RE: Enbridge Line 3 Public Comments
To Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Date: April 10, 2020

Technical comment on *Enbridge Line 3 Pipeline Replacement Project* Draft 401 Certification and Preliminary Antidegradation Assessment

Authors (Curricula vitae provided in Appendix A*)***:**
Laura D. Triplett, Ph.D., Associate Professor of Geology
Christine L. Dolph, Ph.D., Water Resources Scientist
Vishnu Laalitha Surapaneni, M.B.B.S., M.P.H., Assistant Professor of Internal Medicine
Willis Mattison, BS, Biology, Chemistry, Broad Sciences; MS, Biology/Ecology
Robert Merritt, BS, Earth Science and Geology; M.S. Hydrology
James Doyle, Ph.D, Professor of Physics

Statement of purpose: Based on our review of the draft 401 certification and preliminary antidegradation assessment provided by MPCA for the Line 3 project, we assert that MPCA's conclusions that purport to justify granting of the 401 permit are neither scientifically sound nor complete. The temporary and permanent water quality and cumulative ecosystem impacts from construction and operation of Line 3 support denial of the 401 permit for this project.

Executive summary

<u>New scientific information presented herein:</u>

- Water quality impacts from construction will likely exceed one year and are not limited to the crossing locations.
- Dry trench crossing will result in water quality standard violations and should not be applied to ORVWs under any circumstances.
- Soils crossed by pipeline are listed as incompatible with proposed trenching operations.
- Enbridge fails to provide justification for why dry crossing methods are applied to many high quality, higher risk stream crossings.
- The LaSalle Creek crossing has previously been deemed geologically problematic, but the public's and agency staff's concerns have still not been fully addressed and water quality degradation is likely.
- Estimates of impacts to wetlands did not consider hydrologic connectivity among wetland complexes, so the acreage of potentially impacted wetlands is ~10 times greater than that reported by Enbridge.
- Wetlands cannot and will not be returned to pre-disturbance conditions, and the proposed wetland mitigation banking will likely result in net loss of ecosystem function in violation of Minn. R. 7050.0265.
- Proposed stream compensation tool has not been adopted in Minnesota Rule and is likely to result in net loss of ecosystem function in violation of Minn. R. 7050.0265.
- Peatland hydrology must be monitored for at least 12 months before construction to adequately assess potential impacts to water quality from construction.
- Enbridge does not address secondary impacts arising from the project as required by the Clean Water Act.
- MPCA fails to specify what their "watershed approach" to mitigation entails as mandated by the 2008 Federal Wetland Compensation Rule.
- Pipeline crossings of buried paleochannels could result in rapid contamination of surface waters from oil spills. Similar geologic conditions allowed for the spread of PFAS contamination from 3M disposal sites in the East Metro.
- Pinhole leaks from pipelines are likely, and in this geologic setting could cause widespread contamination of ground and surface water. This hazard is severely underestimated in the draft certification.
- Percent area of subwatersheds in the pipeline construction corridor indicates potential for cumulative impacts to biological water quality standards that MPCA has not addressed.
- Impacts of habitat fragmentation on biological water quality standards are not addressed.

- Invasive species control efforts are inadequate as proposed.
- Wetland restoration plan is inadequate in terms of definition of success, length of monitoring and specificity about seed mixes and potential for success. The restoration plan also fails to account for climate impacts on restoration success.
- Changing climate conditions must be accounted for in plans for stream crossings, compensation, mitigation, pipeline stability and spill response.
- Toxicity and expanse of petroleum spills is dominated by toxicity of metabolites.
- Oil release assessment is inadequate and spill impacts on water quality are not sufficiently considered; the unique properties of tar sands oil have not been properly accounted for.
- Surface water degradation and wetland loss causes broad human health impacts that have not been included in estimates of the social costs of the project.

Other key findings contrary to MPCA's draft approval:

- MPCA has not provided information that would allow for an adequate determination of 'important social and economic changes' arising from the project. Such an accounting requires a valuation of the ecosystem services potentially impacted by the project, including the value of provisioning services such as drinking water protection and protection of traditional food diets of native communities, the value of supporting ecosystem services including biodiversity and nutrient cycling, the social costs of carbon emitted from the project as well as the climate regulating services provided by impacted streams and wetlands, and the value of cultural services associated with water quality impacts.
- The carbon footprint of this project will have a quantifiable impact on water quality, and thus must be considered.
- Based on historical data, oil release into the environment from a pipeline is inevitable, and therefore must be considered as a long-term water quality degradation in the 401 certifications. Oil particulate aggregation (OPA) formation and oiled sediment are major concerns for long term water quality but are given only minimal consideration in the DOC EIS. MPCA can not evaluate the risks from this project to water quality degradation based on assurances of pipeline safety that do not specifically address the changed climate conditions (i.e., extreme flooding and more frequent high flow events) that we will experience now and into the near future.
- Vulnerable lakes and wetlands are too far from emergency access points in case of spill.

1. Background on our scientific expertise

In our review of the draft 401 certification and anti-degradation assessment for the proposed Line 3 pipeline, we have drawn on our expertise and background as scientists and professionals in the fields of geology, hydrology, biogeochemistry, stream and river ecology, wetland ecology, energy systems, and public health.

Dr. Laura Triplett is an Associate Professor and Chair of the Geology Department at Gustavus Adolphus College*. She has Master's and PhD degrees in Geology from the University of Minnesota, with a focus on how watershed-scale land-use change impacts stream water quality. Dr. Triplett's recent research has been funded by grants from the National Science Foundation, the McKnight Foundation, the MPCA, the Legislative-Citizen Commission on Minnesota Resources and others. She conducts geochemical analyses of sediment records to reconstruct past environmental conditions, monitors contemporary water quality, and calculates pollutant load budgets to answer questions about past and present conditions. Previously, she worked at the MPCA in water quality enforcement.
** Dr. Triplett's credentials are listed here for identification purposes only; she is participating in this public comment process as a private citizen unaffiliated with her institution.*

Dr. Christine Dolph is a research scientist at the University of Minnesota. She has Master's and PhD degrees in Water Resources Science from the University of Minnesota, and has extensive experience working with water chemistry and biological monitoring datasets from streams and rivers in Minnesota. She has worked in partnership with the Minnesota Pollution Control Agency and Minnesota Department of Natural Resources to design and evaluate biological indicators of water quality, and has conducted EPA-funded research evaluating the success of reach-scale stream restoration projects. Her focus is on the impact of human land use on water quality, biophysical processes and aquatic communities in streams, rivers, lakes and wetlands. She frequently applies statistical modelling and GIS spatial analyses in her work, and is a frequent reviewer of scientific manuscripts for publication in peer reviewed journals.
** Dr. Dolph's credentials are listed here for identification purposes only; she is participating in this public comment process as a private citizen and does not speak on behalf of the University of Minnesota.*

Dr. Vishnu Laalitha Surapaneni is an Assistant Professor of Internal Medicine, a practicing physician with a Master's in Public Health from Johns Hopkins Bloomberg

School of Public Health. She has co-authored several reports on the public health impacts of fossil fuels and has provided expert testimony to the Minnesota House Energy and Climate Finance and Policy Committee on the public health impacts of climate change.

Willis Mattison, is currently retired from a 28 year career as Regional Director for the Minnesota Pollution Control Agency and was formerly a Mayo Clinic Biochemistry Research Scientist and Secondary School instructor of Biology, Chemistry and Environmental Science. He holds BS degree in Biology, Chemistry, the Broad Sciences and MS degree in Biology/Ecology. He has authored or co-authored numerous state and Joint State/Federal environmental review documents and served on Advisory Panels for the Environmental Quality Board, the Red River Basin Board and was a driving force behind the MPCA's development of biodiversity criteria for assessing ecological health of NW Minnesota Streams, Lakes and Wetlands. He has provided expert testimony on water quality impacts of structural riverine manipulation and structural wetland modification projects.

Robert Merritt has bachelor's degrees in Earth Science and Geology, and a master's degree in Hydrology. He has investigated: groundwater/surface water interaction of the Pineland Sands Aquifer and Straight River near Park Rapids, Minnesota; the Felton Fen near Felton, Minnesota; and quarry effects on Southeast Minnesota water resource. Mr. Merritt retired after 32 years as a hydrologist with the Minnesota Department of Natural Resources. His primary work area was Becker, Clay, Mahnomen, and Norman Counties. Throughout his MNDNR career Mr. Merritt worked on surface water, groundwater, and surface water/groundwater interaction issues. He extensively critiqued the Enbridge Line 3 Public Utilities Environmental Impact Statement. Mr. Merritt is currently the principle of Merritt Hydrologic and Environmental Consulting, LLC.

Dr. James Doyle is a Professor of Physics at Macalester College in St. Paul, MN. He has a Ph.D in Physics from the University of Colorado. His research focus has been on the experimental and computational materials science of renewable energy with an emphasis on materials for thin film solar cells and electrochemical storage. He has also published work on computational modelling of storage requirements for the electrical grid when large penetrations of solar and wind power are present, and most recently has started a collaboration with an ecologist on computational modelling of invasive species dispersal. His work has been funded by the National Science Foundation, and he is a frequent reviewer for the journals Renewable Energy, Energies, and others.
** Dr. Doyle's credentials are listed here for identification purposes only; he is participating in this public comment process as a private citizen unaffiliated with his institution.*

2. **The draft permit certification and anti-degradation assessment issued by MPCA do not reflect the current state of the science.**

In the following pages, we describe in detail the local and larger scale water quality impacts that will arise from the construction and operation of this project. We identify temporary and permanent risks to water quality standards at water bodies crossed by the project that are not adequately addressed in MPCA's draft 401 certification or preliminary antidegradation assessment. At the same time, we wish to emphasize that the impacts from the proposed Line 3 project should also be viewed from a larger landscape perspective. It is this larger landscape scale at which many of the most formidable and significant negative impacts of this project will function. To pretend that this project is not occuring in the midst of a global mass extinction event and the onset of climate crisis otherwise requires citizens, agencies and elected officials to intentionally blind themselves to the predictable outcome of their collective actions or inactions. The impacts from Line 3 have not been accounted for in the context of existing impacts to public health, our planet's climate and its vital ecosystems arising from land and water quality degradaion.

The precipitous decline in global populations of insects, birds, mammals, reptiles, amphibians, fish, coral reefs, trees, flowering plants and even soil microbes is reported with increasing frequency in scientific journals and even in the general news media (e.g., Diaz et al., 2019). Yet environmental review and permitting of large projects such as Line 3 bear no reference to these phenomena let alone make the obvious connection between the human built environment and the failing ecosystems that result.

In 1994, Mary H. O'Brien, staff scientist for the Environmental Research Foundation of Annapolis Md. published a commentary entitled: "The Scientific Imperative to Move Society Beyond the 'Just Not Quite Fatal'" in *The Environmental Professional*, the Journal of the Association of Environmental Review Professionals. She wrote:

"Ecosystems and organisms are exhibiting stress. We must explain what we do know regarding the larger picture of multiple stresses on individuals and ecosystems; that people and other species are showing the signs of multiple toxic effects; that species are going extinct at a rate faster than expected from natural conditions; that populations of organisms are showing signs of stress from our consumption of the land….There is no question that environmental problems are nearly overwhelming. I do not know of a single environmentally conscious scientist or activist who does not at times fear that humans will simply and inexorably destroy everything around them until the earth has been rendered

nearly silent, nearly dead. But if we allow ourselves to care at all, we have no choice, except to work for alternative ways of behaving."

The Minnesota Environmental Policy Act (MEPA) and its companion statute the Minnesota Environmental Rights Act (MERA) contain mandates that empower citizens to hold their government accountable not only for their actions but for the outcomes of these actions. Moreover, under Minn. R. 7050.0265, subp. 5, B. the MPCA Commissioner is required to engage with the public when a project will degrade water quality:

"D. The commissioner shall provide an opportunity for intergovernmental coordination and public participation before allowing degradation of existing high water quality….

The agency summarizes their 'public engagement' as follows, on p. 10 of the Preliminary Antidegradation Determination:

> "The MPCA has hosted multiple meetings regarding the Project upon request by interested stakeholders and has provided project updates to its Environmental Justice Advisory Group. Additionally, the MPCA has shared GovDelivery listserv messages and regularly updated its webpages as new project information became available, and plans to host two public meetings during the public notice and comment period for draft permits and certifications."

Many of us personally attended these meetings with 'stakeholders'; in fact, we initiated several of them. At every one of these meetings we sought to communicate the most relevant information that MPCA would need to make a scientifically-defensible permitting decision. It is clear from reviewing the draft permit and the preliminary antidegradation determination that the agency took no steps based on the scientific input we provided. Indeed, parts of the draft permit certification and preliminary antidegradation assessment are at odds with the science of water quality protection *conducted by MPCA's own scientists* (for example, see section 9). **As such, we conclude that MPCA's conclusions that purport to justify granting of the 401 permit are not based on sound science.** A detailed discussion of the state of the science needed to evaluate permitting for the proposed project appears below.

3. Project need has never been credibly established.

3.A. If the MPCA chooses to interpret the project "need" or purpose in the narrow way that Enbridge has asserted, it does not comport with the intention of the Clean Water Act and does not allow full consideration of science. The purpose should be stated in terms of the public good in many dimensions, rather than the good of a single corporate entity.

Contrary to the claims of Enbridge Inc., The Line 3 Replacement Project is not about the deteriorating condition of the existing Line 3, rather it's about increasing crude oil imports from Canada to allow even greater exports of petroleum products from the US. As it currently stands, MPCA should rewrite paragraph 6 of the draft 401 certification to read "The purpose of the project is to construct a new pipeline that will continue and expand Enbridge's capacity for transporting crude oil to facilities and markets outside of Minnesota." If MPCA also wants to assert, as they currently do, that this project will "improve public safety and better protect the environment", then they must explicitly consider other means of achieving <u>those</u> purposes. For example, not building this pipeline while abandoning the old pipeline would *better* protect public safety and the environment than building it. This is the position of the Minnesota Department of Commerce, who has stated "in light of the serious risks of the existing Line 3 and the limited benefit that the existing Line 3 provides, Minnesota would be better off if Enbridge proposed to cease operations of the existing Line 3, without any new pipeline being built." (O'Connell 2017).

3.B. Minn. R. 7050.0265, subp. 5, B. requires the commissioner to evaluate '*economic gains <u>or losses</u> attributable to the proposed activity*' [emphasis ours], as well as '*benefits associated with high water quality for uses such as ecosystem services*' and '*other relevant environmental, social, and economic impacts of the proposed activity*'. However, the preliminary anti-degradation assessment contains no evaluation whatsoever of the social or environmental costs of this project (e.g., the economic losses associated with water quality degradation), or of the impacts to ecosystem services. Instead, the draft asserts that, 'In summary, the important economic or social changes related to the Project include: the future adequacy, reliability, and efficiency of energy supplies; removing the risk of accidental release of oil from the existing Line 3; and the potential for positive economic impacts to communities along the Project route.' (p. 9, Preliminary Antidegradation Assessment). The agency has presented only information from Enbridge about the ostensible 'benefits' of the project from Enbridge's perspective, **and has provided no independent information or assessment of the relevant counterbalancing *costs* to the public that will arise from the project.** Thus, it appears the MPCA has not provided information that would allow for an adequate determination of 'important social and economic changes' arising from the project. To provide such an accounting would require a full valuation of the ecosystem services potentially impacted by the project, including the value of provisioning services such as drinking water protection and protection of traditional food diets of native communities, the value of supporting ecosystem services including biodiversity and nutrient cycling, the social costs of carbon emitted from the project as well as the climate regulating services provided by impacted streams and wetlands, and the value of cultural services (Díaz et al., 2020). Such an accounting or valuation of full ecosystem service impacts arising from the project was never conducted as part of the PUC's review.

Given the failure by the MPCA to demonstrate a net benefit to society from the project, water quality degradation arising from the project will violate Minn. R. 7050.0265.

4. Water quality degradation arising from project construction

4.A. Water quality violations classified as "temporary" violate the CWA section 401 and may have impacts beyond one year

Previous studies have shown that isolated pipeline construction methods (such as the 'dry crossing' method proposed by Enbridge for 161 of 212 streams crossed by the project, including 4 trout streams; Table 1) result in acute spikes in stream and river TSS, typically for several hours. For example, Reid and Anderson (2000) documented the effects of isolated pipeline crossing construction on watercourses in northwestern Alberta. Installation of dams and flumes for water diversion, removal of dams and flumes, and accidental leaks from construction infrastructure were shown to result in TSS concentrations up to 520 mg/L, 703 mg/L and 820 mg/L over background, respectively. Plumes of highly turbid water were observed downstream of construction, particularly at crossing sites with bed and bank materials consisting of fine-grained sediments and soils, and those with rapidly flowing waters. These findings indicate that the dry crossing method will likely violate water quality standards for TSS and result in the downstream transport of considerable volumes of fine sediments.

Table 7.1.1-1
Proposed Waterbody Crossing Construction Method Summary

Waterbody Crossing Construction Method	Number of Proposed Waterbody Crossings
Trench: Open Cut (Non-Isolated) Method (includes 6 push-pull)	8
Trench: Modified Dry Crossing	9
Trench: Dry (Isolated) Method	152
Trenchless: Bore Method	22
Trenchless: HDD Method	21
Total	**212**

Table 1. Construction methods proposed by Enbridge for each of the 212 waterbodies that would be crossed by the project. From p. 19 of Enbridge's Antidegradation Assessment.

MPCA is choosing to allow such water quality violations as long as they last less than one year. However, CWA section 401 and MEPA do not allow for temporary violations of water quality standards. MPCA acknowledges that there will be an increase in TSS during construction, then does not provide any evidence for the subsequent statement that it "would not be expected to …prevent attainment of water quality standards (p. 4)." Based on existing prior studies, construction activities are likely to result in violation of TSS water quality standards at every stream crossed using trench methods.

Temporary, acute increases in sedimentation and other impacts arising from pipeline construction can also negatively impact fish and invertebrates, thereby also affecting biological water quality standards (see Levesque and Dube, 2007 and studies therein). In addition to alteration of water quality and sediment dynamics, construction impacts affecting aquatic life include alteration of stream and river bed and banks, and physical alteration of channel morphology and habitat (see Levesque and Dube, 2007 and studies therein). For example, dewatering the stream during dry crossing will cause 100% loss of aquatic habitat that will only recover slowly and will be exacerbated by ongoing turbidity disturbances.

There is a paucity of research regarding how such impacts arising from pipeline construction might temporarily or permanently impact aquatic life, and the small number of existing studies have not generally considered a full risk assessment of the combined effects of concentration, duration and spatial extent of changes in water quality on fish, invertebrates or macrophytes (Courtice and Naser, 2019). However, some studies have indicated that the biological effects of pipeline construction in a stream may last well past one year, especially if 'temporary' increases in TSS results in longer-lived deposition of fine sediments to the stream bed that can occlude habitat for benthic invertebrates (Armitage and Gunn, 1996; Tsui and McCart, 1981). Thus, what MPCA has designated 'temporary' impacts may well result in longer term impacts to water quality and biological integrity standards for streams. **These findings specifically contradict Enbridge's claim that "all discharges with the Project are temporary and limited to the crossing location" (p. 54).**

4.B. **Proposed stream crossing methods can permanently destabilize streambeds and streambanks, leading to long-term increases in suspended sediment and associated nutrients like phosphorus.**

Because many of the streams crossed have sensitive and complicated hydrogeomorphology, rewatering of the streams after construction can cause disturbance to the bed and banks of the streams that can result in instability and future vertical or lateral erosion. This down- or side-cutting of the stream channel could contribute to additional ongoing (ie, permanent) increases in TSS and impairment of water quality. In addition, such channel migration can lead to exposure of the buried pipe and increase the risk of pipeline rupture and spills (Castro et al., 2015). Moreover, any sensitivity to erosion arising from pipeline construction will likely be compounded by extreme rainfall events (see section 8.F. for additional discussion). Such increased sensitivity by the stream channel to erosion will be compounded by the ongoing effects of climate change.

In addition to channel and bed impacts arising from pipeline construction, pipeline construction will result in permanent riparian habitat loss for all stream crossings, which will potentially contribute to water quality degradation and negatively impact aquatic life. While Enbridge proposes to regrade and reseed select zones of the impacted riparian areas following construction, fully in-kind vegetation, including mature trees, will not be replanted nor ever be allowed to fully regrow to pre-construction conditions since vegetation on top of the pipeline must be maintained for the entire operational life of the pipeline. Riparian habitat values will therefore not return to previous capacity to protect each water body from erosion and resulting sedimentation and TSS in violation of state water quality standards. The permanent loss of the native, established riparian vegetation in these locations will also have a negative effect on stream ecological health for the full service life of the pipeline.

