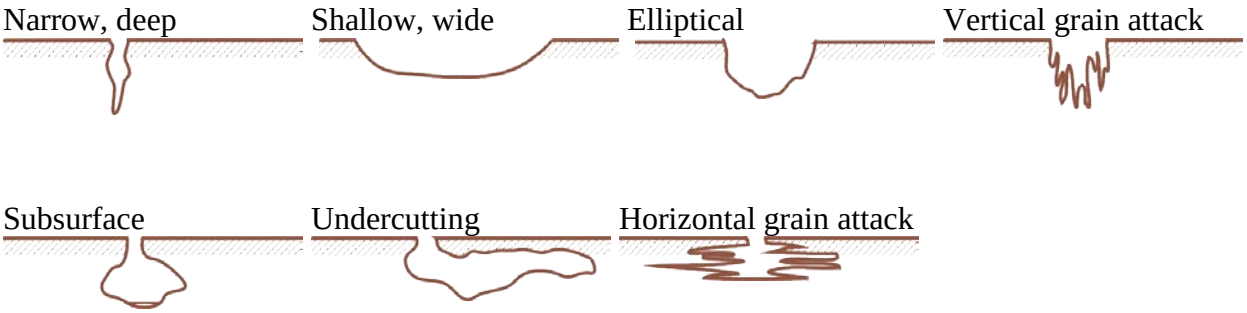
[12] https://www.fws.gov/nevada/nv_species/invasive_species/mussels.htm

than Uniform Corrosion because it is more difficult to detect, predict, and design against. Corrosion products often cover the pits.

Quoting the National Association of Corrosion Engineers (NACE),[13]

> *"Pitting is considered to be more dangerous than uniform corrosion damage because it is more difficult to detect, predict and design against. Corrosion products often cover the pits. A small, narrow pit with minimal overall metal loss can lead to the failure of an entire engineering system."*

Typical examples of pitting corrosion are shown below:[14]



Limitations to the Detection of Pitting Corrosion by Smart Pigs

Enbridge relies on "Smart Pigs" to monitor corrosion in their pipelines. However, "Smart Pigs" are not 100% reliable.

Quoting a recent article in the Wall Street Journal:[15]

> *"… smart pigs might not be enough. Enbridge…a major Canadian pipeline company, has spent over $4.4 billion to upgrade pipeline safety. It is spending big bucks after one of its pipelines spilled oil into the Kalamazoo River in 2010 – a corrosion breach that Enbridge's smart pigs failed to detect ahead of time."*
>
> *"… **despite recent advances, smart pigs aren't terribly accurate.**"*

[13] https://www.nace.org/Pitting-Corrosion/

[14] https://www.nace.org/Pitting-Corrosion/

[15] Fowler, Tim, and Gilbert, Daniel, "Oil-Pipeline Cracks Evading Robotic Smart Pigs", Wall Street Journal, August 16, 2013.

Corrosion Rates

Corrosion rates in the U.S. are expressed in mils per year (mpy), a mil being a thousandth of an inch.[16] So how much corrosion can be tolerated before it becomes alarming?

> *Mils per year or mpy, is used to give the corrosion rate in a pipe, a pipe system or other metallic surfaces. To calculate the material loss or weight loss of a metal surface, there is a formula using the type of metal, the size of the sample area and the time of exposure, giving the value of mils per year. The expression mpy is mostly used in the United States. One Mil is equal to one thousandth of an Inch. In metric, one mil per year equals to 0.0254 mm/y.*
>
> *In an open water system a corrosion rate of around 1 mpy is normal. Having corrosion rate of around 10 mpy, you should take action.* ***Corrosion rates of 20 MPY and above, you should be concerned, as the corrosion is eating the metal rather fast.***

The 1998, the US Army Corps of Engineers issued a definitive report that addresses how much corrosion, in mpy, can be caused by the impact of zebra mussels on bare steel.[17] **Their report concludes the pitting corrosion rate would be in the range of 10-30 mpy. This is within the "you should be concerned" range of the reference cited above.**

A "Most Probable Scenario" Regarding Pitting Corrosion on the Exterior of Line 5:

- US Army Corp of Engineers pitting corrosion rate on bare steel by zebra mussels: 30 mpy
- Possible years of exposed bare steel for Line 5: 14 years

30 mpy = 30/1000 inches per year = 0.03 inches per year
For 14 years, this amounts 0.03*14 = 0.42 inches of pitting corrosion.

Original wall thickness of Line 5 at the Straits = 0.812 inches (schedule 60 pipe, 20 inches outside diameter).

Probable wall thickness in 2017 due to pitting corrosion since 2003 = (0.812-0.42) = 0.392 inches.