In addition to the reach-scale impacts discussed above, conversion of largely forested and wetland land cover throughout the entire pipeline corridor to grassland or other herbaceous species that Enbridge plans to reseed will potentially have watershed-scale effects on water quality for streams, rivers, lakes and wetlands. Watershed-scale changes in land use are well known in the scientific literature to have impacts on biological integrity and other water quality parameters, and often exhibit stronger effects than riparian- or reach-scale variables (e.g., Roth et al., 1996; Wang et al., 1997; Hansen et al., 2018) For some of the streams crossed by the pipeline, watershed-scale land cover change due to the implementation of the 750ft pipeline construction corridor could be substantial (see Figure 1 for an example). **Such watershed-scale impacts of the project have not been addressed by MPCA in the draft permit certification or in the preliminary antidegradation assessment.**

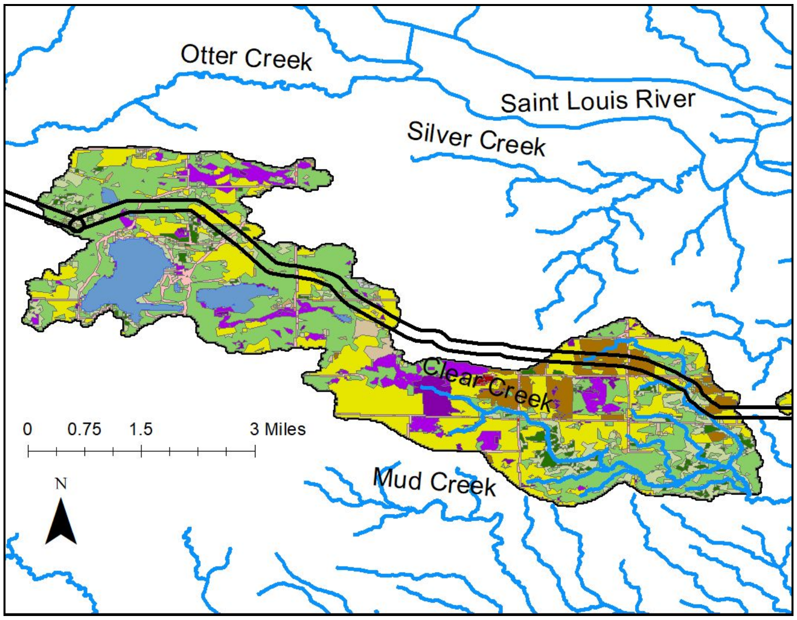

Figure 1, showing an example watershed crossed by the pipeline, where the pipeline corridor makes up a substantial proportion (~7%) of land cover in the watershed (black outline). Land cover data is from the 2016 National Land Cover Dataset, accessed April 3, 2020. Areas in green represent forest cover, areas in purple represent wetland cover.

4.C. **The proposed route crosses many areas with soils that are inappropriate for trenching and pipeline construction.** Wetlands contain hydric soils which often have high organic content because soils are frequently water logged within a few inches of the surface (Shaw and Fredine 1956, USDA-NRCS 2018), which are particularly ill-suited to pipeline stability. In these areas, trenching will require more invasive techniques and more disruption to natural soil properties and hydrology. As a result, these areas will be at increased risk for spills due to trench instability, soil erosion, and will have diminished capacity for water infiltration and purification. For example, in the area of the Mississippi River crossing, most soils are listed as unfavorable for constructing shallow trenches and the limitations can "generally not be overcome with major soil reclamation, special design or expensive installation procedures" (Figure 2). The MPCA should evaluate soil conditions for the entire route, in order to determine cumulative impacts to the watershed.

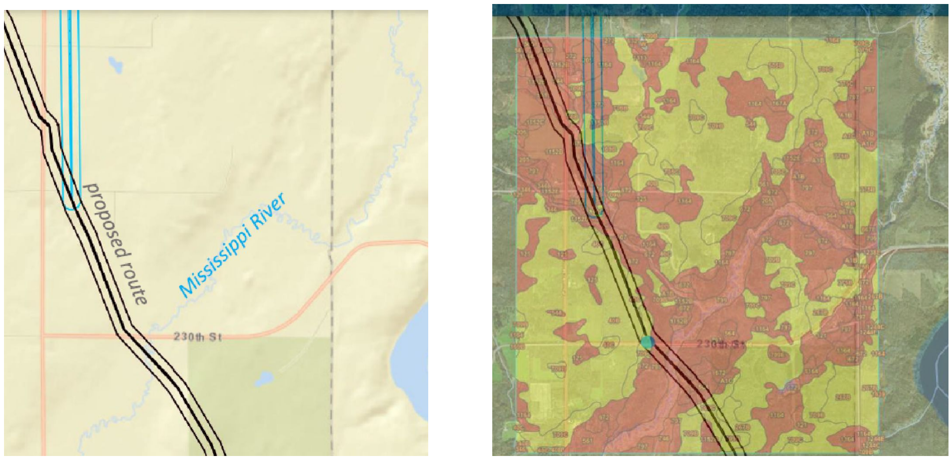

Figure 2: The proposed pipeline route crosses the Mississippi River (left), which is listed as an Outstanding Resource Value Water (ORVW), near its headwaters. Soils in the area are poorly suited to trenching (right); red indicates that the soil has one or more features that are "unfavorable for the specified use" (including shallow trenching). This limitation "generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected." Source for soil information and description of soil properties is Soil Survey Staff, 2020.

4.D. **Digging and backfilling trenches in wetlands will permanently alter the hydrology, with a high likelihood of diminishing wetland function and thereby diminishing water quality in downgradient surface waters.** In this project, Enbridge asserts that the only wetland acreage that will be impacted is the area that is filled to construct pumping stations and the narrow strip of right of way. We dispute this claim. A wetland is a complex *system* that cannot be dissected or partitioned without affecting the whole (Cohen et al., 2016; Golden et al., 2016; Rains et al., 2016*)*. Specifically, although Enbridge's Environmental Protection Plan purports to replace subsoil and soil at near its original density, that is improbable. For one, Enbridge does not indicate that they are conducting high-resolution density measurements before and after disruption (because there is high spatial variability in density), and more importantly, it is virtually impossible to do such replacement anyway because of the nature of organic soils and the coarse methods Enbridge will be using. Therefore, the re-filled trenches will have different hydraulic conductivity than the surrounding soil, and that will permanently change hydraulic gradients in each wetland. **If, as a result, water's residence time in wetland soils is reduced, the result is to diminish the wetland's ability to remove nutrients and other pollutants. That will contribute to cumulative degraded water quality in**

surface waters downgradient of the wetland. See Section 9 below for additional discussion of wetland-specific impacts.

4.E. **The alternative crossing strategy for the Mississippi River ORVW (MP 1069.6) would cause severe degradation and impairment.** Conducting a wet open cut trench crossing at this site would inevitably cause severe turbidity impairments to the ORVW during and following the construction; according to the company's plan, construction would last approximately one week. That construction zone would be highly destructive to riparian zones and the natural channel bed, and impacts would be long-term or permanent. The MPCA should prohibit this crossing strategy and clearly state that if the company cannot cross with HDD, then any permits and certifications become invalid.

4.F. **Especially sensitive areas such as the LaSalle Creek crossing have not had adequate geological characterization to assess construction impacts**. DNR internal documents dated February 12, 2020 obtained from a Data Practices Act request express concerns that the LaSalle Creek area lacks sufficient geologic data as well as unverified and likely incorrect locations of well logs (Walker 2020). There is also a concern that the aquifer on the west side of the tunnel valley that forms LaSalle Creek is shallow enough to result in groundwater discharge with a sufficiently deep trench. Concern is also expressed regarding inadvertent return could occur with HDD if the borehole runs into pressurized groundwater. It is particularly disturbing that two years ago the crossing at LaSalle Creek was characterized as "very geologically challenging and has issues there in the past" (Thibodeaux, 2018) and yet the issues apparently had not been resolved by February 12, 2020. In addition, as of February 10, 2020 the following issues had been flagged as problematic:

> *"De-watering in and around LaSalle Creek will need to be very careful to prevent potential water quality issues. This is a tunnel valley so the topography won't allow for discharge too far from the stream. May need site specific plans here for where their discharge is"*, as well as
>
> *"mitigation for impacts will need to be documented in the file, since we can't waive PW mitigation to the USACE. Either way, for legal reasons I believe you will need to have the proof of mitigation for PW impacts documented in the file" (Klamm 2020a).*

The LaSalle Creek has a trout stream designation (Klamm 2020b) which is a restricted outstanding resource value water (but, see section 4.G. for more on this topic). According to the antidegradation rules **"**The commissioner shall restrict a proposed activity in order to preserve the existing water quality as necessary to maintain and protect the exceptional characteristics for which the restricted outstanding resource value waters identified under part 7050.0335, subparts 1 and 2, were designated" (7050.0265).

In general it is not evident that sufficient characterization of construction impacts has been carried out for this project taking into account unique geological conditions at many of the water crossings. Appendix C provides further visual examples of potential pipeline construction impacts on water crossings that may not have been adequately considered in the 401 draft certifications (DNR, 2020).

4.G. From MDNR records received in response to a Data Practice Act request it is noted LaSalle Creek (and other streams crossed by Line 3) currently have or recently had MDNR trout stream designation (Klamm 2020b) . It is unclear from the DNR documents whether or not the trout stream designation also qualifies LaSalle Creek as a "restricted outstanding resource value water" for purposes of applying MPCA's antidegradation rule. **We request that MPCA review and disclose the current classification status for LaSalle Creek and any other prospective Line 3 trout stream crossings.** This review and disclosure should include any recent MPCA or MDNR changes in designation (within the last five years) including changed ORVW designations of all trout streams to be crossed by Line 3. Any water quality standards or applicability of antidegradation protection protocols that may have relaxed requirements for project such as Line 3 should be also be explained.

4.H. **Cumulative impacts on water quality standards (including on measures of biological integrity) will be substantial and must be considered**. MEPA states that the lead agency must consider "the degree to which the action is related to other actions… with cumulatively significant impacts." And, "significance cannot be avoided by terming an action temporary or by breaking it down into small component parts."

i. MPCA has not quantified nor evaluated the cumulative effect of wetland loss and streambank degradation at the subwatershed scale.
ii. MPCA has not conducted an assessment of the *additive* effects of the multiple utilities in this corridor. Instead, they are assessing this new proposal as a one small component part.
iii. A model like InVEST (e.g., Tallis & Polasky, 2009) should be used to estimate the cumulative impact of land-use change to the surface water quality at the subwatershed and watershed scale. See work by Stephen Polasky, Regents and Fessler-Lambert Professor of Ecological/Environmental Economics, at the University of Minnesota.

4.I. **The MPCA must consider impacts to biological water quality standards from cumulative habitat fragmentation effects across the entire project.** The MPCA's antidegradation assessment does not fully account for ecosystem service losses directly and indirectly attributable to fragmentation of large upland and bottom land (aquatic) ecosystems potentially impacted by Line 3.

The project would incise significantly large areas of relatively intact ecosystems of Northern Minnesota into smaller patches adding to the cumulative fragmenting impacts of all past linear infrastructure such as highways, power lines and forest service roads recreational trails etc. Because the remaining patches of intact ecosystems in Minnesota and the rest of the world are constantly shrinking in size and are being spaced wider and wider apart, ecologists consider them increasingly rare and threatened by current and future human development. Ecosystem fragmentation, when combined with other human-induced stresses of climate change and invasive species, is leading to dramatic declines in biodiversity at alarming rates (Reid et al., 2019). Freshwater biodiversity in particular is exhibiting catastrophic declines that outpace those of marine and terrestrial environments (He et al., 2019).

Linear transportation infrastructure is recognized globally by Haddad et al (2015) as a primary cause of ecosystem deterioration that results in losses of ecosystem services:

"Destruction and degradation of natural ecosystems are the primary causes of declies in global biodiversity. Habitat destruction typically leads to fragmentation, the division of habitat in to smaller and more isolated fragments separated by a matrix of human-transformed land cover. The loss of area, increase in isolation and greater exposure to human land uses along fragment edges initiate long-term changes to structure and function of the remaining fragments."

"Beyond the direct impacts of forest loss and expanding anthropogenic land cover (for example, agricultural fields and urban areas) remnant forests are likely to suffer from being smaller, more isolated and with great area being near the edge of the forest."

And because the biodiversity metrics for assessing ecological damage to ecosystem services lag well behind initial perturbation, monitoring plans intended to assure early remediation of such damage are difficult if not impossible to design and enforce as a condition of project permitting. Again from Haddad et al., (2015):

"First, we found strong evidence for temporal lags in extinction in fragments. Species richness of plants, arthropods, and birds sampled in the experiments conducted in mature forest fragments and replicated in moss landscapes showed degreases of 20-75% after fragmentation. Some declines were evident almost immediately after fragmentation, whereas others increased in magnitude over the experiment's duration. Across experiments, average loss was >20% after 1 year, >50% after 10 years, and is still increasing in the longest time series measured (more than two decades)."

To transparently and understandably represent the significance of adverse fragmentation impacts caused by the project the permitting agencies must use recognizable frames of reference to depict these losses in Minnesota as was done by Haddad et al 2015:

"The area of Earth's land surface devoted to cropland already occupies 1.53 billion hectares and may expand 18% by the middle of this century, and the area committed to urban centers is predicted to triple to 0.18 billion hectares by 2030. The capacity of the surviving forests and other natural habitats to sustain biodiversity and ecosystem services will hinge upon the total amount and quality of habitat left in fragments, their degree of connectivity, and how they are affected by other human-induced perturbations such as climate change and invasive species."

A clear accounting of remaining acreages of the several major and minor types of ecosystems impacted by the project relative to historic and predicted acreages of these types is necessary for the public to comprehend these impacts.

European countries have incorporated objectives for avoiding natural habitat fragmentation as a matter of public policy for nearly two decades (Damarad and Bekker, 2003) and have recognized how essential public involvement is to ensure the success of these policies.

"General Principles to consider –

"The fragmentation of natural habitats by transportation infrastructure is a problem which can only be solved through acceptance of the issue at a policy level. Only an interdisciplinary approach involving planners, economists, engineers, ecologists and landscape architects etc., can provide the necessary tools for successfully addressing fragmentation. Public involvement is also essential to ensure the success of the chosen solutions.

"Habitat connectivity is a vital property of landscapes and is especially important for sustaining animal movement across the landscape. The preservation of habitat connectivity should be a strategic goal in the environmental policy of the transport sector.

"Avoiding and mitigation should be applied from the start of the planning process."

Since sustaining ecosystem services and making wise ecological decisions are specifically cited in MPCA antidegradation rules and the Minnesota Environmental Policy Act, the Line 3 assessment is deficient and should be revised.

5. A detailed risk analysis is not provided for the type of crossing method proposed for each stream site.

There are a number of high quality, public waters that Enbridge proposes to cross with the dry crossing method, **without providing any justification** as to why this destructive construction practice is necessary. Castro et al., (2015) describe a risk matrix that can be used to evaluate the lowest risk crossing method for each individual stream crossed by a pipeline project. This risk matrix includes information about:

- Landscape sensitivity and stream type -- i.e., how sensitive is the stream reach to abrupt changes in flow regime and/or sediment supply that can result in stream morphological changes and habitat degradation.
- Riparian corridor -- i.e., is the stream connected to the floodplain.
- Bank characteristics (lateral scour potential) – i.e., what is the character of the native bank materials and the binding effect of dense vegetation.
- Bed characteristics (vertical scour potential) – i.e., what is the potential for rapid reductions in bed elevation (resulting in permanent erosion impacts due to vertical stream migration). Note that channels with erodible bed materials such as sand and silt are naturally prone to vertical adjustments and that these channel types are common throughout the project area.
- Dominant hydrologic regime – i.e., the range of discharges experienced in a reach, which depends on precipitation, geology, elevation, topography, soils and vegetation.

Enbridge does provide information regarding specific stream attributes such as bed materials and riparian vegetation in 'Attachment O' of their Antidegradation Assessment. However, from a review of the waterbody crossing justifications provided by Enbridge ('Attachment G' in the Antidegradation Assessment prepared by Enbridge), it is unclear how or if MPCA applied such criteria to evaluate the risk from each crossing method proposed by Enbridge for each stream crossing. For example, many of the stream and river crossings are described in Attachment O as having bed materials of silt, sand, silt loam, or sand loam. **These bed materials are erodible and thus are naturally prone to rapid vertical adjustments that can result in permanent water quality degradation (Castro et al., 2015). Yet, Enbridge proposes to cross many of these stream sites with**

the higher risk dry crossing method, without providing any justification for why this higher risk method is appropriate to these higher risk sites.

6. Compensatory mitigation for streams is unvetted and likely to result in a net loss of biodiversity and ecosystem function.

6.A. **The MPCA proposes to use a new compensation tool to allow degradation at stream crossings; the MNSQT compensation tool has not been scientifically-vetted, reviewed by the public, nor adopted in Minnesota state rules.** The MNSQT tool itself is available on the BWSR website "to allow for review and use by stream restoration practitioners", but the website goes on to say that "a scientific support document for the overall tool is being finalized and will be provided upon completion". (A document dated August 2017 and imprinted "Draft" is available, but presumably is not final.) Until the scientific community is able to review the final scientific document explaining the basis for the model, it is impossible to ascertain whether the tool has been applied appropriately to this permit issuance.

6.B. **Compensatory mitigation is likely to result in net degradation of water quality**. The user manual[1] available for the MNSQT tool proposed as a compensatory mitigation approach by MPCA notes that 'partial restoration is the most common restoration-potential level for stream restoration projects' (p. 70). This statement suggests that compensatory mitigation is likely to occur through projects targeting 'partial restoration' that are unlikely to restore full ecosystem function in a way that might adequately compensate for the function lost due to pipeline construction and operation.

From a brief review of the MNSQT user manual, it appears that while the Stream Mechanics approach purports to be 'function-based', this approach does not actually measure stream function. The assessments of stream function are not based on careful, detailed quantitative study of the systems to be damaged, but instead on relatively rapid visual assessments based on best professional judgement.

When evaluating whether compensatory mitigation might be expected to 'make up for' the loss of high quality waters resulting from project construction, the key question is: how much biodiversity or ecosystem function will be lost due to the temporary and permanent impacts of pipeline construction, vs the amount of biodiversity or ecosystem function that might be gained from partial restoration

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1 https://bwsr.state.mn.us/sites/default/files/2019-09/MNSQT%20User%20Manual%20v1.0%2008292019_combined.pdf

elsewhere? We are unable to answer this question with the information provided by MPCA in the draft 401 certification or the anti-degradation assessment. Indeed, it is likely that MPCA does not know the answer to this question, as almost no studies examining the outcomes of compensatory mitigation have been conducted for streams anywhere in the nation (Lave, 2017).

However, based on what is known in the fairly robust body of scientific literature evaluating stream restoration projects more broadly, it is likely that the types of restoration MPCA is likely to engage in as part of 'compensatory mitigation' -- i.e., channel reconfiguration, additions of boulder or wood materials to the stream channel, riparian buffer restoration -- will have limited if any positive impacts on the diversity of fish, insects and other organism groups in the stream (Palmer et al., 2014; Wohl et al., 2015; Lu et al., 2019). This limited response is likely when larger watershed-scale factors -- such as pollution, eutrophication, altered hydrology and a regional species pool limited by habitat fragmentation -- set the bar on what type of biological recovery is possible at a given stream site (Lepori et al., 2005; Rosi-Marshall et al., 2006; Li et al., 2014; Brederveld et al., 2011; Sundermann et al., 2011). With the compensatory approach proposed in their draft certification, it appears that MPCA would allow for the degradation of reach scale conditions where existing watershed scale conditions are favorable (i.e., high quality waters), while trying to compensate for these water quality losses by 'restoring' reach scale conditions at sites where watershed conditions are potentially not as favorable to full recovery. This failure to recreate water quality conditions that were as favorable as those lost is likely to result in a *net loss of biodiversity and ecosystem function.* Such outcomes of net loss of ecosystem function and biodiversity have been demonstrated for compensatory mitigation projects applied to coal development projects in Appalachia (Sudduth et al., 2011; Violin et al., 2011; Palmer and Hondula, 2014). On top of the general likelihood of failure for the compensatory mitigation approach proposed, MPCA also does not state which sites will be selected as restoration targets for compensatory mitigation, making it impossible to assess even qualitatively what the likely net gains or losses in biodiversity or ecosystem function might be.

Finally, we note that MPCA does not even consider the impacts to water quality and biological condition from pipeline operation, including the impacts of potential spills. There is no information in the draft certification to indicate that MPCA would require any sort of compensation or restoration from water quality degradation that arose from the result of an oil spill.

6.C. **It has been well-established by a number of studies that climate change will have important implications for watercourse restoration following human disturbance.** Despite the abundance of studies on the topic, the draft 401 certification and the Antidegradation Assessment do not make a single reference to climate change. Indeed, the only reference found to "climate changes" (a disingenuous term, at best) in the draft is a single sentence in the Post Construction Wetland and Waterbody Monitoring Plan (Attachment N of AA), page 4:

"During monitoring years 3 and 5, Enbridge will conduct another Rapid FQA of the reference sites to account for external variables (e.g., drought/flooding, climate changes, land use activities)..."

Current climate science gives us much more specific information than is implied by that generic statement. For example, climate forecasts for Minnesota indicate that one of the biggest and most relevant changes for wetlands will be increased incidence of high-volume rain events (MPCA 2020; USGCRP 2018) .

In particular, there does not appear to be any proactive strategy to include the effects of climate change on restoration in the 401 certification. The need for such strategy is now well-established in the ecology literature. For example, Erwin (2009) observes "Climate change will make future efforts to restore and manage wetlands more complex… Thus, successful long-term restoration and management of these systems will hinge on how we choose to respond to the effects of climate change." Erwin goes on to emphasize the specific difficulties posed by invasive species "Based on the synergistic effect of multiple stressors, the management and restoration of these habitats may be more difficult in the future due to the present availability of many more efficient colonizer species…. " He concludes "If climate change and variability are not proactively taken into account, the potential for conservation plans to succeed will likely be much reduced."

Zedler (2010) emphasizes the need for careful management of native species using an adaptive framework in wetland restoration: "Downstream wetlands should be prioritized, monitored, and efficiently sampled, to identify multiple effects of extreme events on vegetation. Using an adaptive framework, restoration ecologists could install large-scale experimental plantings of diverse native species, genotypes, and assemblages, all of which would be affected by extreme events under future environmental extremes. Persistent plantings could then be selected for later restoration efforts; taxa that are vulnerable would be recognized as needing further research to sustain populations, and the knowledge gained could guide subsequent adaptive approaches in a broader spectrum of ecosystems."

In a comprehensive recent review Timpane-Padgaham (2017) also advocates for an adaptive approach instead of the usual static restoration approach:"Ecological restoration proceeds in the face of advancing climate change, which imposes additional stress on systems already under pressure from human use and this can undermine the long-term success of restoration efforts. To address this concern, many have suggested a shift away from static restoration end points and towards dynamic and adaptive ecological process goals…Despite many systems demonstrating a considerable resilience to disturbance, prolonged disturbance is more likely to result in persistent habitat changes and reduce the ability of a system or populations to recover. There is also considerable concern about future impacts on disturbance duration, magnitude, frequency, and timing from human induced climate change…In the face of climate change, restoration approaches that promote natural sources of resilience are more likely to be successful than those that focus on creating optimal steady states. Third, certain ecological attributes, such as diversity and connectivity, are more commonly considered to confer resilience because they apply to a wide variety of species and ecosystems… Past trends in climate and streamflow, for example, make it clear that stationarity of the physical environment is no longer a valid assumption in restoration planning."

For example, Bohnen and Galatowisch (2005, and personal communication April 2020) have monitored one restoration project for 23 years. It was populated with a high diversity of local plants: 112 species sourced almost exclusively from within 60 miles of the site. It is very resilient to the high-volume rain events that are becoming more frequent, which speaks to the previously well-documented importance of having diverse plant communities to best persist through extreme events. Enbridge's restoration plan does not appear to prioritize this level of diversity and locally-sourced species composition.

Finally Noon (2020) summarizes the need for designing restorations with resilience to climate change impacts:

> "Because climate change effects are causing changes more rapidly, wetland managers have to embrace a new paradigm when designing wetland restorations, i.e., we are no longer designing wetlands just to restore predisturbance conditions; we are now challenged to design wetland restorations that will also facilitate adaptation and increase resilience capacity over the long term."

Thus, the available evidence is overwhelming that watercourse restoration requires consideration of climate change impacts on restoration. Since the 401 draft certification restoration plan lacks such considerations, it is incomplete.

7. Contaminant spread would be rapid due to geologic conditions

7.A. **Paleochannels full of sand and gravel intersect this region and will cause soluble contaminants to rapidly spread through surface and groundwater.** The modern-day Mississippi River is located in a deeper, wider channel that was carved by glacial meltwater at the end of the last ice age. That paleochannel is filled with sand to a depth of 60 feet (MGS 2020). Clearwater County, where the crossing is located, does not have a current geologic atlas, but adjacent Hubbard County does (Figure 3). The paleochannel is clearly distinguished and extends southwest into Hubbard County, to the site where the proposed pipeline route makes its first crossing of the Mississippi River. **Similar buried paleochannels in Washington County, Minnesota, led to the rapid spread of a different group of chemicals, PFAS, from 3M disposal sites, resulting in contamination of ~1,000 drinking water wells and a $850 million settlement between 3M and the state.** In northern Minnesota, these paleochannels create a tight hydrologic connection between streams, lakes and groundwater. Leaks and spills can thereby degrade streams and lakes that appear distant from the proposed pipeline corridor. Because of the heterogeneous geology, the entire route in this area needs to be evaluated for spill risk with these conditions in mind. MPCA has not evaluated the spill risk to every water body that could be impacted by this project.

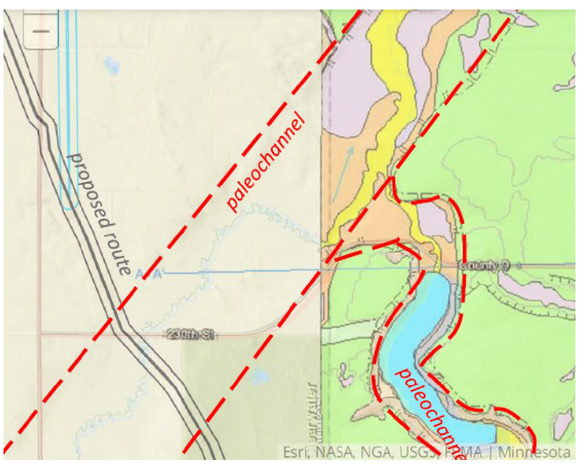

Figure 3. The location of the first Mississippi River crossing by the proposed pipeline route. Nearby Hubbard County has a current geologic map of surficial materials, and the presence of paleochannels with fast groundwater velocity are outlined in red. Any spill reaching this paleochannel will be rapidly transported through surface and subsurface waters, quickly spreading contamination to other surface waters. Map by Lusardi (2018) with highlights added.

Furthermore, these paleochannels filled with high conductivity sands and gravels are ubiquitous in this area. For example, Twin Lakes are wild rice lakes that are in a crossed paleochannel and would be rapidly impacted by a surface spill or subsurface leak in this area (Figure 4). MPCA should identify all such paleochannels along the route, determine the impact of the proposed crossing routes within those paleochannels, and make a spill response plan for each scenario. During a 2014 evaluation of the proposed Sandpiper pipeline route at this same location, MPCA staff noted that the nearest point of access for an emergency response is 6,700 feet from the pipeline crossing – too far for a rapid response that could protect these wild rice lakes.

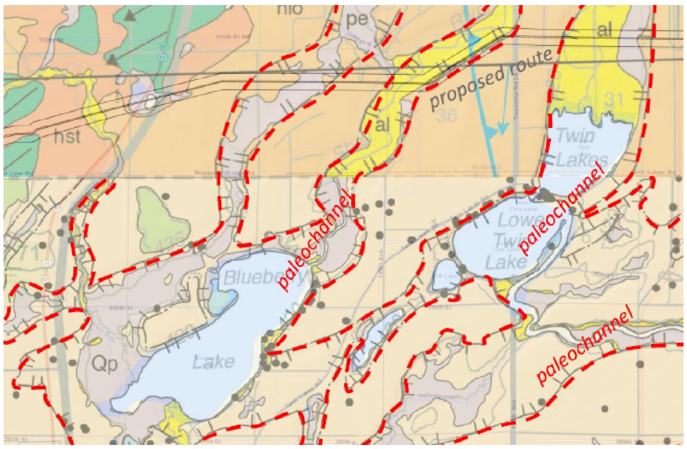

Figure 4. In this location, the proposed route crosses three paleochannels. Any subsurface spill reaching these paleochannels will be rapidly transported through surface and subsurface waters, potentially spreading contaminants to the Twin Lakes, which are wild rice lakes, and Blueberry Lake. Map by Lusardi (2018) with highlights added.

7.B. **Widespread glacial outwash sand units combined with the presence of high-capacity groundwater wells in the area (for example, the Park Rapids region), will cause contaminants to rapidly spread through surface and groundwater. The sensitivity of this area to surface-groundwater exchange renders it inappropriate for pipeline construction and operation.** The proposed route crosses many areas mapped by DNR as having high sensitivity to pollution in near surface materials (Figure 5).

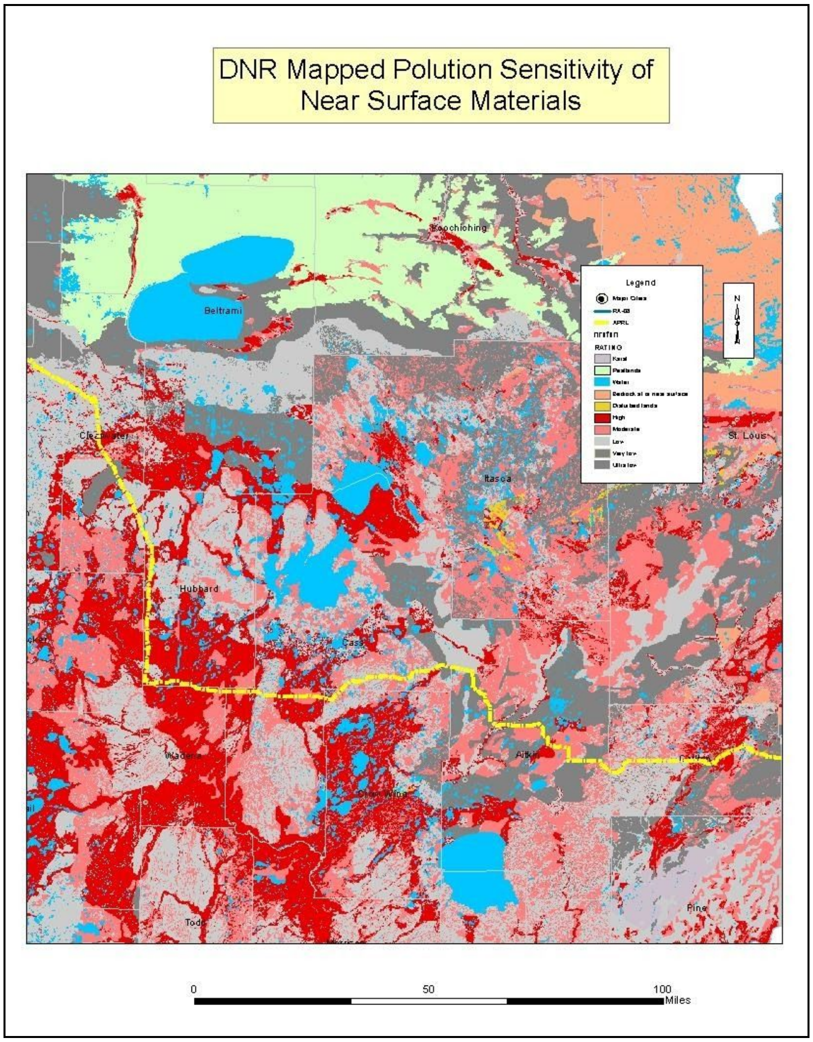

Figure 5. Near surface soils that are highly sensitive to pollution (shown in red) crossed by the proposed project.

For example, the Straight River Ground Water Management Area Plan (DNR 2017; Figure 6) states that the Straight River Basin is one of the most important aquifers in the state, and that "the Straight River area [is] an area of specific concern where groundwater resources are at risk of overuse and degraded quality". It goes on to state "the geologic formations found in the Straight River GWMA form a complex groundwater system that **is interrelated with the surface water in the area**" (emphasis added), giving citations of all the geologic reports and articles demonstrating such. **These statements show that this is a particularly vulnerable and economically-valuable aquifer, and thus is an inappropriate location for pipeline infrastructure.**

The proposed alignment passes through the Park Rapids area irrigation heart. Twelve high capacity (100 and above gallons per minute) irrigation wells and 33 center pivot systems are within ¼ mile of the proposed alignment; 24 irrigation wells and 33 center pivot systems are situated within ½ mile of the alignment. High capacity well drawdown will capture pinhole leak dilbit discharge, moving it away from the pipeline and intensifying the plume extent.

The Straight River receives approximately ½ of its discharge from the Pineland Sands groundwater. The Fishhook River is also within the Pineland Sands Aquifer, receiving substantial groundwater inflow. Dilbit contaminated groundwater will eventually reach the Straight River trout stream and Fishhook River.

Though multiple MPCA publications recognize the groundwater – surface water connection , and the potential for land use impacts on groundwater and surface water (https://www.pca.state.mn.us/water/groundwater-data), this contamination vector has not been considered in the potential impacts of the proposed project.

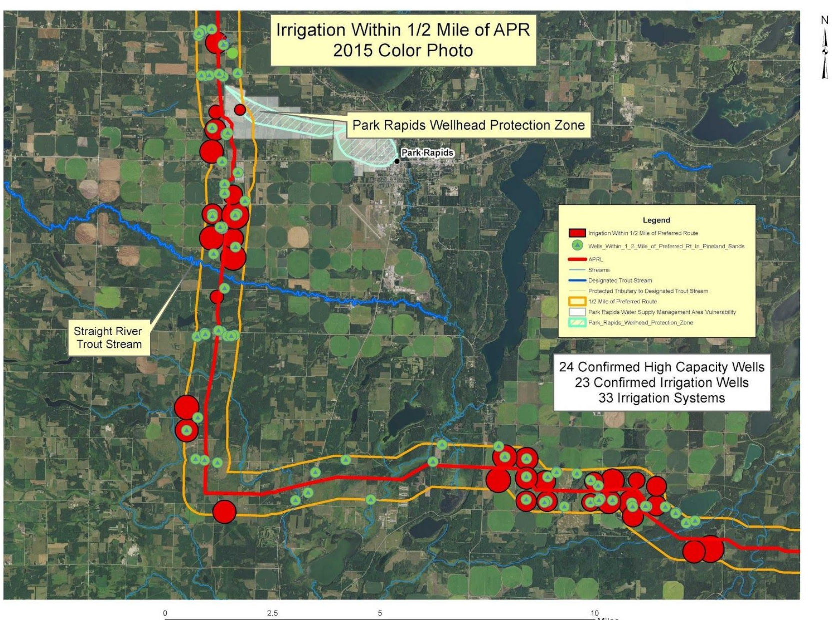

Figure 6. The proposed project crosses the Straight River Groundwater Management Areas, which is a particularly vulnerable and economically important aquifer

8. Underestimation of damage from spills

Contamination of watercourses by oil along the Line 3 APR is highly probable. Because the MPCA must consider all water quality impacts over the entire lifetime of the project, without consideration of the impact of oil spills the 401 draft certifications is incomplete. Spill probabilities, modeling, and possible consequences were discussed in the DOC EIS; however, this does not absolve the MPCA from an independent assessment of oil release impacts. The anti-degradation rules are very specific that the MPCA commissioner must make an independent finding that the water quality degradation associated with the project are justified by economic and societal need:

*"*The commissioner shall approve a proposed activity only when the commissioner makes a finding that lower water quality resulting from the proposed activity is necessary to accommodate important economic or social changes in the geographic area in which degradation of existing high water quality is anticipated (pg 170).*"*

Along with the construction impacts and other impairments to water quality discussed in the draft certification, the consequences of oil release must be no less part of this finding. According to the anti-degradation rules, the MPCA, not the DOC or PUC, has final authority for ensuring water degradation is minimized in any project, and this must include likely release of oil into the watercourses.

8.A. **Based on historical data, oil release into the environment from a pipeline is inevitable, and therefore must be considered as a long-term water quality degradation in the 401 certifications.** Oil can be released into watercourses through pipeline ruptures as well as pinhole leaks. Using data from Enbridge itself, the Polaris Institute found 804 spills occurred from Enbridge pipelines between 1999 and 2010, contaminating the environment with 7.08 million gallons of oil [Polaris]. Leaks do not only occur with old pipelines. A recent study by Greenpeace found that "between 2002 to 2018, Enbridge (and its joint ventures and subsidiaries) averaged one pipeline incident every 20 days" and 46 of those spills were due to equipment less than 10 years old (Greenpeace, 2018). It is a significant omission in the DOC EIS that historical spill frequencies were not discussed for Enbridge, rather only for the US as a whole and for Minnesota (10.1.3 of the DOC EIS).

It is important to emphasize that leaks do not occur just from old pipelines, but new pipelines spill as well. Figure 7 below shows data compiled in 2015 by the Pipeline Safety Trust based on PHMSA, where the number of pipeline incidents in relation to the decade those same pipes were installed is plotted for hazardous liquid pipelines. The results show that although in general the "the very oldest pipes were more dangerous (pipe installed before the 1930s), the more dangerous still were the very newest pipelines – those installed since 2010." The reasons for this phenomena are unknown, but one possibility is that newly installed pipelines have weaknesses that result in initial failures and only after repairing these initial failures do the pipelines continue to operate safely (Pipeline Safety Trust). In any case, the assumption that the new Line 3 pipeline has a lower probability of a release than the existing Line 3 pipeline is not justified. Indeed, it is possible that the existing Line 3 actually has a lower probability of a release than the new pipeline would have, given the high degree of monitoring that the existing pipeline is currently subject to.

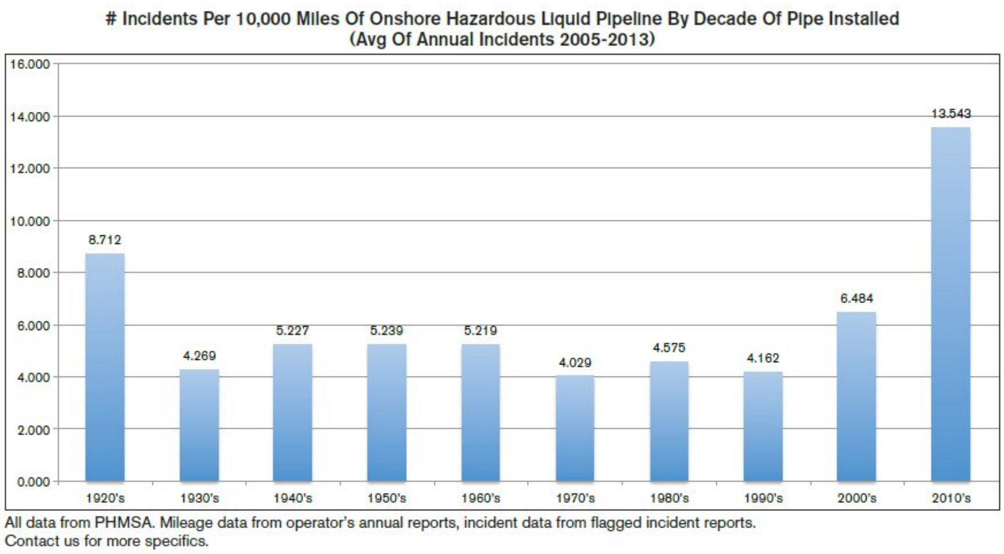

Figure 7. Number of pipeline incidents in relation to the decade those same pipes were installed for hazardous liquid pipelines.

Due to the possibility of non-detection for a significant amount of time, pinhole leaks can have a very high impact on water quality along the pipeline route. Pinhole leaks are discussed in general terms in the Stantec Assessment of Potential Pinhole Release (APPR) section of the DOC EIS and a number of case studies are presented. This analysis was highly inadequate and a detailed critique of the Stantec report is provided in Appendix B. The critique discusses the lack of justification for release rates, an infiltration rate that is a factor of 57 times lower than that recommended by the MPCA, lack of consideration of lateral migration within the pipeline trench and migration of oil through trench walls (which will inhibit detection), and insufficient consideration of the unique geological and hydrological aspects of the pipeline route. In addition the APPR contains many unsubstantiated statements such as "Vertical migration of contamination into groundwater is extremely limited, and much less than horizontal migration", and discusses only in very general term potential impacts of a release to sensitive wetlands, fens, and peatlands, areas which would have difficulty recovering from a release. From this analysis (Appendix B) we conclude that adequate assessment of the fate of oil from pinhole leaks and its impact on watercourses has not been carried out. It is important to emphasize that pinhole leaks can easily release oil comparable to the full bore ruptures modeled in the DOC EIS. Leaks below 1% of the pipeline flow rate (average 760,000 bpd) are below the limit of detection by the SKADA system (APPR pg 8). Visual surveillance and/or odor reports are the principal means of detecting pinhole leaks (APPR pg 10). Small leaks can go undetected for times on the order of weeks (APPR pg 11). For example, 0.1% leak undetected for 14 days will result in 760 bpd x 14 d x 42 gal/b = 447,000 gallons of oil released. In comparison, the full bore spill modeled at Otter Creek in the EIS released 546,000 gallons (DOC revised EIS 3.2.2). The 14 day detection time is overly optimistic and assumes that there will be visual evidence of the leak during routine pipeline inspection. As discussed in the Appendix B, detection times quoted in the APPR are from the Keystone XL project and applied to the Line 3 route without justification in spite of different environmental conditions and infiltration rates.

8.B. i. **Oil particulate aggregation (OPA) formation and oiled sediment are major concerns for long term water quality but are given only minimal consideration in the DOC EIS**. According to the DOC EIS:

"The effects on sediment quality typically persist for months or longer because the heavier molecular weight compounds (many PAHs, resins, and asphaltenes) are slow to weather and degrade; these compounds tend to have chronic, rather than acute toxicity to aquatic biota. Effects on physical habitat (from oil stranded on shorelines and sediment (e.g., as tar balls or OPAs) can also persist, and constituents in the deposited oil can dissolve into the water column over time, resulting in ongoing toxicity to aquatic organisms. (7.1.2.5.3)"

Since there is no spill remediation analysis in the DOC EIS that includes OPA formation, the fate of OPAs and oiled sediment resulting from a spill has not been addressed[2]. Oiled

[2] [EIS OPA] Only Mississippi at Palisades was modeled in the EIS for a spill response, which did and not consider suspended oil and oiled sediment. Indeed, as admitted by Dr. Matthew Horn, the RPS lead on spill modelling in his 2017

sediment is what resulted in the Enbridge Line 6B spill in the 2010 Marshall MI requiring over 5 years of clean-up and over a billion dollars in cost [Marshall]. According to the DOC EIS significant suspended oil and oiled sediment will very likely occur in the St. Louis River (Stantec Addendum 2019) and the river bottom below Little Falls Dam (DOC EIS 7.8.5.2**)** in the event of an oil release, as well as in any other watercourse having turbulent hydrology.