To say it another way, where pitting corrosion due to the impact of zebra mussels on bare steel has occurred, **the wall of the pipeline <u>may be</u> only 48% as thick as it was in 1953 when it was originally installed.**

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[16] https://www.merusonline.com/mpy-mils-per-year/

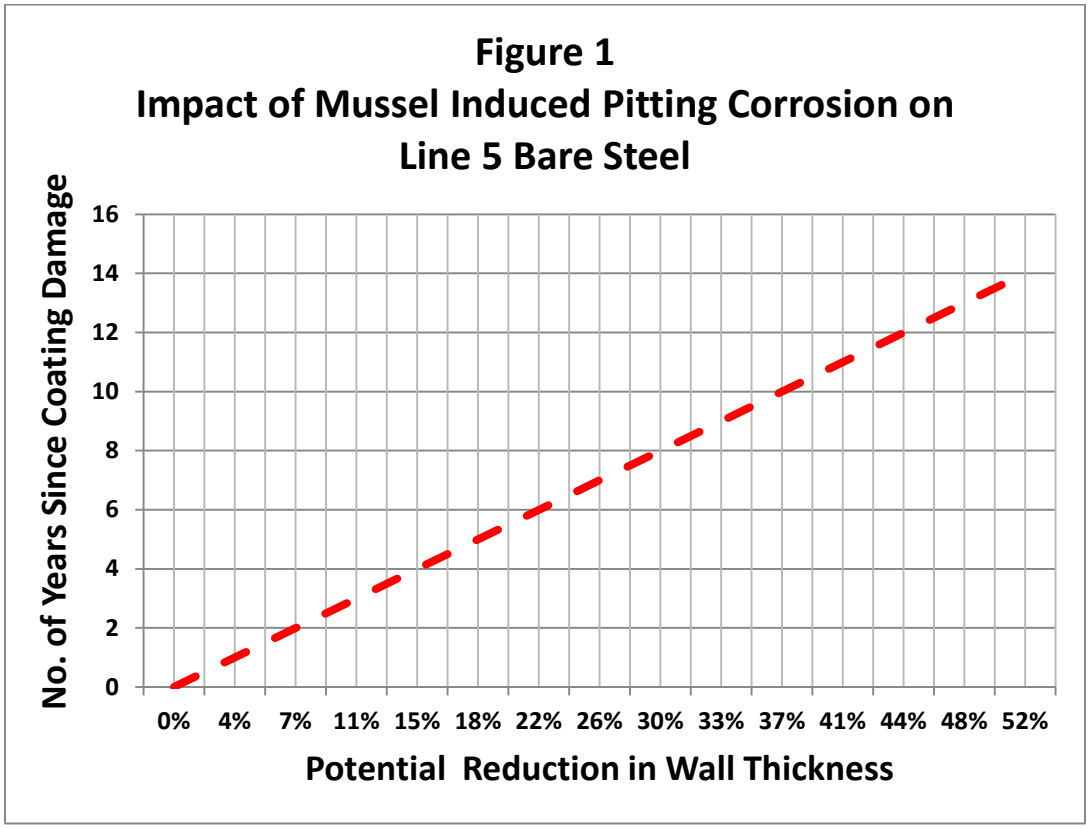
[17] Zebra Mussel Research Technical Notes, Prepared and published by the Zebra Mussel Research Program, U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS, 39180-6199, Technical Note ZMR-2-07, and Section 2, Revised January 1998, p. 2-3.

In addition, it must be remembered that **corrosion never stops. Every year Line 5 remains in service, pitting corrosion will increase by 0.03 inches. While this may seem small, the cumulative effect spells disaster.**

Summary

- Enbridge has admitted that large areas of the coating are missing, exposing the bare steel to the underwater environment.
- Zebra mussels had arrived in all five Great Lakes by 1991.[18]
- The excrement of zebra mussels is acidic, and corrosive to bare steel.
- The U.S. Army Corps of Engineers has stated the corrosion rate caused by zebra mussels can be as much as 30 mpy (mpy = mils per year. One mil per year = 1/1000 of an inch per year).
- The type of corrosion caused by zebra mussels would be pitting corrosion.
- Pitting corrosion is very difficult to detect.
- If damage to the coating took place in 2003 when the initial supports were installed, pitting corrosion has occurred for 14 years.
- Regardless of whether the damage to coating took place in 2003, or some time thereafter, where there is bare steel, pitting corrosion has occurred and continues to occur.

Figures 1 & 2 portray the impact of corrosion on bare steel caused by mussels.