The National Oceanic and Atmospheric Administration (NOAA) spill response document [NOAA] cautions that "for spills in rivers, sunken oil-particulate aggregates can become re-suspended during higher flow conditions, migrate downstream, and again accumulate in low-flow areas." This behavior further exasperates the long term effects of a spill on water quality. <u>Complete remediation of oils spills, especially those resulting in OPA formation, is nearly impossible. The high probability of oil release into watercourses must be considered as a likely long-term impact on water quality the the 401 certifications.</u>

ii. **A major omission in the DOC EIS that would have profound effects on surface water quality is OPA formation by soil entrainment by oil spilled on land enroute to a watercourse.** Such effects are expected due to the very high adherence properties of dilbit (NA 2016). According to Dew et al.:

"If, on the other hand, the spill occurs on land and the dilbit travels over land, it may release volatiles and potentially become saturated with solid particles before entering into a water body. (Dew 2015)"

which would result in the immediate sinking of the oil upon entering the water. The 2010 spill in Marshall MI into the Kalamazoo River is cited as an example of the unique problem with dilbit spills:

"The Kalamazoo River spill represents a worst-case scenario in that dilbit was spilled onto land, the dilbit weathered as it travelled overland, and entered into a fast-flowing river containing small particulates in the water column.(Marshall)"

iii. **The modeling of OPA formation in the DOC EIS has severe deficiencies and does not conform to sound computer modelling protocols.** As an example,

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rebuttal testimony:Perhaps it is notable that the Mississippi River at Little Falls, which was the other option for this follow-on study, is a far more variable hydrodynamic environment than is present at Palisade. As a result, had modeling been done at Little Falls, it likely would have resulted in differences in fate and weathering processes than occurred in the modeling that was done, which would include enhanced entrainment at the waterfall at Little Falls and potential for enhanced interaction with SPM, formation of OPA, and sedimentation of oil.[8]

an important parameter in OPA formation is the water sediment concentrations. In the 2017 Stantec/RPS report (Stantec 2017) we find

"As a default, the model uses a mean value of total suspended solids of 10 mg/l (Kullenberg 1982); alternatively data on suspended sediment concentrations in a watercourse can be used as model input."

The issue of sediment loads comes up again in the 2019 Lake Superior Watershed Addendum report:

"For modeling purposes, the sedimentation rate was set to 1 mm/day for high flow scenarios and 0.1 mm/day for low flow scenarios. ***Sediment loads of 99, 25, and 10 mg/l were assumed*** *to be present at constant values for the high, average, and low river flow conditions. These values are identical to the assumptions used in the previous AAR (Stantec et al. 2017).* ***At a suspended sediment concentration of approximately 100 mg/L, sedimentation of oil and polycyclic aromatic hydrocarbons (PAHs) becomes substantial*** *(i.e., following an oil release, suspended sediment particles may adhere to oil droplets, and the resulting oil-particle aggregate may settle out to the bottom). Therefore, low and average river flow conditions were unlikely to result in large amounts of oil settling to the bottom, while high river flowconditions would result in the potential for substantial settling of oil in quiescent regions*. [7, pg 3.53, bold added]"

Incredibly, the assumed sediment load was set just below the threshold for "substantial" sedimentation of oil. With this assumption it is inevitable that the modelling would indicate minimal sedimentation and OPA formation. The input parameters into the models must be presented with appropriate uncertainties, and simulations must be run to determine the sensitivity to these parameters.

8.C. **The DOC EIS uses questionable and unverified methodology for assessing the consequences of oil releases.** The applicability of the spill modelling software used (OILMAPLand and SIMAP) to fresh water oil spills is in serious question. The models have only been validated in the peer-review literature for coastal and marine spills. The DOC EIS lists the references French and Hines 1997; French et al. 1997; French McCay 2004 [DOC EIS 10-51] as validating the models. However all of these studies are for coastal and marine spills. Spill modeling for riverine spills require different effects than those for open water spills. According to Yapa (1994):

When modelling oil spills in rivers the special needs of the narrower water body(compared to ocean) and wide variation of flow conditions need to be recognized [Yapa 1994]

The lack of validation of the models for freshwater spills is particularly troubling since there exists a well-documented and extensively studied case of a major freshwater spill that could be used in the validation process, the Marshall MI Enbridge Line 6B spill of 2010 [Marshall].

In addition, the claim is that only a small number of sites that are appropriately diverse need be modeled (the basis group) since any spill scenario can be constructed from these varied sites (DOC EIS 10-63 Table 10.3.2) is an unproven and unverified assumption. It assumes that site characteristics are additive and this is not at all obviously true. This hypothesis should have been verified by selecting several additional test sites outside basis group, run the simulation for the test sites, and show that the results of those sites could have been predicted from the basis group. Without such verification the whole approach on which the spill modeling is based is invalid.

Because of these deficiencies (and many others noted in the comments in the CN/RP PUC docket), a supplementary and independent assessment of oil release is needed to ensure the maximal protection of Minnesota watercourses. Consultants retained and paid by Enbridge Inc. obviously have a vested interest in minimizing the impacts of an oil spill, resulting in an EIS is that replete with minimalist approaches to evaluating the consequences of oil releases.

8.D. **Enbridge's Antidegradation Assessment underestimates the impact of a spill ("accidental release") on wild rice beds**, saying it would constitute a temporary impact as wild rice is an annual plant. The dilbit carried through these pipelines has many toxins, and long-term research at the Bemidji site and others shows that metabolites may be just as toxic as the original petroleum compounds. For these reasons, it is not clear how an oil spill into a wild rice lake will impact future crop yield. Thus, this cannot be placed under temporary impacts. Wild rice, or "manoomin," has special cultural and economic significance in Minnesota. According to the FEIS, 17 wild rice water bodies occur within 0.5 miles of the proposed pipeline construction pathway, and four wild rice water bodies could be affected by the construction and operation of the pipeline.[i] The FEIS acknowledges that there could be damage to at least one of these wild rice beds during construction.

8.E. As described above, during a 2014 evaluation of the proposed Sandpiper pipeline route at this same location, MPCA staff noted that the nearest point of access for an emergency response is 6,700 feet from the pipeline crossing – too far for a rapid response that could protect these wild rice lakes. **The MPCA staff at that time asserted that this type of analysis should be done for the entire route, and spill response materials should be pro-actively put in place as needed.** We do not think this has been done.

8.F. **Recent research from the National Crude Oil Spill Fate and Natural Attenuation Research Site near Bemidji (in which MPCA and Enbridge collaborate, and thus presumably know about) shows that regulatory assessments must consider secondary contamination from chemical reactions in soil.** Specifically, McGuire et al. (2018) found that:

i. When crude oil is released into an environment rich in iron oxides, like the soil in wetlands that are dry for part of the year, those oxides will be reduced. Adsorbed metals, like arsenic and chromium, can be released and mobilized into water.

ii. The metabolites from the original petroleum hydrocarbon compounds are perhaps the most important story in terms of toxicology. Enbridge and MPCA must have both an emergency response *and* a long-term monitoring protocol that will assess mobilization of toxic chemicals into surface waters. That response must consider each site's unique geologic conditions in order to fully protect surface waters (see sections 5. and 6.).

Also, Bekins notes that toxic metabolites can exceed that of more well-known petroleum components, but are largely unmonitored (2016).

8.G. **The 401 draft certification is inadequate since it does not take into account the risk of oil releases on human health**. Hundreds of thousands of Minnesotans get their drinking water from the Mississippi River, downstream of the proposed stream crossings. In the event of OPA formation (see above), long term effects to water quality will occur and a long term water quality monitoring program is required.

From the human health perspective, dilbit is especially problematic since its actual composition is unknown. Tar sands requires a diluent that is trademarked so the chemical composition of the toxins that will be released into the rivers as well as the atmosphere as the dilbit weathers is not known. The lighter unknown constituents will evaporate into the air or dissolve into the water and can cause widespread contamination and illness as in other oil releases (DOC EIS 7.1.2.1.1). Water treatment plants downstream of a spill will be unaware of what to test for in these conditions before they declare drinking water safe for consumption.

Despite the trademarked nature of dilbit, it is well established that dilbit contain highly carcinogenic substances like benzene. In 2015, during the Poplar pipeline spill into the Yellowstone River in Montana, the Glendive water treatment plant had to temporarily shut down and the water supply to the town interrupted when toxic levels of benzene were detected[3].

8.H. **The risk of water quality degradation from oil spills must consider the compounding impacts from a rapidly changing climate in Minnesota.** High flow events are becoming increasingly common throughout the region due to climate change (Pryor et al., 2014), representing an increased risk of pipeline rupture. In 2011, for example, a 25- to 50-year flood event in Montana resulted in stream bed erosion that exposed Exxon Mobil's Silvertip Oil Pipeline, which then ruptured to release ~ 50,000 gallons of oil into the Yellowstone River (Atkins, 2012). Extreme flooding along the San Jacinto River in Texas in 1994 resulted in eight pipeline ruptures during a single event, including ruptures because of the formation of new channels in the floodplain, and releasing 1.47 million gallons of petroleum into the river (NTSB, 1996). An Enbridge oil spill into the Kalamazoo river carrying the tar sands oil 40 miles downstream (Marshall et al., 2014). These examples, together with the documented increase in extreme rainfall events in Minnesota over the last 50+ years (Villarini et al., 2013), indicate that **MPCA can not evaluate the risks from this project to water quality degradation based on assurances of pipeline safety that do not specifically designed to address the extreme climate conditions (i.e., flooding and high flow events) that we will experience now and into the near future.**

9. Estimates of impacts to wetlands did not consider hydrologic connectivity among wetland complexes

9.A. We estimated the area of all wetlands intersected by the proposed pipeline route using the recently updated National Wetlands Inventory for Minnesota (MNDNR, 2019). Figure 8 shows that nearly the entire proposed pipeline route is lined by wetlands.

[3] https://deq.mt.gov/DEQAdmin/dir/postresponse/yellowstonespill2015

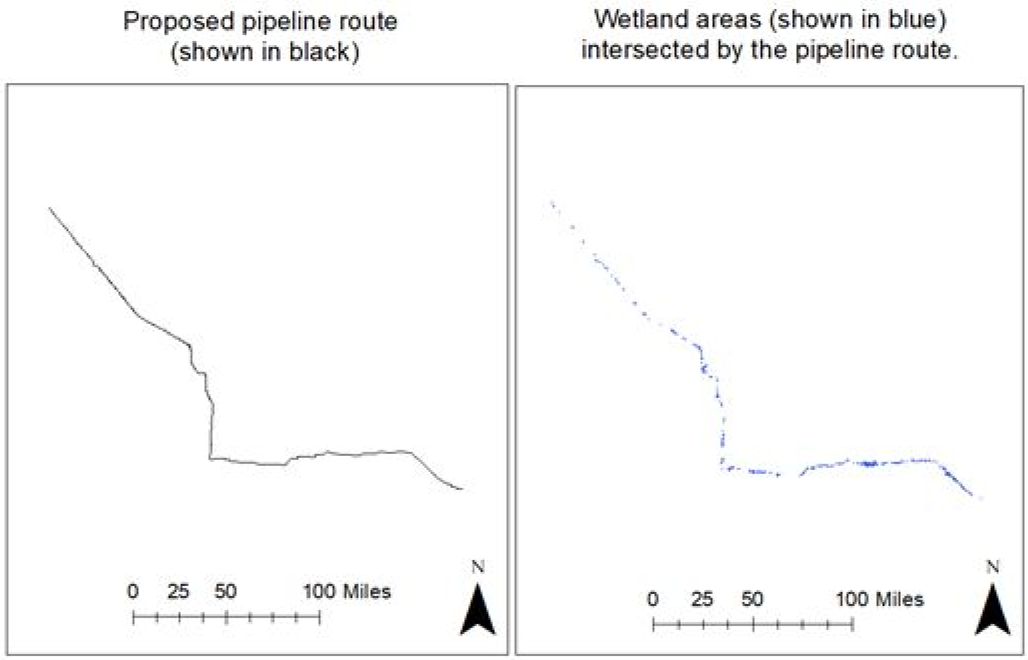

Figure 8. Wetland areas (right panel, in blue) intersected by the pipeline route (left panel, in black). Wetland spatial data is from the recently updated National Wetlands Inventory for Minnesota (MNDNR, 2019).

The total area of wetlands potentially affected by pipeline construction and operation should include the entire area of wetlands that are hydrologically connected to the pipeline route. This potential area of impact represents ~11,000 wetland acres (i.e., the entire acreage of all blue areas shown in Figure 8), as opposed to the <1,000 acres reported as potentially impacted by Enbridge. Wetlands are complex *systems* that cannot be dissected or partitioned without affecting the ecosystem services provisioned by the individual basins and the group of wetlands that are connected by surface and groundwater flow (Ferone and Devito 2004, Mitsch and Day 2006, McLaughlin and Cohen 2013, McLaughlin et al. 2014, EPA, 2015, Cohen et al. 2016, Golden et al. 2016). Also, as noted by MPCA staff (Patrice Jensen letter to ALJ) during the 2014 review of the Sandpiper pipeline proposal, trenching through a wetland's perched aquifer can permanently lower the water table in the wetland, causing a fundamental change in biodiversity, plant communities and wetland function. **Therefore, when a wetland is intersected by the pipeline route, the entire area of the wetland should be included in estimates of potential water quality degradation and resulting impacts on ecosystem services, unless a site-specific determination is conducted and shows otherwise.** See Figure 9 for an example of one wetland complex intersected by the proposed pipeline route.

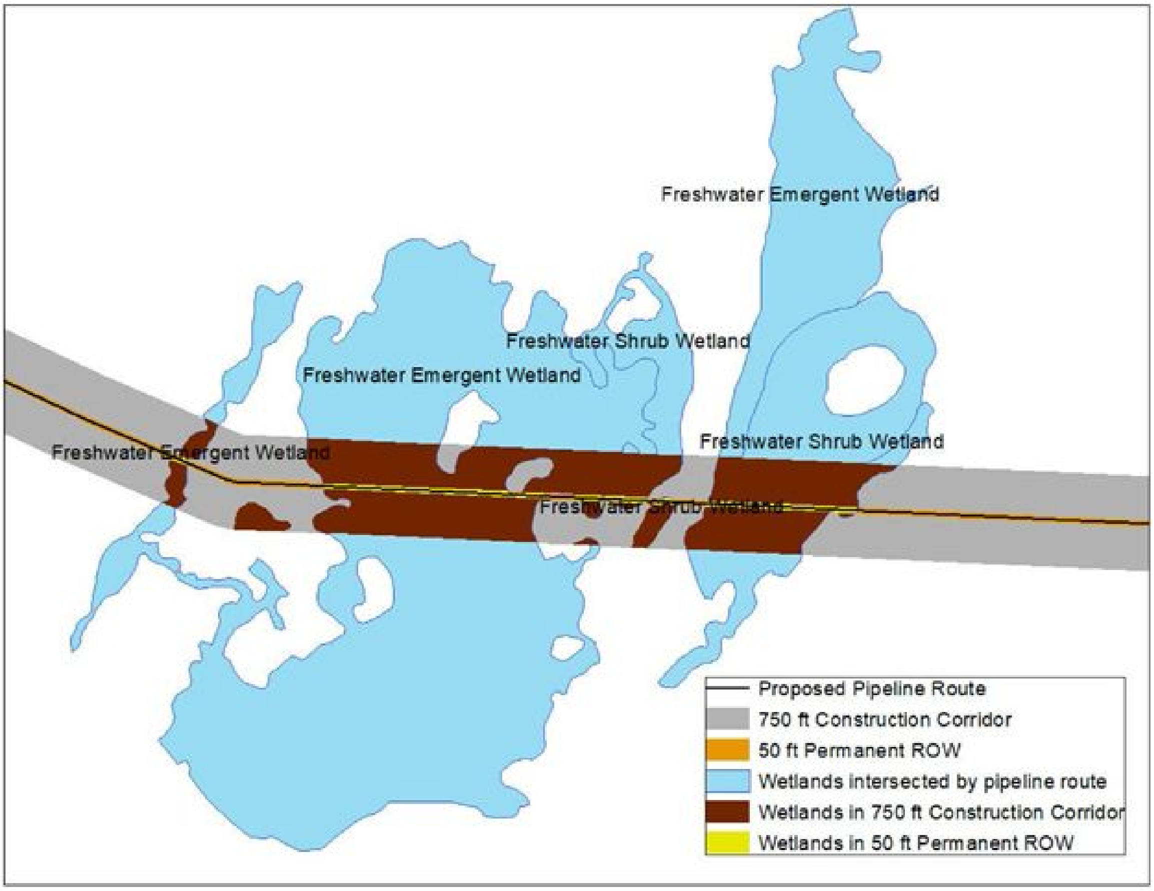

Figure 9 shows two wetlands crossed by the proposed route. In each case, the entire wetland (blue) will be degraded by the existence of the trench. Because wetlands are hydrologically-interconnected and closed (or semi-closed), the trench will permanently and substantively change the hydrology of the whole. Wetland spatial data is from the recently updated National Wetlands Inventory for Minnesota (MNDNR, 2019).

On a related point, **Enbridge also does not address "secondary and cumulative impacts" (also known as "indirect impacts") in their compensation plan.** Under 40 CFR §230.11(h) of Clean Water Act, "Determination of secondary effects on the aquatic ecosystem", the regulation says that "information about secondary effects shall be considered prior to the time final section 404 action is taken by permitting authorities", and that such information includes "effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material." Such secondary impacts could include wetland fragmentation or changes in wetland hydrology as discussed above.

9.B. **Peatland hydrology should be determined before the pipeline is built, not afterward.** In Attachment N, Enbridge proposes to install monitoring wells in peatlands "to determine groundwater flow direction and to assess if there are changes to groundwater conditions upgradient and downgradient of the pipeline". We assert that hydrologic monitoring should be done beforehand to determine whether such construction will impact each wetland, rather than using post-construction monitoring to determine whether damage has been done. Specifically, groundwater monitoring must be collected *at minimum* for 12 months (one hydrologic year) before pipeline construction begins, to have any hope of adequately characterizing baseline hydrology in peatlands *and all wetlands*.

9.C. **The MPCA fails to specify what their "watershed approach" to mitigation entails as mandated by the 2008 Federal Wetland Compensation Rule.** MPCA appears to use 'watershed approach' in reference to selection of a bank within the same 4-digit HUC. According to the 2008 Federal Compensation Rule in §332.3(c), the Watershed Approach is at barest minimum a <u>planning process</u>. Failure to engage in such a process is a violation of the 2008 Rule. No Watershed Approach is evident in MPCA's Compensation Proposal. The MPCA needs to explain why they are not following this approach. From 33 CFR §332.3(c):

> "(c) Watershed approach to compensatory mitigation.
> (1) The district engineer must use a watershed approach to establish compensatory mitigation requirements in DA permits to the extent appropriate and practicable. Where a watershed plan is available, the district engineer will determine whether the plan is appropriate for use in the watershed approach for compensatory mitigation. In cases where the district engineer determines that an appropriate watershed plan is available, the watershed approach should be based on that plan. Where no such plan is available, the watershed approach should be based on information provided by the project sponsor or available from other sources. The ultimate goal of a watershed approach is to maintain and improve the quality and quantity of aquatic resources within watersheds through strategic selection of compensatory mitigation sites.
> (2) Considerations.
> (i) A watershed approach to compensatory mitigation considers the importance of landscape position and resource type of compensatory mitigation projects for the sustainability of aquatic resource functions within the watershed. Such an approach

considers how the types and locations of compensatory mitigation projects will provide the desired aquatic resource functions, and will continue to function over time in a changing landscape. It also considers the habitat requirements of important species, habitat loss or conversion trends, sources of watershed impairment, and current development trends, as well as the requirements of other regulatory and non-regulatory programs that affect the watershed, such as storm water management or habitat conservation programs. It includes the protection and maintenance of terrestrial resources, such as non-wetland riparian areas and uplands, when those resources contribute to or improve the overall ecological functioning of aquatic resources in the watershed. Compensatory mitigation requirements determined through the watershed approach should not focus exclusively on specific functions (e.g., water quality or habitat for certain species), but should provide, where practicable, the suite of functions typically provided by the affected aquatic resource.

(ii) Locational factors (e.g., hydrology, surrounding land use) are important to the success of compensatory mitigation for impacted habitat functions and may lead to siting of such mitigation away from the project area. However, consideration should also be given to functions and services (e.g., water quality, flood control, shoreline protection) that will likely need to be addressed at or near the areas impacted by the permitted impacts.

(iii) A watershed approach may include on-site compensatory mitigation, off-site compensatory mitigation (including mitigation banks or in-lieu fee programs), or a combination of on-site and off-site compensatory mitigation.

(iv) A watershed approach to compensatory mitigation should include, to the extent practicable, inventories of historic and existing aquatic resources, including identification of degraded aquatic resources, and identification of immediate and long-term aquatic resource needs within watersheds that can be met through permittee responsible mitigation projects, mitigation banks, or in-lieu fee programs. Planning efforts should identify and prioritize aquatic resource restoration, establishment, and enhancement activities, and preservation of existing aquatic resources that are important for maintaining or improving ecological functions of the watershed. The identification and prioritization of resource needs should be as specific as possible, to enhance the usefulness of the approach in determining compensatory mitigation requirements."

9.D. **Wetland degradation arising from project impacts is unlikely to be 'compensated' for by proposed wetland mitigation, and the preservation of the state's remaining high quality wetlands has been articulated by MPCA's own wetland ecologists as a top conservation priority.**

The scientific literature is rife with examples indicating that wetland restoration and wetland construction result in poorer quality ecosystems than those that are lost. Extensive research on the biological integrity of restored wetlands and comparisons to natural wetlands in Minnesota and elsewhere have shown fairly conclusively that natural wetlands have higher plant diversity (Verhagen et al. 2001, Aronson and Galatowitsch 2008, Moreno-Mateos 2012, Smith et al. 2016, Winikoff et al. 2020). Sometimes that failure is due to incomplete understanding of the natural system, such as will be the inevitable result of the "rapid assessment" technique used by Enbridge to characterize wetland species diversity. And, it is because some species do not propagate well from seed and thus cannot be easily re-established as demonstrated by Bohnen and Galatowitsch (2005) in a study of wetland restoration in northern Minnesota. As in that study, some of the relatively high-quality wetlands along the proposed route will have a high proportion of *Carex* species, which do not reliably re-establish from seed. And, sometimes it is because of under-reported but widespread soil compaction following pipeline construction (e.g. Olson and Doherty 2012).

The MPCA itself has done biological function studies on restored wetlands and has yet to find one where they identify the full biological diversity that would qualify as full restoration. For example, a recent report by the MPCA entitled 'Status and Trends of Wetlands in Minnesota: Vegetation Quality Baseline' concludes (p. 3, emphasis in original):

> "**Ultimately, a greater emphasis on protection would be an appropriate approach to further promote the no-net-loss of wetland quality and biological diversity of Minnesota's wetlands.** The plant community changes that occur (i.e., increased abundance of non-native invasive species) when wetlands are exposed to virtually any variety of impact are typically not self-correcting. Direct management of the vegetation itself is often required—in addition to correcting external impacts—to reestablish native composition and abundance distributions. Enhancing degraded

> wetland plant communities is typically time consuming and requires a significant financial investment (MPCA, 2015)."

Similarly, Moreno-Mateos et al. (2012) conducted a meta-analysis of the available scientific literature around wetland restoration efforts globally and found that restoration activities typically do not restore the structure and functional attributes of wetlands that are lost or damaged during development projects. For example, both wetland plant assemblages and biogeochemical functioning in terms of carbon storage in wetland soils remained critically reduced even 100 years post-restoration of damaged wetlands. Likewise, nationally renowned restoration ecologist Margaret Palmer and colleagues recently concluded: (emphasis added):

> "Because they are often poorly conceived or undertaken in a landscape or environmental context that will not support the system (Figure 1), many mitigation projects have very limited objectives and fail to produce fully functioning ecosystems (Gebo and Brooks 2012; Bronner et al. 2013). While mitigation projects may comply with regulatory requirements, assessments of mitigation projects are increasingly revealing that these projects have resulted in inadequate ecological structure or function, indicating that the goal of "no net loss" of aquatic resources is not being met (Hossler et al. 2012; Palmer and Hondula 2014).....In summary, incorporating the term "restoration" into administrative laws and grouping together different types of efforts that are not fully consistent with the basic tenets of ecological restoration are at best contributing to confusion over what it means to restore a system and at worst facilitating the net loss of natural resources. The latter is of great concern because **restoration-as-mitigation is being increasingly used to justify development and natural-resource extraction based on the unfounded assumption that restoration projects will guarantee the replacement of degraded or lost ecosystems (Palmer and Hondula 2014)." –** Palmer and Ruhl (2015)

And, a recently LCCMR-funded study of 78 restoration plans in Minnesota found overall poor articulation of restoration goals and poor attainment of desired outcomes (Galatowitsch and Bohnen, accepted). Also, wetland ecosystems were found to require 5-10 years of maintenance and monitoring, so Enbridge's assumption that most monitoring will be complete by 5 years is misleading and overly optimistic.

These findings lead us to specific rebuttals of Enbridge's claims. We dispute Enbridge's statement that they will "restore all affected wetlands to pre-construction conditions" (section 8.1.2). **That is scientifically unfounded; it has never been done.** Specifically, Enbridge's Wetland and Waterbody Monitoring Plan considers 'success' to be when a restored area (of any vegetation type) has 80% of the pre-construction ground cover; that is inadequate, and not anything near to "pre-construction conditions". We propose 95% as a more reasonable standard.

Next, we question whether their plan to purchase seed from BWSR is practical; is there enough seed supply? Even if so, we question whether those seed mixes are appropriate to the specific sites where they will be deployed, and how will some species that have poor seed propagation (e.g. *Carex*, as described above). And, we insist that 5 years of post-disturbance monitoring is not enough to determine whether revegetation has been successful even if stated 'performance standards' are met; we believe 10 years is better supported by the science of wetland restoration. Also, we strongly recommend that such monitoring be done under the auspices of state agencies, rather than by a third-party contractor beholden to Enbridge.

Minnesota's system of allowing wetland destruction in exchange for inevitably-poor-quality of restoration -- even if more acres are "restored" than are destroyed -- is fundamentally a giveaway of our wetlands and waterways. It is as if you removed just a small piece -- say, the kidneys -- from a human being. Mitigation in the watershed is like putting a person on dialysis; technically it can replicate some function of the kidneys, but no one would consider it an equal and acceptable trade. Moreover, MPCA's proposed wetland mitigation will 'restore' wetlands in a different watershed than the wetlands which were degraded. This proposed practice not only contradicts Minn. R. 7050.0265 Subp. 3A (4), which states that "the mitigation occurs within the same watershed, to the extent prudent and feasible". Moreover, this proposed mitigation strategy is fundamentally an environmental justice issue (place of impact not necessarily commensurate with place of attempted restoration). **It is critical to note that Indigenous communities will bear the burden of this injustice. These communities are tied to place both through law and jurisdiction and through community practice, such that replacement at another location means irremediable loss for these communities.**

Finally, the Minnesota region impacted by the pipeline route currently retains a high proportion of intact wetlands, whereas the large majority of naturally occurring wetlands in the southern and western portions of Minnesota have been eliminated and the ones that do remain are in poor or fair condition (MPCA, 2015). Thus, the importance of protecting the state's remaining intact wetlands is paramount to a no-net-loss wetland strategy.

9.E. **Fully-functioning wetlands will be even more important in Minnesota's future climate, which will have more frequent and more intense rainfall events.**

As we move into an era of unprecedented global uncertainty regarding the ability of ecosystems to withstand changes in climate and the ability of humans to mitigate carbon emissions, every effort must be made to conserve the natural wetland resources that remain in Minnesota. For example, the negative effects of "mega-rains" can be partially mitigated by wetlands, which have the capacity to absorb precipitation and diminish stream flood peaks. The loss of wetlands in southern Minnesota is a well-documented cause of increased flood damage and turbidity in the Minnesota River watershed (Schottler et al., 2017). Wetlands also represent invaluable areas of carbon storage that may well be crucial to a desperately-needed climate mitigation plan for the state. These wetlands are also critical in providing landscape-scale protection of water quality and biodiversity.

9.F. **Seasonal prohibition of construction activities in wetlands should be extended to March through November due to growing uncertainty in annual weather predictions stemming from climate change.** In addition, Enbridge should be required to demonstrate (via site-by-site soil borings in the 5 days before construction activity begins at that site) that the ground is frozen or dry to a depth of 48" before construction commences. If that criterion is not met, permanent soil compaction will occur and the 'temporary' construction zone must be considered permanently impaired. In that case, Enbridge should be required to provide wetland compensation and mitigation for the 'temporary' construction zone. (Note that from a science perspective, compensation and mitigation are not recommended and will likely still result in lost ecosystem function, and that the strongest approach to water quality protection would be to avoid construction of unnecessary projects; see sections 6.A., 6.B., 9.D.)

9G. **Displacement of trench backfill due to placement of the pipe has not been adequately assessed.** A 36-inch diameter pipeline will displace 1382 cubic yards of soil per mile of pipeline. Assuming 10 cubic yards of soil per truckload, this represents nearly 140 truckloads of displaced soil per mile of pipeline. We request more detailed explanation of how they will dispose of this large quantity of soil, and whether this additional truck traffic on access roads will impact road stability and neighboring communities.

9.H. **Human health costs related to lost wetland function should be included in a determination of the costs and benefits of the project.**

In their determination of 'social and economic costs and benefits' arising from the project, MPCA should consider the following human health 'costs' related to wetland impacts:

i. Increase in Harmful Algal Blooms in surface waters: Wetlands filter pollutants and protect the water quality of downstream lakes and rivers (EPA, 2015) earning them the nickname "the Earth's kidneys." They help remove nutrients from surface runoff and aerial deposition, thus reducing nutrient concentrations in downstream surface waters. For example, a University of Minnesota study on wetlands in the Minnesota River Basin found that "wetlands are five times more efficient per unit area at reducing riverine nitrate concentration than the most effective land-based nitrogen mitigation strategies." (Hansen et al., 2018). At the same time, a recent study of water quality across the continental United States has found that stream and lake nutrient concentrations have increased over the past two decades, particularly in relatively undisturbed watersheds (Stoddard et al., 2017). Thus, changing nutrient conditions are a potential concern not just for heavily impacted agricultural regions of the state, but also for water quality in forested areas like the Lake Superior watershed.

Excess nutrients lead to harmful algal blooms (HABs) that can negatively impact human health depending on the type of algae in the bloom. Freshwater cyanobacteria called *Microcystis* are increasingly common in the Great Lakes region. Although there is no systematic monitoring network, reports of HABs in recreational lakes throughout the region have increased dramatically over the last decade (EPA, 2013; EWG, 2019).

Ingestion of *Microcystis* and other cyanobacterial pathogens can result in gastrointestinal illness and liver damage (NIEHS). As always, climate change makes matters worse for HABs. According to the Minnesota Department of Health (MDH), climate change is predicted to increase summer temperatures and precipitation levels, creating ideal conditions for HABs to impact Minnesota water quality (MDH, 2014). Thus, healthy wetlands form a crucial part of a clean hydrological system and natural climate resiliency infrastructure. When modeling for "mitigation" efforts of wetlands, harmful algal bloom modeling was not considered in the current 401 water permit to be considered along with economic impacts of being unable to use lakes impacted by HABs.

ii. Protection from Infectious Diseases: Functional wetlands are key to protecting human health. Their biodiversity strengthens bioregulatory mechanisms that typically prevent the proliferation of pathogenic species. For example, a study in New Jersey found a lower prevalence of West Nile virus and West Nile virus-infected animal vectors in areas adjacent to urban wetlands than in developed areas (Johnson et al., 2012). In Minnesota, climate change is warming winter temperatures and reducing their overall length. This is predicted to increase the season and geographical range favorable for tick and mosquito proliferation (Beard et al., 2016). Modeling from the Fourth National Climate Assessment predicts that "annual national cases of West Nile neuroinvasive disease are projected to more than double by 2050 due to increasing temperatures, among other factors, resulting in approximately $1 billion per year in hospitalization costs and premature deaths under a higher emissions scenario (RCP8.5; in 2015 dollars). In this same scenario, an additional 3,300 cases and $3.3 billion in costs (in 2015 dollars) are projected each year by the end of the century." Thus, healthy wetlands will be a crucial factor for climate-health resiliency against the spread of infectious diseases. MPCA does not appear to have accounted for these human health impacts in their assessment of the social and economic costs of the project.

iii. **Food Security:** Wetlands are an important source of high nutritional value food items such as wild rice and fish including crappie, bluegill, brown bullhead, large and smallmouth bass, northern pike, and muskellunge. These fish are present in the major river drainages crossed by the proposed project (Table 6.3.4-4).These resources are central to the traditional diet of Indigenous Minnesotans, and if these culturally significant food sources are destroyed, Indigenous communities are more likely to consume a non-traditional Western diet, which places them at an increased risk of diabetes (Williams, 2001) and hyperlipidemia (McMurray, 1991). This results in a cascading effect on Indigenous communities, who are already at a higher risk of food insecurity due to climate change (Ford, 2012; Fieldhouse & Thompson, 2012). MPCA needs to conduct a study to evaluate the current food security benefits the wetlands provide, which can be done with a simple survey of households near the impacted wetlands, and include this in their estimate of social and economic costs of the project and their proposed wetland mitigation strategy.

iv. **Medicinal Benefits:** Many common wetland plants are used in traditional, folk, or holistic (complementary) medicinal practices all over the world (Kindscher & Noguera, 2002; Davidson-Hunt et al., 2005); As of 2007, 38% of U.S. adults and over 50% of Native American adults used some form of alternative medicine (Barnes et al., 2008). Such practices are particularly important in rural settings where access to medical care is limited or unavailable (Merwin et al., 2006). The proposed L3RP route traverses rural Indigenous lands. According to an MPCA (2015) report, "wetlands have also been woven into the fabric of Minnesota's culture, beginning with the customs of Native Americans who harvested wild rice and traditional medicinal plants from wetland habitats." A loss of wetlands thus means a loss of sources of medicinal plants and traditional cultural practices for Indigenous Minnesotans. Negative mental health impacts due to ecological damage from L3RP construction, such as wetlands degradation, will also be felt more profoundly in frontline Indigenous communities (Consulo & Ellis, 2018). **Prior to approving a permit allowing for destruction of these medicinal sources, MPCA needs to quantify the current use of wetlands for medicinal purposes and incorporate this into their assessment of project costs and their proposed wetland mitigation strategies.**

10. Water quality degradation and risks to wild rice beds

10.A. The proposed project near many wild rice lakes (Figure 10). Wild rice is central to the culture of the Anishinaabe people, and loss of wild rice has many negative impacts on the health of Native American communities across Minnesota. Direct impacts include a loss of food security, as many depend on wild rice through subsistence farming. An Earth Economics report concluded that "wild rice contributes to an average of 90,000 dollars per year of prevented health care costs for Native Americans in Minnesota, or 5.90 dollars per food insecure person" (Fletcher et al., 2018). Wild rice is considered a nutritionally complete food, high in protein and nutrients and low in fat and high-glycemic carbohydrates, and the substitution of traditional foods like wild rice with a Western diet may be responsible for the higher rates of diabetes in Indigenous communities in Minnesota (Fond du Lac Band, 2020). Wild rice is also an important factor in mental health and wellbeing. There is an increasing body of psychological research on solastalgia, "distress that is produced by environmental change impacting on people while they are directly connected to their home environment exacerbated by a sense of powerlessness or lack of control over the unfolding change process." (Albrecht, 2007). Solastalgia is most pronounced in Native American communities (Clayton et al., 2017). Harvesting wild rice provides physical activity, a sense of community, and spiritual wellbeing, and thus constitutes an effective climate health resiliency strategy. MBWSR, along with MNDNR, has been working to preserve wild rice beds since 2015, declaring in a report that "Minnesota is the epicenter of the world's natural wild rice (MBWSR, 2015)". The social, economic and health benefits of wild rice as identified in the Earth Economics report have not been taken into account in the 401 water permit.

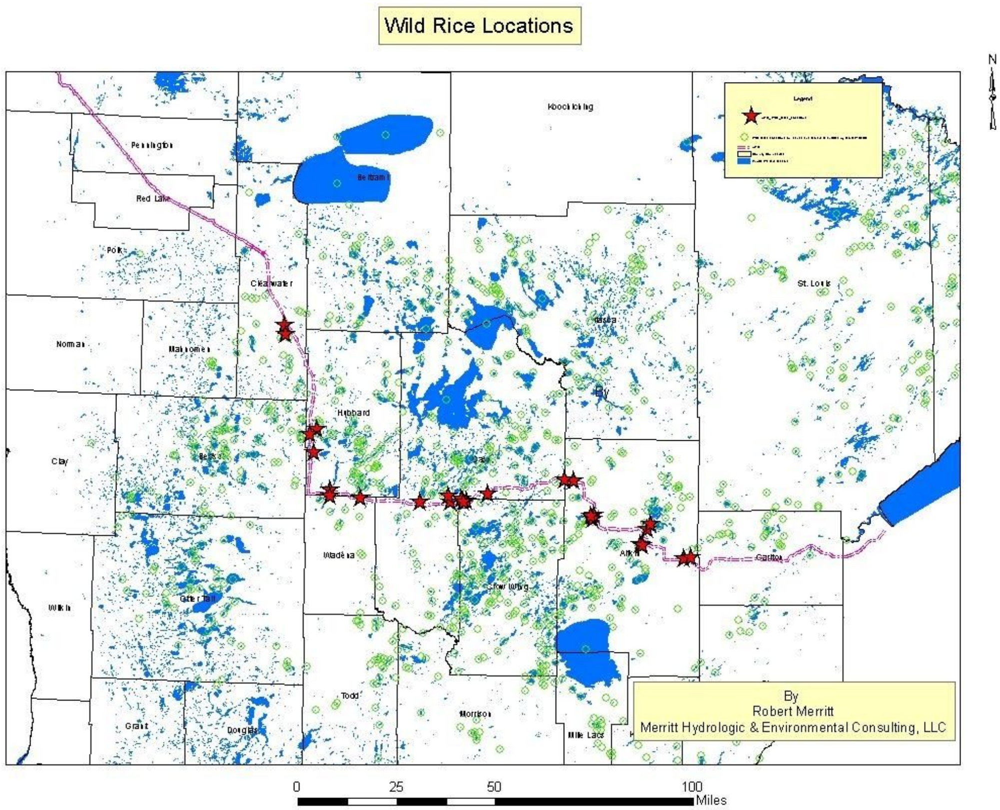

Figure 10 shows locations of wild rice lakes in close proximity to the proposed project.

11. Broader climate change impacts from project must be considered in the social and economic costs

11.A. **Climate change, including that wrought by Line 3 emissions, is an enormous threat to Minnesota's water quality, aquatic biodiversity, and human health – the very things that 401 certification and antidegradation are meant to address.** The climate change implications of Line 3 are profound. The 193 million tons of CO2eq that annually results from the new pipeline (ALJ) exceeds the total Minnesota CO2eq from all sectors by 39 million tons and is a factor of 5 larger than emissions from transportation as well as a factor of 5 greater then emissions from electricity production (MPCA GHG).

The antidegradation rules are clear: "The commissioner shall conduct an antidegradation review based on the information provided under subpart 2 and other reliable information available to the commissioner concerning the proposed activity and other activities that cause **cumulative changes** in existing water quality in the surface waters." (7050.0280 Subp. 3.) (bold added). The facts that the emissions will not occur primarily in Minnesota, or that a specific GHG molecule impacting a Minnesota watercourse cannot be attributed to Line 3 emissions, are not grounds for dismissing GHG impacts on Minnesota water quality. According to Guidance from Council on Environmental Quality (CEQ) NEPA requires agencies "analyze the **cumulative effects** of a proposed action because the potential effects of GHG emissions are inherently a global cumulative effect." (bold added) and defines indirect effects as "Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. 40 CFR 1508.8(b). Following the rule of reason, agencies should assess effects when a sufficiently close causal relationship exists between the proposed action and the effect. A ''but for'' causal relationship is not sufficient." [Federal Register].

The conclusion from the ALJ findings, antidegradation rules, NEPA guidance, and data from the MPCA itself are clear. The climate change impacts of the proposed Line 3 project are immense and the MPCA has the obligation to consider these climate change impacts on water quality in Minnesota. The fact that the PUC dismissed climate change implications of the project does not relieve the MPCA of this obligation. MPCA is the final arbiter of the Line 3 project water quality impacts, not the PUC, and the MPCA must make an <u>independent</u> assessment of climate change impacts on water quality. Therefore, we assert that MPCA must attempt to quantify and evaluate the environmental impacts of climate change resulting from Line 3.

11.B. **Water quality will be substantially and negatively impacted by climate change.** Wetlands, lakes and streams in Minnesota will be stressed by climate change, and water quality degradation will occur via a variety of mechanisms and processes.

i. **Fully-functioning wetlands provide important ecosystem services such as moderating peak streamflows, improving water quality and providing habitat and nurseries for biotic indicators.** The increased variability of temperature and precipitation forecast for Minnesota under a changing climate will stress wetlands and diminish their capacity for providing these services (see above for more detail).

ii. **Fully-functioning forests provide ecosystem services such as improved water quality.** Minnesota forests are already stressed by warmer temperatures, new pests, and greater variability in precipitation. By allowing further incremental climate change, the agency is permitting diminished ecosystem services and degraded water quality.