[18] http://www.mlive.com/news/index.ssf/2017/09/line_5_coating_inspection.html#incart_river_home

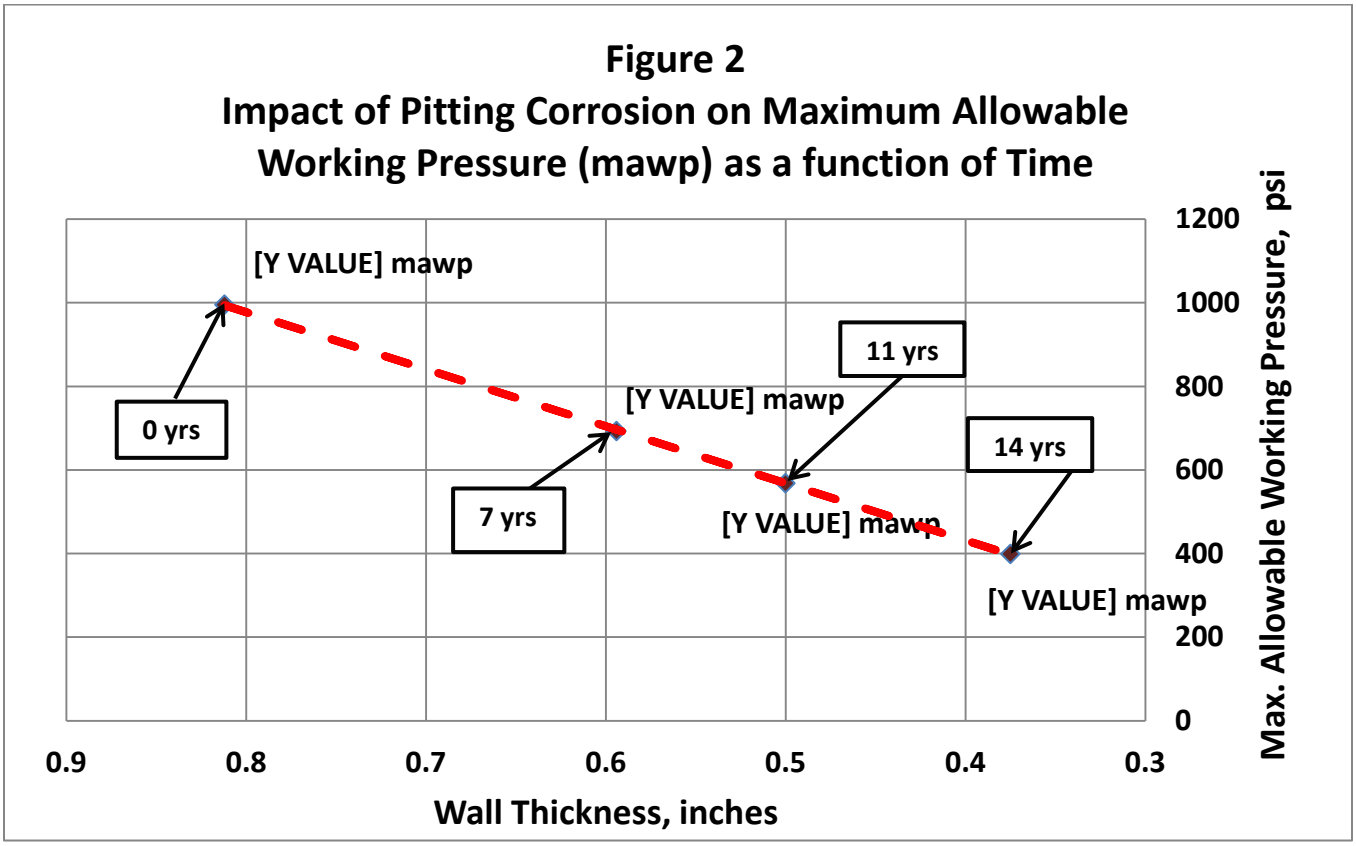


Figure 2 is a plot of Maximum Allowable Working Pressure (mawp) for schedule 60, 20 inch outside diameter, seamless carbon steel pipe.[19] This is the pipe that was installed at the Straits of Mackinac in 1953.

For example, the chart tells us that in 7 years, pitting corrosion will cause the MAWP to decrease from 995 psi to 693 psi; in 14 years (the period of time from 2003 to 2017), the MAWP can decrease to 399 psi.

Figure 2 assumes that pitting corrosion did not occur prior to 2003. Enbridge has recently admitted that damage has occurred to the pipeline coating while the new supports were being installed.[20] They apparently have been aware of this since 2014, but only recently acknowledged it. While Enbridge claims to have discovered the damage in 2014, we do not know when it actually occurred, so have assumed that at least some of the damage to the coating took place in 2003.

[19] Stritt and Priebe, 37 Clyde Avenue, Buffalo, New York, 14215, www.strittandpriebe.com
[20] http://www.mlive.com/news/index.ssf/2017/10/enbridge_line_5_damage_2014_de.html