11.C. **A 2008 MNDNR report to the Minnesota Legislature stated that of all the threats facing wild rice, "climate change has the potential for the greatest long-term impacts on natural wild rice."**[ii] Every phase of the ecological life cycle of wild rice is impacted by climate change. Minnesota is among the top five fastest warming states in the U.S.[iii] Warmer winters impact wild rice seed germination. Fifteen mega-rain events have been identified in Minnesota since 1858, and seven of these events have occurred since 2002, according to MDH. The floating leaf stage of the ecological cycle of wild rice is highly impacted by heavy rainfall and flooding.[iv],[v]

11.D. **MPCA is obligated to consider social costs and benefits of projects seeking this certification and permit approval.** For example, social costs from Line 3 emissions have previously been calculated as $287 billion in the DOC-EIS. Specifically, the social cost we'd like to address here is that the climate change attributable to this project will have substantial negative human health outcomes.

i. In 2009, the Lancet warned that climate change is the greatest threat to public health in the 21st century (Costello). However, no significant reductions in emissions were made over the past decade, and global temperatures have continued to rise. The 2018 Fourth National Climate Assessment, a report written by 13 U.S. agencies, stated that "the health and wellbeing of Americans are already being impacted by climate change" (Ebi, 2018). In 2019, over 75 medical organizations, including Health Professionals for a Healthy Climate, issued a call to action on climate and equity, declaring climate change a health emergency (Climate Health Action, 2020). In 2019, after a decade of inaction, the Lancet Countdown on Climate and Health reports that "the health of this generation will be defined by climate change, if significant action is not taken" Watts, 2019).. Under MEPA, "significant environmental impacts" need to be considered. As humans, we are an integral part of the environment. The following are the human health impacts of this project. By permitting a pipeline that is carrying tar sands oil, the combustion of which will accelerate climate change, MPCA is promoting degradation of our environment. The EIS already estimated the social cost of this pipeline to be $287 billion over the lifetime of this project. This social carbon cost modeling was done based on a calculator from 2015.Even in 2015, the calculator lays out that "The models used to develop SC-CO2 estimates do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research." In 2020, we are now aware of the feedback and compounding impacts of climate change. In the case of this pipeline, we have shown over and over that the impacts to water quality are compounded. In this case, MPCA is looking at a carbon cost that is higher than $287 billion.

ii. **Respiratory Health Impacts**

a. **Allergies and Asthma:** The ragweed pollen season has increased by 18–21 days in Minnesota. Increased heat and carbon dioxide levels increase the duration of the season and the allergenicity (a measure of how much particular allergens, such as ragweed, affect people) of pollen, triggering asthma attacks and reducing the productivity of Minnesotans (Neil, 2006).
b. **Poor Air Quality:** Air pollution has negative impacts on human health, including asthma (Khreis, 2017), stroke (Shah, 2015) and cardiovascular mortality (Beelen, 2014).. The American Lung Association releases an annual "State of the Air" report discussing the air quality progress in different parts of the country. Minnesota cities rank among the top 25 cleanest cities, but this is threatened by increasingly warm summers, which cause stagnation of polluted air (MPCA, 2019). Air pollutants such as VOCs and nitrogen oxides (NOx) react with each other in the hot sun to form ground-level ozone (O_3), a known trigger for asthma attacks. Wildfires are also contributing to poor air quality. Seven of the nine poor air quality days experienced in Minnesota in 2018 were due to wildfire smoke from Canada (MPCA, 2019). Canada is warming at twice the rate of the rest of the globe (Bush, 2019) and wildfires in Canada are becoming more frequent and severe due to climate change. Thus, the extraction and use of tar sands oil from Canada subsidizes a decline in our air quality. The main pollutant in wildfire smoke is fine particulate matter (PM2.5). The American Heart Association outlined a direct causal link between PM2.5 and cardiovascular mortality (Brook, 2010).] PM2.5 has also been associated with asthma attacks (Zheng, 2015), high blood pressure (Byrd, 2016), strokes (Feigin, 2016) and chronic kidney disease (Afsar, 2019; MDH 2015).
c. **Heat-related Illness:** Minnesota has grown noticeably warmer, especially over the last few decades. Data for the last half century (1960–2013) show

that the rate of warming in Minnesota has sped up substantially to 0.5°F per decade (5.3°F per century) (MDH, 2015). Extreme heat can exacerbate previously existing medical conditions such as diabetes, cardiovascular disease, chronic obstructive pulmonary disease, kidney ailments, and mental or behavioral disorders, and can cause direct health effects such as heat stress, heat stroke, and even death. With a rise in dew point and the urban heat island effect, seniors who live alone and in homes without air conditioning will be at highest risk for heat stroke. Heat awareness is very low in Minnesotans, which also increases the risk of heat-related illness (Howe, 2019).

d. **Vector-Borne Illnesses:** Warming winters and higher precipitation levels are expected to result in earlier seasonal tick activity and an expansion in tick habitat range, increasing the risk of human exposure to tickborne illnesses, such as Lyme disease (Beard, 2016). While the spread of Lyme disease is multi-factorial, including deforestation and changing patterns of human-deer interaction, temperature variability has a well-defined role. MDH is also monitoring the spread of mosquito-borne illnesses, including West Nile virus. As noted above, West Nile virus is predicted to increase in Minnesota due to climate change. Clear cutting of forests for pipeline corridor can be linked to potential increased incidence of tick-borne disease such as Lyme disease. White Footed mouse populations that harbor and act as reservoirs of the Lyme Disease bacteria (*Borrelia burgdorferi*) often increase dramatically following such clear cut logging practices. Consequently, the percentages of black legged ticks that parasitize both the mice and humans also increases thus increasing the threat of human Lyme infections. (Granter et al., 2014).

e. **Impacts of Increased Precipitation:** The Midwest is already experiencing an increase in precipitation due to climate change (Pryor, 2014), with 2019 on track to become the wettest year on record for Minnesota (MDNR, 2019). Increased precipitation could lead to chronic flooding of homes, and water damage leads to a rise in mold and respiratory illnesses. This disproportionately impacts low-income families who are unable to afford clean-up or relocation. This was best demonstrated in New Orleans after Hurricane Katrina (Cummings, 2008). Currently there are no programs to track mold and respiratory illnesses related to flooding in Minnesota. Increased precipitation also leads to increased runoff and increased nitrate levels in lakes, which can trigger HABs, as described in Chapter 1.

f. **Mental Health Impacts:** Minnesotans are increasingly experiencing solastalgia, a sense of loss experienced due to the changing climate damaging the natural environment.[xxiii] Communities that rely on the natural environment for sustenance and livelihood, or live in areas most hard-hit by climate change events, are at increased risk for adverse mental health impacts (MDH, 2017; Dodgen, 2016).

g. Climate change worsens drought and flooding, leading to unpredictable crop yields and a lack of financial stability for farmers, and an increase in farmer suicides, as demonstrated in studies from India and Australia (Vins, 2016). Robust studies on the mental health impacts of climate change on Minnesota farmers are needed, although there are anecdotal reports of negative impacts after the 2019 flooding in the Midwest (Schwarz, 2019).

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Klamm 2020b **From:** Klamm, Stephanie (DNR) **Sent:** Friday, January 24, 2020 11:44 AM **Subject:** RE: Public Water Site Specific Plans LaSalle/EWR REAE/emails/

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Walker, M., 2020, email. **From:** Walker, Michele (DNR) **Subject:** RE: Line 3 Meeting Follow-up**, Date:** Wednesday, March 07, 2018 3:08:15 P LaSalle/EWR Employees/EWR Hydo1/.

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Appendix A:
Curricula vitae of authors

Technical comment on *Enbridge Line 3 Pipeline Replacement Project* Draft 401 Certification and Preliminary Antidegradation Assessment

Laura Day Triplett

Department of Geology
Gustavus Adolphus College
800 West College Avenue
St. Peter MN 56082
triplett@gustavus.edu
(507) 933-7442

Education

Ph.D. University of Minnesota, Minneapolis, Geology **2007**
Advisors: Dan Engstrom, Emi Ito; "*Two Rivers, Two Lakes, Two Legacies: Anthropogenic alterations to silica cycling and heavy metal deposition in Lake St. Croix and Lake Pepin, USA*"

M.S. University of Minnesota, Minneapolis, Geology **2004**
Minor, Quaternary Paleoecology
Advisor: Dan Engstrom; "*A Whole-Basin Reconstruction of Sediment and Phosphorus Loading to Lake St. Croix*"

B.A. University of Colorado, Boulder, Geology **1996**

Williams College, Williamstown, MA **1992-1994**

Academic Appointments

Associate professor, Department of Geology, Gustavus Adolphus College **2016-present**
Assistant professor, Department of Geology, Gustavus Adolphus College **2007-2016**

Select courses taught at Gustavus:
- Our Planet (GEO 111)
- Geochemistry of the Environment (GEO/ENV 120)
- Earth Surface Processes (GEO 246)
- Climate Change: Geo-Solutions (GEO 225)
- Hydrogeology (GEO 350)
- Research in Geology I and II (GEO 392, 393)
- IEX: Paleolimnology (GEO 110)

Adjunct professor, Department of Geology, University of St. Thomas **2004**

Publications

** indicates student co-author*

Triplett, L.D., Tal, M., Wagner, Z. and Kettenring, K.M. *Accepted for publication, March 2020.* Invasion of a widespread, non-native grass causes downstream reductions in bioavailable silica. Journal of the American Water Resources Association.

Triplett, L.D., Kettenring, K.M., Tal, M. and Smith, C.* 2014. The potential for multiple signatures of invasive species in the geologic record. Anthropocene 5, p. 59-64, DOI 10.1016/j.ancene.2014.06.002

Triplett, L.D., Engstrom, D.R., and Conley, D.J. 2011. Changes in amorphous silica sequestration with eutrophication of riverine impoundments. Biogeochemistry, v.108, p. 413-427

Balogh, S. J., **Triplett, L.D.,** Engstrom, D.R., Nollet, Y.H. 2010. Historical trace metal loading to a large river recorded in the sediments of Lake St. Croix, USA. Journal of Paleolimnology, v. 44, p. 517-530

Triplett, L.D., Engstrom, D.R., Edlund, M.B. 2009. A whole-basin stratigraphic record of sediment and phosphorus loading to the St. Croix River, USA. Journal of Paleolimnology 41, p.659-677

Edlund, M.B., **Triplett, L.D.**, Tomasek, M. and Bartilson, K. 2009. From paleo to policy: Partitioning of historical point and nonpoint phosphorus loadings to the St. Croix River, USA. Journal of Paleolimnology 41, p.679-689

Edlund, M.B., Engstrom, D.R., **Triplett, L.D.**, Lafrancois, B.M., Leavitt, P. 2009. Twentieth century eutrophication of the St. Croix River (Minnesota-Wisconsin, USA) reconstructed from the sediments of its natural impoundment. Journal of Paleolimnology 41, p.641-657

Triplett, L.D., Engstrom, D.R., Conley, D.J., Schellhaass, S.M. 2008. Silica fluxes and trapping in two contrasting natural impoundments of the upper Mississippi River. Biogeochemistry 87, p.217-230

Research Grants

EPA Section 319: Seven Mile Creek Assessment and Implementation. **Funded, $475,524.**

McKnight Foundation: Environmental monitoring in Seven Mile Creek watershed. **Funded, $74,996.**

National Science Foundation-Division of Undergraduate Education: Development and assessment of mobile geo-referenced games for geoscience education using Grand Canyon as a virtual laboratory, 2013-2015. Grant acquired by Utah State University; I am a collaborating faculty member, so no direct funding to Gustavus.

Le Sueur River Sediment Sampling, 2013-2014, University of Minnesota-Duluth. **Funded, $25,186.**

Le Sueur River Sediment Sampling, 2013, Utah State University. **Funded, $5,000.**

National Science Foundation Geobiology and Low-Temperature Geochemistry program, 2011, RUI-Collaborative Research: Reduction in riverine silica transport due to human-induced change in riparian vegetation. Co-PIs: K.M. Kettenring and M. Tal. **Funded, $158,756.**

Gustavus Adolphus College Research, Scholarship and Creativity Grant, 2010, Measuring the effect of an invasive species on silica cycling in the Platte River, USA. **Funded, $2,113.**

National Science Foundation Major Research Instrumentation program, 2009, Acquisition of an ICP-MS for interdisciplinary water quality and geochemistry research. Co-PI with J. Jeremiason, J. Bartley, D. Stoll. **Funded, $246,820.**

Science Museum of Minnesota, 2008, Sediment-Source Apportionment of Bluffs and Ravines in the Le Sueur River Basin: A Pilot Study. **Funded, $6,400.**

Presentations and Abstracts

Abstracts accompanying presentations (indicates student co-author)*

Perry, McKenzie*, **Triplett, L.D.**, Westfield J.*, Clause C.*, Smith C.* 2017. TSS and nitrate monitoring in Seven Mile Creek, MN, to inspire increased best management practices. Abstracts with Program – American Geophysical Union, Fall Meeting, New Orleans.

Triplett, L.D., Kettenring, K.M. and Tal, M. 2014. Using silica to explore links between agriculture, hydrology and geochemical budgets in the Platte River, USA. Abstracts with Program – 9th International Symposium on Geochemistry of the Earth's Surface, Paris, France.

Choquette, A.*, **Triplett, L.D.**, Gran, K. 2014. Sediment mobilization in ravines draining Minnesota cropland. Abstracts with Programs – American Geophysical Union, Fall Meeting, San Francisco CA.

Van Orsdel, Z.R.*, Mohr, R.C.*, Ford, E.M.*, Wagner, Z.*, **Triplett, L.D.** 2014. How is physical depositional setting related to silica chemistry in the Platte River, USA? Abstracts with Programs – American Geophysical Union, Fall Meeting, San Francisco CA.

Triplett, L.D., Kettenring, K.M. and Smith, C.* 2011. Invasion! How the sedimentological effect of one plant species is changing the geochemistry of the Platte River, Nebraska. Abstracts with Program – Geological Society of America, v. 43(5), p. 165, Mpls MN.

Triplett, L.D., Carlson, B.*, Degner, E.* and Johnston, J.* 2011. A team-based approach to teaching environmental history using lake sediments. Abstracts with Program – Geological Society of America, v. 43(5), p. 462, Mpls MN.

Triplett, L.D., Kettenring, K.M. and Smith, C.A.* 2011. Eight years of silica sequestration by *Phragmites australis* in a fluvial environment. Abstracts with Program – 9th International Symposium on Geochemistry of the Earth's Surface, Boulder CO. Late-breaking abstract.

Triplett, L.D. and Engstrom, D.R. 2006. Silica fluxes in two large, natural riverine lakes help quantify human impacts to global silica cycle. International Paleolimnological Symposium.

Triplett, L.D., Edlund, M.B. and Engstrom, D.R. 2003. A Whole-Lake Sediment and Pollutant Mass Balance from a Naturally Impounded Large River System. International Paleolimnological Symposium.

Triplett, L.D., Edlund, M.B. and Engstrom, D.R. 2003. A Whole-Basin Sediment and Pollutant Mass Balance from a Naturally Impounded Large River System in the Upper Mississippi River Basin. Proceedings, American Society of Limnology and Oceanography, Salt Lake City.

Triplett, L.D., Edlund, M.B. and Engstrom, D.R. 2000. A Whole-Basin Sediment Record of Local and Regional Land-Use Change from Lake St. Croix in the Upper Mississippi River Basin. Proceedings, American Geophysical Union Fall Meeting, San Francisco CA. **Outstanding Student Speaker Award: Hydrology section*

Service to the College

Chair of Geology Department	**2017-present**
Co-chair of 2018 Nobel Conference *Living Soil:A Universe Underfoot*	**2016-2018**
Program assessment liaison for Geology and Environmental Studies	**2011-2016**
Nobel Conference Planning Committee (2012)	**2011-2012**
Curriculum Committee	**2009-2012**
Nobel Conference Planning Committee (2009)	**2009**

Other Professional Experience

Pollution Control Specialist, Minnesota Pollution Control Agency **1997-2000**

Water Quality Division and Metro Division: Evaluated compliance with state and federal wastewater discharge permits and water quality rules, investigated noncompliance and initiated enforcement actions, assisted with issuance of discharge permits.

Society and Professional Association Memberships

American Association for the Advancement of Science
American Geophysical Union
Geological Society of America
Minnesota Ground Water Association
National Association of Geoscience Teachers

BIOGRAPHICAL SKETCH
Christine L. Dolph
Research Scientist, University of Minnesota

(a) Professional Preparation
Grinnell College, Grinnell, IA, USA, B.A. in Biology (2002)
University of Minnesota, St. Paul, MN, USA, M.S. in Water Resources Science (2008)
University of Minnesota, St. Paul, MN, USA, Ph.D. in Water Resources Science (2012)
Dissertation title: *Defining stream integrity using biological indicators*

(b) Appointments

2020-present	Research Scientist, Department of Ecology, Evolution & Behavior, University of Minnesota
2018-2019	Research Scientist, Atkinson Center for Sustainable Development, Cornell University
2017-2018	Research Scientist, Department of Ecology, Evolution and Behavior, University of Minnesota
2013-2017	Postdoctoral Associate, Department of Ecology, Evolution and Behavior, University of Minnesota
2007-2009	Graduate Research Assistant, U.S. Geological Survey, Fish and Wildlife Cooperative Research Unit, St. Paul, Minnesota
2006	Biologist, LGL Alaska Research Associates, Inc., Anchorage, Alaska
2004-2005	Biological Science Technician, Environmental Contaminants Division, U.S. Fish and Wildlife Service, Anchorage, Alaska

(c) Related Publications

Cho, S.J., Braudrick, C.A., **Dolph, C.L.**, Day, S., Dalzell, B.J. & Wilcokc, P.R. In review. Simulation of fluvial sediment dynamics through strategic assessment of stream gaging data: a targeted watershed sediment loading analysis. Journal of Environmental Management.

Boardman, E., Danesh-Yazdi, M., Foufoula-Georgiou, E., **Dolph, C.L.**, Finlay, J.C. 2019. Fertilizer, landscape features and climate regulate phosphorus retention and river export in diverse Midwestern watersheds. Biogeochemistry. https://doi.org/10.1007/s10533-019-00623-z

Dolph, C.L., Boardman, E., Danesh-Yazdi, M., Finlay, J.C., Hansen, A.T., Baker, A.C., and Dalzell, B. 2019. Phosphorus transport in intensively managed watersheds. Water Resources Research. https://doi.org/10.1029/2018WR024009

Gran, K.B., **Dolph, C.L.**, Baker, A., Bevis, M., Cho, S.J., Czuba, J.A., Dalzell, B., Danesh-Yazdi, M., Hansen, A.T., Kelly, S., Lang, Z., Schwenk, J., Belmont, P., Finlay, J.C., Kumar, P., Rabotyagov, S., Roehrig, G., Wilcock, P., and Foufoula-Georgiou, E. 2019. The power of environmental observatories for advancing multidisciplinary research, outreach, and decision support: the case of the Minnesota River Basin. Water Resources Research 55: 3576-3592.

Hansen, A.T., **Dolph, C.L.**, Foufoula-Georgiou, E., and Finlay, J.C. 2018. Contribution of wetlands to nitrate removal at the watershed scale. Nature Geoscience 11: 127.

Dolph, C.L., Hansen, A.T., Kemmitt, K.L., Janke, B., Rorer, M., Winikoff, S., Baker, A, Boardman, E., Finlay, J. C. 2017. Characterization of streams and rivers in the Minnesota

River Basin Critical Observatory: water chemistry and biological field collections, 2013-2016. Retrieved from the Data Repository for the University of Minnesota, https://doi.org/10.13020/D6FH44.

Dolph, C.L., Hansen, A.T., and Finlay, J.C. 2017. Flow-related dynamics in suspended algal biomass and its contribution to suspended particulate matter in an agricultural river network of the Minnesota River Basin, USA. Hydrobiologia 785: 127-147.

Hansen, A.T., **Dolph, C.L.**, and Finlay, J.C. 2016. Do wetlands enhance downstream denitrification in agricultural landscapes? Ecosphere 7: e01516.

Dolph, C.L., Eggert, S.L., Magner, J., Ferrington, L.C., and Vondracek, B. 2015. Reach-scale stream restoration in agricultural streams of southern Minnesota alters structural and functional responses of macroinvertebrates. Freshwater Science 34: 535-546.

Dolph, C.L., Huff, D.D., Chizinski, C.J., and Vondracek, B. 2011. Implications of community concordance for assessing stream integrity at three nested spatial scales in Minnesota, USA. Freshwater Biology 56: 1652-1669.

Reeves, M.K., Jensen, P., **Dolph, C.L.**, Holyoak, M., and Trust, KA. 2010. Multiple stressors and the cause of amphibian abnormalities. Ecological Monographs 80: 423-440.

Dolph, C.L., Sheshukov, A.Y., Chizinski, C.J., Vondracek, B.C., and Wilson, B. 2010. The Index of biological integrity and the bootstrap revisited: an example from Minnesota streams. Ecological Indicators 10: 537-537.

Reeves, M.K., **Dolph, C.L**., Zimmer, H., Tjeerdema, R.S., and Trust, KA. 2008. Road proximity increases risk of skeletal abnormalities in wood frogs from National Wildlife Refuges in Alaska. Environmental Health Perspectives 116: 1009-1014.

(d) Synergistic activities.

1. Organizer of a forthcoming special issue of Water Resources Research, entitled ‘*Dynamics in Intensively Managed Landscapes: Water, Sediment, Nutrient, Carbon, and Ecohydrology*.’
2. Discussant: Linking Agricultural Nutrient Pollution to the Value of Freshwater Ecosystem Services, Social Cost of Water Pollution Workshop, Cornell University, April 3-5, 2019.
3. Organizer and moderator for an ongoing series of university symposia (four events in 2018-2020), connecting researchers and academics to community-centered research questions and practice, and identifying community-led pathways for achieving environmental justice.
4. Member of the Minneapolis Parks and Recreation Board Pesticide Advisory Committee, charged with assisting and advising the park board in transitioning towards pesticide-free resource management alternatives and recommending modifications to the Integrated Pest Management Plan.
5. Peer reviewer for Global Biogeochemical Cycles, Aquatic Ecology, Axios Review, Ecological Indicators, Environmental Monitoring and Assessment, Hydrobiologia, Marine and Freshwater Science, North American Journal of Fisheries Management, Restoration Ecology, Transactions of the American Fisheries Society, Biogeochemistry, Energy Ecology and Environment.

2929 University Ave SE, Apt 1301
Minneapolis, MN, 55414
Email: vishnulaalitha@gmail.com
Cell: 443-525-8774
Twitter: @LaaliMD

Dr. Vishnu Laalitha Surapaneni

CURRENT POSITION

Assistant Professor, General Internal Medicine — 2018- Present
University of Minnesota
Minneapolis, Minnesota

Faculty Advisor — 2019- Present
Health Students For a Healthy Climate
University of Minnesota
Minneapolis, Minnesota

Associate — 2019- Present
Institute on the Environment
Minneapolis, Minnesota

Steering Committee Member — 2018- Present
100% Minnesota Campaign
Minneapolis, Minnesota

Executive Committee Member — 2018- Present
Health Professionals for a Healthy Climate
Minneapolis, Minnesota

Science Advisory Council Member — 2019- Present
MCEA
Minneapolis, Minnesota

Advisory Council Member — 2019-Present
Climate Resiliency Workgroup
Minneapolis Parks and Rec Board
Minneapolis, Minnesota

Sustainable Transportation Advisory Council Member — 2020- Present
Minneapolis, Minnesota

EMPLOYMENT HISTORY

Instructor of Medicine — 2017- 2018
Johns Hopkins Bayview Medical Center
Baltimore, Maryland

Hospitalist — 2014-2017
Sanford Clinic North
Bemidji, Minnesota

EDUCATION

Master of Public Health 2009-2010
The Johns Hopkins Bloomberg School of Public Health
Baltimore, Maryland

Bachelors in Medicine and Bachelors in Surgery, M.B.B.S (6-year program) 2001-2007
Andhra Medical College
Andhra Pradesh, India

BOARD CERTIFICATION

American Board of Internal Medicine, Board certified 2014

MEDICAL TRAINING

Internal Medicine Residency 2011- 2014
University Hospitals Case Medical Center
Cleveland, Ohio

Rotating internship 2006 – 2007
King George Hospital
Visakhapatnam, Andhra Pradesh, India

INTERNATIONAL MEDICAL EXPERIENCE

Vth AMHE Medical Mission to Justinien University Hospital 2012
Cap-Haitien, Haiti

Emergency Disaster Relief Response 2010
Port-Au-Prince, Haiti

RESEARCH

Reviewer 2019
Lancet Countdown on Climate and Health, US Policy brief

Student Investigator 2011- 2014
Standardizing Resident Handoffs in Times of ACGME Duty-Hour Regulations
University Hospitals Case Medical Center

Research Assistant 2010-2011
Effective Enterprise-wide Transitions at Discharge
Johns Hopkins University

Student Investigator 2009 -2010
Haiti Iodized Salt Use Initiative: Strategic Behavior Change Communication Program
Johns Hopkins Bloomberg School of Public Health

Student Research Volunteer 2008
Pamphlet for Vitamin A preventable blindness
King George Hospital, Visakhapatnam, Andhra Pradesh, India

Student Research Volunteer 2005
Annual surveillance of family planning services
Simhachalam, Andhra Pradesh, India

Student Research Volunteer 2004
Household nutrition assessment survey
Urban Slum, Visakhapatnam, Andhra Pradesh, India

Student Research Volunteer 2003
Environmental sanitation surveys in urban slums
Allipuram, Visakhapatnam, Andhra Pradesh, India

PRESENTATIONS

Poster Abstract Presentation 2013
Standardizing Resident Handoffs in Times of ACGME Duty-Hour Regulations
2013 Association of Program Directors in Internal Medicine Spring Meeting

Oral Abstract Presentation 2011
Higher Quality Discharge Summaries of Hospitalized Adults are Associated with Reduced Risk of Readmission
34th Annual Meeting, Society of General Internal Medicine 2011

Poster Abstract Presentation 2011
KAP of Iodized Salt among Adult Women in Rural Haiti
Unite For Sight Global Health & Innovation Conference, 2011

MPH Capstone presentation 2010
Haiti Iodized Salt Use Initiative: Strategic Behavior Change Communication Program
Johns Hopkins Bloomberg School of Public Health

PROFESSIONAL SPEAKING

PSR Workshop 2017
How Fossil Fuels Affect Health in Maryland
Med Chi, Baltimore, Maryland

Grand Rounds 2018
How Climate Change Affects our Patients
Johns Hopkins Howard County Hospital, Baltimore, Maryland

Community Health and Advocacy Talks 2019
Environment: If you're not outraged, you're not paying attention
University of Minnesota, Minneapolis, Minnesota

Panel discussion, Women advancing Environmental Justice in Minneapolis 2019
Women's Environmental Network, Minneapolis, MN

Webinar on Climate advocacy 2019

Health Professionals for Healthy Climate

INVITED GUEST LECTURES: LOCAL

Health Impacts of Climate Damage 2018
University of Minnesota, Minneapolis, Minnesota

Health Impacts of Climate Damage 2019
McAlester College, Minneapolis, Minnesota

Health Impacts of Climate Damage & Physician Advocacy Solutions (CME activity) 2019
Global Health Course
University of Minnesota, Minneapolis, Minnesota

Key Note Speaker: Climate Justice 2019
American Humanist Society, Minneapolis, Minnesota

EXPERT TESTIMONY

Health Expert Testimony 2017
Request for State Action - Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator
City Council, Baltimore, Maryland

Health Expert Testimony 2017
Setting limits for Nitrogen Emissions from BRESCO Incinerator
Maryland Department of Environment, Baltimore, Maryland

Health Expert Testimony 2018
Ban on Chlorpyrifos
The House Environment and Transportation Committee, Maryland

Health Expert Testimony 2018
Prohibiting Crude Oil Terminals For the purpose of prohibiting new or expanded crude oil terminals throughout Baltimore City
City Council, Baltimore, Maryland

Health Expert Testimony on climate change and health 2018
Metropolitan Council Transportation Committee
Transitioning Metro buses to electric buses by 2022

Invited health expert testimony on climate change and health at MN State Capitol 2019
Public health impact of climate change
House Energy and Climate Finance Committee

Health Expert Testimony on air pollution and environmental justice 2019
House Committee on Transportation and Infrastructure
Bill HF195: Upgraded buses in poor air quality regions first

Health Expert Testimony on climate change and health 2019
Bill HF1833: Clean Energy Omnibus Bill

PUBLICATIONS

Book Chapter 2015
50 Studies Every Internist Should Know
Edited by Surapaneni VL, Hochman ME, Hochman SD, Swiger K, Boueiz A, Thomas JR.Oxford University Press, 2015

PROFESSIONAL SERVICE

Member, Resuscitation Committee, Sanford Health Bemidji 2015- Present
Member, Acute Stroke Ready Hospital Committee, Sanford Health Bemidji 2015- Present

AWARDS

MPH Field Experience Award 2009
The Johns Hopkins Bloomberg School of Public Health

Best Oral Presentation Award 2011
Higher Quality Discharge Summaries of Hospitalized Adults are Associated with Reduced risk of Readmission
SGIM Mid-Atlantic Region, 2011 Regional Meeting

CERTIFICATIONS

Certificate in Health communication 2010
NIH plain language online training certificate 2010

INTERNATIONAL PUBLIC HEALTH EXPERIENCE

Oral Cancer Awareness program 2009
Visakhapatnam, Andhra Pradesh, India

Nutrition education program for pregnant women 2008
Sabbavaram, Rural Andhra Pradesh, India

Breast Cancer Awareness Program 2008
Gayatri Engineering College, Visakhapatnam, India

Community Tuberculosis Awareness Program 2004
Yandarda, Rural Andhra Pradesh, India

VOLUNTEERING

Project C.U.R.E. Minneapolis – Community Liaison 2014-2016
Baltimore 350.Org - Co-Group Leader 2017- Present

Willis Mattison 42516 State Highway 34 Osage, Minnesota 56570 Phone: 218-841-2733
Email: mattison@arvig.net

ORIGIN: Born in Thief River Falls, Minnesota July 11, 1943

EDUCATION:

- H.S. Diploma: Pershing High School, Plummer Minnesota, 1961, Honors: Valedictorian.
- Bachelors Degree: Bemidji State University 1964 Broad Science and Biology Major, Chemistry Minor.
- Masters Degree: St. Mary's University 1972, Biology, Environmental Studies and Ecology.

EXPERIENCE:

- Research Biochemist, Mayo Clinic, Rochester Minnesota 1964-65
- Secondary School Science Instructor, Biology, Chemistry, Environmental Science, Tracy High School, Tracy Minnesota 1965-1972.
  Honors: Outstanding Teacher of the Year-1971.
  State President, Minnesota Science Teachers Association and Appointed Minnesota Junior Academy of Science Advisor.

- District Representative, Minnesota Pollution Control Agency, Rochester Minnesota 1972 to 1977

- Regional Director, Minnesota Pollution Control Agency, Detroit Lakes, Minnesota – 1977-99, Retired 2001.

Primary MPCA Responsibilities: Administering MPCA air, water, solid and hazardous waste programs in a 28 county region; issuing and enforcing MPCA permits, supervising MPCA Regional Office staff, managing office budget, representing the MPCA's policies and programs to citizens, local units of government, and elected officials; preparing and reviewing agency program plans, reviewing, commenting and approving County Solid Waste Plans and Local Water Plans; preparing, reviewing and commenting on complex local, state and federal environmental review documents and projects subject to review. Large and complex environmental review projects include co-authoring Upper Mississippi Navigation Channel Maintenance Dredge Spoil Disposal and testimony in resulting Federal Court lawsuit, Co-authoring water quality chapters of the Joint State/Federal Red River Basin Flood Control Impoundment EIS, three RDO Potato Irrigation citizen petitioned environmental assessment worksheets and court ordered EIS's .

Special Skills Training: Conflict Resolution, Nominal Group Process; Public Meeting Facilitation; News Media Relations.
After Retirement: Served on the Minnesota EQB's Environmental Review Advisory Panel appointed to review and recommend alternatives for improving efficiency and efficacy of EAW's and Environmental Impact Statements. Also serving as volunteer citizen advisor/advocate in several high profile controversial project environmental reviews.

RESUME

Robert G. Merritt

Experience

6/2011 to Present	**Principal, Merritt Hydrologic and Environmental Consulting, LLC** Provide hydrologic and environmental services to clients such as watershed districts, nonprofit organizations and individuals. Projects include water level management analysis and permitting; watershed and groundwater investigation to identify lake water quality impacts; review, analysis and critique of proposed crude oil pipeline EIS (environmental impact statement) route alternatives.
3/08 to 6/2010	**Half-time Area Hydrologist and Half-time Regional Groundwater Specialist,** Minnesota Department of Natural Resources, Waters, Bemidji, Minnesota. **Area Hydrologist**: See below for description. **Ground Water Specialist**: Perform technical evaluation of data concerning availability and use of ground water. Assist communities to develop long-term water supplies and implement sound water supply management. Technically, review community water management plans; recommend and supply additional water supply scenarios. Analyze groundwater/surface water interactions and develop strategies to ensure ground water withdrawals do not affect streams, lakes, and wetlands. Develop 3-dimensional groundwater models. Review and interpret hydrogeologic, soil and engineering data and reports; determine adequacy of the reports and the need for additional investigation.
11/04 to 11/05	**Hydrogeologist 3**, Minnesota Department of Natural Resources, Waters, Detroit Lakes, Minnesota. Analyzed the impacts of quarry mining on groundwater and developed a 3-dimensional model to document and display the effects on groundwater resulting from high capacity ground water dewatering. Produced a report for the Legislative Commission on Minnesota Resources to help legislators and citizens understand the complex dynamics of quarry dewatering.
7/78 to 4/99 10/01 to 1/04 11/06 to 3/08	**AREA HYDROLOGIST**, Minnesota Department of Natural Resources, Waters Detroit Lakes, Minnesota. Review applications and sign permits authorizing projects in state waters. Review and prepare technical reports. Perform hydrologic and hydrogeologic analysis. Provide technical assistance to governmental agencies and private citizens. Administer state floodplain management program. Collect hydrologic data and conduct field investigations. Conduct ground water-surface water interchange investigations.

4/99 to10/01 **ACTING REGIONAL HYDROLOGIST**, Minnesota Department of Natural Resources, Waters, Bemidji, Minnesota.
Directed the administration and implementation of the Departments of Natural Resources Waters programs in 21 counties. Supervised and provide leadership for six professional hydrologists and four clerical staff. Recommended regional budget and controlled expenditures within approved spending plan allotments. Participated in statewide policy setting committees. Supervised the regional program overseeing administration of local zoning controls regulating water-related land use and development of shorelands and floodplains. Supervised processing of applications for work in beds of protected waters and appropriation.

10177 to 6/78 **RESEARCH ASSOCIATE**, Desert Research Institute, Water Resources Center, Reno, Nevada.
Statistically analyze streamflow records, water quality, water consumption and population data of an intermontane basin. Develop a predictive computer model for the basin using the analysis results and a pre-existing hydrologic model. Prepare grant proposals. Manage water quality sampling program.

9/75 to 9/77 **GRADUATE RESEARCH FELLOW**, Desert Research Institute, Water Resources Center, Reno, Nevada.
Perform ongoing water quality sampling of the Truckee River. Execute literature searches and data compilation for hydrologic research projects. Thesis research entailed formulation of a mathematical snowmelt runoff model.

Education

B.S. Degree -Earth Science, 1971 University of Minnesota, Duluth
B.A. Degree -Geology, 1 974 University of Minnesota, Duluth
M.S. Degree -Hydrology-Hydrogeology, 1978 University of Nevada, Reno
Thesis: Digital Simulation of Snowmelt Runoff

Publications:

Merritt, 2017, Review of Enbridge Line 3 Draft Environmental Impact Statement for Honor the Earth.

Merritt, 2012, Evaluation of the Big Cormorant Lake Outlet Temporary Operating Plan (DNR Permit 89-1219) and Review of Pelican River Lake Fluctuations from Melissa to Lizzie Lakes for Cormorant Watershed District.

Green, Pavalish, Merritt, Leete, 2005: Report to the Minnesota Legislative Commission on Minnesota Resources Hydraulic Impacts of Quarries and Gravel Pits.

Merritt, Pavalish, Berg. Leete 2001: Report to the Felton Stewardship Committee, Impacts of Sand and Gravel Mining in the Felton Prairie Fen Area on Down Gradient Calcareous Fens, Minnesota Dept. of Natural Resources.

Merritt, Jacobson, Campana, 1978: Investigation of the Sun Valley Shallow Groundwater System, Project Report No. 52, Water Resources Center, Desert Research Institute, University of Nevada System.

Merritt, 1978: Digital Simulation of Snowmelt Runoff, Publication No. 41055, Water Resources Center, Desert Research Institute, University of Nevada System.

Licenses:

Minnesota Professional Geologist -License No. 30106

Curriculum Vitae
James R. Doyle

Education

Undergraduate:	B.S. (Major: Physics Minor: Chemistry) May 1981 University of Michigan-Dearborn MI 48128
Graduate:	Ph.D. (Physics) August 1989 Joint Institute for Laboratory Astrophysics (JILA) University of Colorado-Boulder CO 80309 Thesis adviser: Alan Gallagher Thesis title: *Deposition Kinetics of Hydrogenated Amorphous Silicon and Silicon-Germanium Thin Films*

Academic Appointments

2005 To present	Professor of Physics Macalester College, St. Paul, MN 55105
1998 to 2005	Associate Professor of Physics Macalester College, St. Paul, MN 55105
1992 to 1997:	Assistant Professor of Physics Macalester College, St. Paul, MN 55105
1989 to 1992	Postdoctoral research associate, Department of Materials Science and Engineering, University of Illinois, Urbana IL (supervisor: John R. Abelson)

Research Interests

General areas of interest: Energy technology, materials science, computational simulations and methods, chemical physics, plasma physics, biophysics, electronics.

Specific areas of interest. Modelling of electrical grid load balance and storage characterization; Demand Response modelling and hardware implementation; Electronic materials used in photovoltaic devices; Fundamental chemical and physical processes in plasma-enhanced chemical vapor deposition and physical vapor deposition; Thin film deposition and characterization; Non-equilibrium chemical kinetics; Computational simulations in ecology; Theory of excitable biological membranes;

Current projects:

- Simulations of grid load balancing and storage with high penetration of wind and solar energy
- Fundamental studies of ZnO:Al thin film deposition for solar cell applications
- Computer Simulation of sputter deposition processes (in collaboration with Professor Keith Kuwata, Department of Chemistry, Macalester College)
- Computer simulation of invasive and native species competition at the Ordway Field Station (in collaboration with Dr. Michael Anderson, Department of Biology, Macalester College

Publications (Macalester undergraduate student co-authors are denoted by *)

37. Nicholas Moore* and James R. Doyle *Storage Considerations for High Grid Penetration of Wind and Solar Power with Added Baseload Power*. Proceedings of the International Conference on Environmental Science and Green Technology (ICESGT) 15th Mar 2020, Agra, India *Conference paper.*

36. Hannah Johlas*, Shelby Witherby*, and James R. Doyle *Storage requirements for high grid penetration of wind and solar power for the MISO region of North America: A case study* Renewable Energy 146, 1315-1324 (2020). *Journal Article* (published online July 2019)

35. Abigail Cotter*, Alexander Stowell*, John Carlson*, and James R. Doyle_ A mass spectrometric method for estimating dissociation rates in hydrogen discharge plasma, Journal of Vacuum Science and Technology A 36, 031304 (2018). *Journal Article*

34. James R. Doyle and Hannah Johlas*. *Energy Storage Considerations for High Renewable Power Penetration: A Case Study*. in: SenGupta S., Zobaa A., Sherpa K., Bhoi A. (eds) Advances in Smart Grid and Renewable Energy. Lecture Notes in Electrical Engineering, vol 435. Springer, Singapore (2018). *Conference paper.*

33. James R. Doyle and Hannah Johlas* *Strategies for the reduction of energy storage capacity for high penetration of wind and solar power* in Sustainable and Renewable Energy Engineering (ICSREE), (2017) 2nd International Conference, Hiroshima, Japan (IEEE, 2017). *Conference paper.*

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Papers in Progress

Yifei Sun*, Nadia Foo Kune*, Michael Kyslinger*, and James R. Doyle *Temperature and Pressure Effects in the Deposition of Aluminum-doped Zinc Oxide*. To be submitted to the Journal of Materials Science Spring 2020.

Presentations without Conference Proceedings (presenters underlined, Macalester undergraduate co-authors denoted by *)

James R. Doyle and Hannah Johlas* *Strategies for the reduction of energy storage capacity for high penetration of wind and solar power"* contributed talk at the Sustainable and Renewable Energy Engineering Conference (ICSREE), 2017 2nd International Conference, Hiroshima, Japan.

Yifei Sun*, Nadia Foo Kune*, and James R. Doyle, *Deposition Kinetics of Zinc Oxide Thin Films by Magnetron Sputtering*, poster presentation at the Materials Research Society Spring 2017 Meeting, Phoenix, AZ.

Samuel J. Levang* and James R. Doyle, *Properties of Hydrogenated Amorphous Silicon-Germanium Alloys Deposited by Dual Target Reactive Magnetron Sputtering* poster presentation at the Materials Research Society Spring 2012 Meeting, San Francisco.

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External Grants Received

National Science Foundation Research in Undergraduate Institution (NSF-RUI) $216,335 (2005-2008) *Fundamental Studies of a-Ge:H and a-SiGe:H by Reactive Sputter Deposition*

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NSF Instrumentation and Laboratory Improvement (with K. Wirth and T. Varberg) Grant $22,538 (1995-1997) *x-ray Diffraction: A Common Interdisciplinary Experience for Geology, Chemistry, and Physics Student*s

NSF Instrumentation and Laboratory Improvement (ILI) Grant $38,460 (1993-1995) *Semiconductor Characterization in Undergraduate Physics*

Petroleum Research Fund Type G Grant $20,000 (1993-1995) *Mass Spectrometric Studies of Methane Glow Discharge Reaction Kinetics*

Appendix B:
EVALUATION OF LINE 3 REPLACEMENT PROJECT: ASSESSMENT OF POTENTIAL PINHOLE RELEASE

Prepared by Clarence Johnson, CJE

Technical comment on *Enbridge Line 3 Pipeline Replacement Project* Draft 401 Certification and Preliminary Antidegradation Assessment

EVALUATION OF:
LINE 3 REPLACEMENT PROJECT: ASSESSMENT OF POTENTIAL PINHOLE RELEASE

Stantec was retained by Enbridge Energy Partners (Enbridge) to evaluate the affects of a pinhole release from the proposed Line 3 Replacement Project (L3RP). The purpose was to assess the potential for environmental damage from a release that is not detected by the automated sensors. The Stantec report includes general discussions of issues related to pipelines, but does not discuss issues and concerns as they specifically apply to L3PR and the several environmental settings along the pipeline route. Further, the report relies on assumptions with no attempt to show that the assumptions are valid for the conditions found along the L3PR route. Therefore, the report is not a valid evaluation of the affects of pinhole leaks along the Line 3 replacement route. Examples of the shortcomings of this report are given below.

SECTION 2.3 – RATE OF RELEASE

In Section 2.1, Stantec gives the following definition of a pinhole release.

> For the purposes of this document, a pinhole release is defined "as a slow and small leak of crude oil from the proposed pipeline, or its remote facilities (e.g., pump station valves) that might not be immediately detected by the leak detection systems".

In Section 2.3, Stantec claims that the sensors to be used for the pipeline are capable of detecting a release of one percent of the flow through the pipeline. At the maximum flow rate of 760,000 barrels per day, a release of less than 7,600 barrels per day (bpd) would not be detected. Yet they select a release rate of 28 bpd to assess pinhole leaks, which is 0.37 percent of the smallest release detectable by the automated sensors. No justification is given for the release rate selected. To accurately evaluate the affects of a release, it would be necessary to use a range of release rates that are below the leak detection capabilities of the instrumentation on the pipeline. It would further be necessary to evaluate the potential environmental damage for the range of release rates for each of the environmental settings along the pipeline route. The Stantec report did not evaluate a range of releases nor does the report evaluate each of the environmental settings along the route.

Stantec uses the arbitrarily-selected leak rate to estimate the infiltration of the oil into the soil along the L3RP route. The Stantec estimation is based on a computer simulation done for the Keystone XL project. Stantec does not provide any of the assumptions used in the Keystone XL study except for the leak rate and the soil infiltration rate making it impossible to determine the accuracy of the computer simulation. There is no description of the environmental setting used in the Keystone XL study nor is any attempt made to establish that the assumptions made and the environmental settings are applicable to the L3RP pipeline route. Further, only one computer simulation is cited. To properly assess the impacts of a release, a computer simulation would have to be done for every environmental setting along the L3RP route. Finally, the assumptions used in the model should be verified by comparing the predicted migration and affects of the computer simulation with data from past pipeline releases. Given the number of pipeline releases known to have occurred, appropriate releases for verifying the computer simulation should be available.

Using the data from the Keystone XL study, Stantec determined the infiltration rate of an oil spill from a pinhole release of crude oil. The assumption is made that a release from a 36-inch diameter pipe will spread out over a 36-inch-diameter circle under the pipe. This appears to be another arbitrarily-selected number as there is no correlation between the diameter of the pipe and the area under and lateral to the pipe impacted by a release. The trench dimensions are better used to estimate the impacts. Further, the justification for the limited area of release should be cited. The 36-inch diameter for the area impacted appears to be arbitrary and completely without foundation.

Stantec used an infiltration rate of 0.21 gallons per day per square foot which they state is typical for "permeable sand." This equates to an infiltration rate of 0.014 inches per hour as shown below.

0.21 gallons per day = 0.028 cubic feet per day
The height of 0.028 cubic feet of liquid in an area of one square foot is 0.028 feet.
An infiltration rate of 0.028 feet per day = 0.34 inches per day = 0.014 inches per hour

The source of the infiltration rate used for "permeable sand" is not cited. However, the Minnesota Pollution Control Agency Stormwater Manual shows that an infiltration rate of 0.014 inches per hour is typical of a clayey soil and that a sandy soil would have an infiltration rate of approximately 0.8 inches per hour or 57 times greater than the number used by Stantec. Again, Stantec does not provide a source for the estimated infiltration rate of 0.21 gallons per day per square foot. Unless Stantec can justify their estimate of infiltration, the entire discussion of infiltration rates is invalid.

Stantec uses their infiltration rate to determine that any release from a pinhole leak would "quickly" daylight. The term "quickly" is not defined. The use of such inexact and subjective terms is not appropriate in an EIS and the statement that the release would "quickly daylight" has no validity.

Stantec does not appear to consider lateral migration within the trench. The trench for the L3RP is to be backfilled with natural materials. Unless extraordinary measures are taken to compact the soil around the pipe, a permeable pathway will exist along the sides and bottom of the pipe as well as within the soil surrounding the pipe. I am unable to find any description of the backfilling operations in the EIS or in Appendix E to the EIS which suggests that any extraordinary backfilling measures will be undertaken. Lateral migration along the pipeline will increase the volume that will remain underground and also increase the area available for infiltration at the bottom of the trench. Finally, Stantec does not include lateral migration of the oil through the trench walls in their evaluation. Migration through the trench walls will also serve to delay the daylighting of a release of crude oil.

In Figure 2.1, Stantec uses a graph which purports to show the length of time a release will be active until it is discovered. The graph is taken from the Keystone XL project. Stantec does not show that the environmental conditions along the Keystone XL project are equivalent to the environmental conditions along the L3RP route. The graph also assumes an infiltration rate which does not apply to the most sensitive areas of the L3RP route and further assumes that only a three-foot-diameter circle will be available for infiltration; no consideration is given to the lateral migration of the oil which will occur. Therefore, the graph is invalid as are any conclusions drawn from the information in the graph.

SECTION 2.4 – ESTIMATED RELEASE VOLUME

In Table 2-2, Stantec purports to show the volume of crude oil released prior to detection of the leak. The times cited for inception of the leak to detection of the leak appear to be arbitrarily selected. If numerical data is used in an EIS, the justification for the data must be included in the EIS. Stantec does not justify use of the times in the table. Further, the table cites data for the volume of oil which will infiltrate the soil. The Stantec assumptions used in estimating the infiltration volume were shown to be invalid in the discussion on Section 2.3. Therefore, the information in the table is moot.

Table 2-2 gives a release volume of 1,760 bpd for a release rate of 0.5 percent of the throughput. Based on the information given by Stantec, the actual volume would be 3,800 bpd and the amount released using the Stantec estimate would be 7,600 barrels, not 3,500 barrels.

In the text following the table, an attempt is made to justify the detection times presented in Table 2-2. No studies are cited to justify the detection times and a single figure is used for the times rather than a range. Stantec asserts that the detection times are "conservative" with no data presented to validate any data, conservative or not.

Stantec also uses the incorrect infiltration rates to justify a detection time of 28 days for "small" releases. The infiltration rates are much higher for areas where the soil has a high sand content. The conclusions drawn with regard to detection time cannot be justified or verified using the extremely low and unsupported infiltration rates estimated by Stantec.

The Stantec report cites a Pipeline and Hazardous Materials Safety Administration (PHMSA) study to support the information given in Table 2-2 and the accompanying text which estimates the time from the start of a release to detection of a release. The PHMSA report does not support the Stantec justification of those times in any conceivable manner. The estimate in the Stantec report uses a release period from the start of the release to the time the release is detected. The volume of the release for the PHMSA report uses the time beginning at detection of the release and ending at the time that the pipeline is shut down. The PHMSA report, as cited in the Stantec report, makes no effort to quantify the amount of released oil between the onset of the release and the detection of the release. For pinhole leaks, it would be expected that the amount of crude released from onset of the release to detection would be many times or even orders of magnitude greater than the amount released between detection and pipeline shutdown. The PHMSA report is not germane to the Stantec discussion in any way.

SECTION 2.5 – FREQUENCY

The purpose of this section is unclear unless it is to show that while pipelines are designed not to leak, they do, in fact, have releases. This section, by extension, also shows that pipelines should be built along the route with the least sensitivity to releases, which is not the case with L3RP.

SECTION 3.1 – INTRODUCTION

Stantec makes the following statement:

> "Field investigations at over 600 petroleum hydrocarbon release sites indicate that the migration of dissolved constituents typically stabilize within tens to hundreds of feet from the source area for the crude oil."

In defining the distance traveled by petroleum releases Stantec states only that releases "…typically stabilize within tens to hundreds of feet from the source area for the crude oil." They do not define "hundreds" of feet which renders their statement useless in analyzing the migration of releases. For example: there are 52.8 "hundreds" of feet in a mile; there are 100 "hundreds" of feet in 10,000 feet. An accurate description of the migration of petroleum releases from pipelines would include well-defined ranges for the migration of releases and the number of releases that fall within each range. The Stantec statement regarding the distance required for stabilization of releases serves only as an inaccurate and misleading suggestion that releases do not travel far from the source.

Stantec also does not show that any of the sites are comparable to the L3RP route in terms of geology, biology, groundwater use, agricultural use, sensitive environments, soil chemistry, or microbe population. The Stantec statement completely ignores the fact that highly sensitive environments and receptors may be within a "few hundreds of feet" of the pipeline. Because Stantec ignores any factors other than the distance a release has traveled that must be considered in evaluating the impacts of a release, the Stantec statement has no value in assessing the environmental concerns along the L3RP route.

SECTION 3.2 – FUNDAMENTAL CONCEPTS OF CRUDE OIL TRANSPORT

This section is a general discussion of crude oil movement in the subsurface. However, while the statements are generally correct, the general discussion is not a rigorous or valid assessment of the site-specific conditions along the L3RP route. The flow of liquids in the subsurface is not uniform along the L3RP route and the variations in the flow must be identified and addressed to properly assess the impact of a release of crude oil. Generalities are not a substitute for site-specific data.

One part of the Stantec discussion calls into question the validity of statements made in Sections 2.3 and 2.4. In these sections, a circle three feet in diameter was used as the limit of the area of infiltration. The discussion in these sections ignores the possibility of lateral migration of the crude oil in the trench. The discussion quoted below from Section 3.2 demonstrates that lateral migration of the crude oil should have been considered.

> "Typically, the principal direction of transport is downward in permeable sediments under the force of gravity; however, in a pinhole release within a pipeline trench where the native soils are less permeable then the trench fill material, oil may preferentially follow the path of least resistance filling the relatively higher permeability materials within the trench. For a buried pipe, this could result in filling of the pipe trench and ultimately surface expression of the oil. Lateral migration of the oil along the length of the pipeline could occur within the trench, which could extend the time until surface expression of the leaking oil occurs."

It is obvious that Stantec recognizes that lateral flow of the oil will occur, but failed to include this in the discussions in Sections 2.3 and 2.4.

<u>SECTION 3.4.1 - VOLATILIZATION</u>

Stantec cites Fingas (2011) to show that 20 percent of crude oil will volatilize within a few hours and 30 percent will volatilize within a day. However, they do not state the conditions under which the volatilization will occur and therefore do not show that the numbers are reflective of the volatilization which would occur along the L3RP route. In addition, the composition of the crude oil evaluated by Fingas is not given and may be very different from the crude oil which will flow through the L3RP pipeline. If the compositions of two crude oils are different, the volatilization rates will be different. Until equivalence is proven, the Fingas study is not relevant to the EIS.

<u>SECTION 3.4.2 - DISSOLUTION</u>

Stantec again makes the following statement:

> "Field investigations at over 600 petroleum hydrocarbon release sites indicate that the migration of dissolved constituents typically stabilizes within tens to hundreds of feet from the source area for the crude oil."

The shortcomings in this vague and misleading statement were pointed out in the comments on Section 3.1. The shortcomings include the lack of site-specific data, failure to recognize that the presence of sensitive environments and receptors must be considered, and the failure to state that many pipeline releases extend far beyond a "few hundreds of feet."

Stantec makes the following statement:

"Vertical migration of contamination into groundwater is extremely limited, and is much less than horizontal migration."

Unsupported vague statements such as this should not be used in an EIS. While there is some general truth to the statement, the EIS must be site specific and not a collection of vague statements. To be considered in the evaluation of a release of crude oil, it is necessary to quantify the vertical and horizontal hydraulic conductivities for each of the aquifer types along the L3RP route including confining or semi-confining layers, lenses, vertical gradients, and physical and chemical properties of the aquifer. No such quantification is given nor was it apparently considered.

Stantec makes the following statement:

"Over a relatively short distance, the dissolved hydrocarbon plume will reach an equilibrium state and expand no farther as the flux of dissolved components from the remaining oil is balanced by the mass removed through attenuation processes in the aquifer (Section 3.4.4)."

The term "relatively short distance" must be quantified for each soil and aquifer type along the L3RP route. Such vague pronouncements do not qualify as scientifically valid statements supported by facts.

<u>SECTION 3.4.4 – NATURAL ATTENUATION OF DISSOLVED PLUMES</u>

Stantec makes the following statement:

"Preferential dissolution of the more soluble and volatile components of the crude oil will lead to plumes that are often dominated by BTEX components (Bowers and Smith 2014; Thornton et al. 2013). However, the less soluble and typically more biodegradable aromatic hydrocarbons such as toluene, ethylbenzene and xylenes often develop dissolved-phase plumes that are restricted to the source area."

It is unclear what is meant by this statement. Stantec first states that "…the more soluble and volatile components of the crude oil will lead to plumes that are often dominated by BTEX components…" Stantec then states that the "less soluble" toluene, ethylbenzene, and xylenes "…develop dissolved-phase plumes that are restricted to the source area. Toluene, ethylbenzene, and xylenes are the TEX in BTEX. It defies logic to suggest that they can be both less soluble and more soluble at the same time and be restricted to the source area while not being restricted to the source area.

Stantec makes the following statement:

"Numerous multi-site studies conducted since the 1990s have presented results that indicate dissolved-phase hydrocarbon plumes stabilize at relatively short distances from the source area and are unlikely to be greater than a few hundred feet in length (Newell and Connor 1998; Connor et al. 2015)."

The comments made on this statement for Sections 3.1 and 3.4.2 are valid here; the Stantec statement remains as vague, misleading, and inaccurate as in Sections 3.1 and 3.4.2.

5.1.2 – GROUNDWATER SUSCEPTIBILITY EVALUATION METHODS

Stantec makes the following statement:

"Based on professional judgment, lacustrine materials were considered low vulnerability in this analysis. Lacustrine deposits are typically composed of fine-grained sediments and such deposits have low permeability."

Stantec used the Minnesota Department of Natural Resources (MDNR) Pollution Sensitivity of Near-Surface Materials to assess the sensitivity of the land along the L3RP route. However, based on "professional judgment", lacustrine materials were changed by Stantec and not the MDNR from medium vulnerability to low vulnerability. This was based on the Stantec determination that lacustrine deposits are typically fine grained and have low permeability. Unless Stantec has collected site specific samples to obtain data to prove their hypothesis, it is problematic that they have arbitrarily assumed that they are more qualified than the MDNR scientists to evaluate the vulnerability of lacustrine sediments. Further, lacustrine sediments can show a wide variation in grain size. The assertion that lacustrine sediments are typically fine grained is unsupported speculation.

Stantec also arbitrarily choose to classify a one-mile segment as having low vulnerability if the depth to ground water is greater than 40 feet. There is no data which supports this speculative statement and any reference to a 40-foot standard for low vulnerability should be removed from the report.

To evaluate the vulnerability, Stantec divided the route into one-mile segments. The midpoint of each segment was used to assign the vulnerability rating for the entire one-mile segment. This means that one small hill 50 feet long can incorrectly cause a one-mile segment to be classified as low vulnerability because of the depth to ground water is 41 feet at the top of the hill when the remaining 5,230 feet of the mile have a depth to groundwater of less than 40 feet. It is also possible that a segment can be improperly classified as having low vulnerability if a few feet in the middle are lacustrine sediments (as arbitrarily reclassified by Stantec) and the remaining part of the segment is composed of sand and gravel. If the midpoint method is to be used, it must be established statistically that it will yield the same result as measuring the exact length of each classification along the route. Stantec did not do a statistical analysis (or did not report it if they did) and the evaluation method is not acceptable as a scientifically valid technique.

The error of arbitrarily defining the classifications and using the midpoint method is compounded by the failure to report how many of the segments were changed to a low vulnerability classification based on the Stantec changes to the DNR classifications. It is obvious that the data are skewed by the changes, but the extent to which they were skewed cannot be determined without knowing how many segments had the susceptibility rating changed. Such skewing of the data will not facilitate a fair and unbiased evaluation of the EIS and the results presented in Table 5-1 are of questionable (at best) value.

SECTION 5.2 – SURFACE WATER SUSCEPTABILITY

This section is little more than a general statement of the impact of a release to water and does not consider any site-specific issues. As such, it is not an adequate assessment of the impacts of a crude oil release along the L3RP route.

SECTION 5.3 – WETLANDS, FENS, AND PEATLANDS SUSCEPTIBILITY

As with Section 5.2, this is little more than a general statement of the impact of a release to sensitive wetlands, fens, and peatlands. Perhaps the most important omission is the failure to recognize that wetlands, fens, and peatlands have great difficulty recovering from a crude oil release, in part because of the difficulty of remediating and restoring these lands. At a minimum the discussion should recognize that some or all of the sensitive environments may never recover from a pipeline release. Stantec compounds the error by not considering the impact of the loss of the sensitive areas on the surrounding land. The impacts of the destruction of wetlands is not isolated but can negatively impact the surrounding land. Because this section does not address the specific sites or consider the sum of the impacts, it is not an adequate assessment of the impacts of a crude oil release.

SECTION 6.1.1 – EX-*SITU* TECHNOLOGY

There are several shortcomings in this section. While some possible remediation technologies are discussed, there are several topics related to remediation which were not discussed. These topics are addressed below.

Initial Response. Stantec does not describe the actions which would form the initial response to a release. The actions include preventing or minimizing the impact to surface water, preventing or minimizing the impact to sensitive areas such as fens, protecting wildlife, protecting wellheads, protecting drinking water intakes, and preventing or limiting human exposure to harmful chemicals.

Logistics. No discussion was included on the methods to be used to transport equipment, personnel, and materials to the release areas. Prior planning is especially important for remote areas.

Power Supplies. Several of the remedial techniques proposed require power to operate the equipment. The method(s) of supplying the required power was not discussed.

Waste Management. The methods to be used to secure wastes stored at the release point and to dispose of the wastes in accordance with laws and regulations related to chemically-impacted wastes were not covered.

Freeze Protection. All of the remediation techniques that recover air or water from the subsurface will require burial to a depth of at least four feet below grade or heat tracing and insulation of the pipes.

Extracted Groundwater Disposal. The disposal of extracted ground water was not discussed. Groundwater extraction can generate large amounts of water which makes hauling the water uneconomic. Discharging the water to streams can cause erosion and affect the chemistry in small streams. A permit to inject the water into the aquifer requires that water be treated to prevent any impacts to the ground water. The difficultly is increased by the degree of residual contamination. Complete removal of the contamination can be expensive and technically difficult.

SECTION 6.1.2 – IN-*SITU* TECHNOLOGY

In-*situ* technologies have the advantage of not requiring a lot of machinery. They do, however, usually require closely-spaced injection wells which increase the impact to the environment as the plume size increases. Also, multiple injections are usually required. The methods of mitigating the impact of multiple injection wells were not discussed. Injection of chemicals to treat a release in ground water or soils can result in mobilizing and spreading the plume if not carried out properly.

SECTION 6.1.3 – PHYSICAL BARRIERS AND HYDRAULIC CONTAINMENT

Sheet Piling and Slurry Walls. These methods require heavy equipment and large stocks of materials and can be very invasive. The is a high probability that extensive damage can be cause to sensitive environments when using these methods. They also tend to redirect rather than contain or destroy the contamination.

Extraction Wells for Hydraulic Containment. Containment wells can generate a large amount of contaminated water which must be treated prior to disposal. The net work of wells must extend to the margins of the contamination.

Reactive Barriers. This method is also material and equipment intensive. The reactive materials are subject to surface fouling which reduces the effectiveness of the barrier.

SECTION 7.0 – CASE STUDIES

While the studies in this section discuss the causes, size, and cleanup of releases, there is no discussion of the environmental impact of the releases, any measures taken to minimize the impact, the actions taken to restore the impacted area to the original condition, or the success of those actions. The omitted discussions are central to the stated purpose of the Stantec report.

The main point of this section appears to be to reinforce the Stantec position that natural attenuation will resolve the negative impacts of any release. To that end, it is worthwhile discussing the spill cleanup in Bemidji.

SECTION 7.1 – ENBRIDGE ENERGY LIMITED PARTNERSHIP LINE 3, BEMIDJI

Stantec touts the success of natural attenuation at this site. In particular, they note the stabilization of the plume of contamination at 650 feet downgradient from the point of release. They do not discuss, however, the extent to which the limit of the migration of the plume is due to the removal of over 75 percent of the release of crude oil. It is possible that the plume would have extended much further had the biggest part of the release not been removed. There is also evidence that the is still slowly expanding although this was not included in the Stantec report.

While Stantec stated that the plume of contamination is stable, this reflects only the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes) and diesel range organics (DRO) that have been found in the plume. Sampling has also been undertaken for nonvolatile dissolved organic carbon (NVDOC) by B. A. Bekins, et al. (Groundwater, 2016) of the United States Geological Survey (USGS). NVDOC includes the metabolites of crude oil biodegradation. Analyses for NVDOC are not routinely carried out because of the lack of knowledge about the NVDOC compounds and the lack of governmental requirements to conduct NVDOC analyses at release sites. The NVDOC plume in Bemidji has been shown to be expanding at a rate faster than the BTEX plume and is found in concentrations 10 times higher than benzene and two to three times higher than DROs. While the toxicity of these compounds is not well understood, there is evidence that NVDOCs are toxic to aquatic life and mammals. Given that an Enbridge pipeline was the source of the release of the crude oil at Bemidji, it is somewhat puzzling that Stantec did not include this information in their report.

SECTION 8.0 – CONCLUSIONS

The conclusions start with a list of the improved materials, construction methods and operating procedures which are designed to prevent leaks. The Dakota Access Pipeline segment of Keystone 1, which was completed in 2010, presumably used all of the modern improvements and had 12 releases in the first year of operation.

The second paragraph uses the data from studies on the Keystone XL project to show that a release of crude oil would quickly rise to the surface where it would quickly be discovered. However, the Stantec analysis gave little weight to the lateral movement of crude oil in the pipeline trench and used an infiltration rate for clayey soils. The releases of greatest concern would be in sandy soil. That possibility was not discussed in the Stantec report. This combination of errors grossly underestimates the volume of crude oil that would infiltrate the soil and gives an unreasonably short time for discovery of the leak through surface observations.

The third paragraph in the conclusions again states that:

"Field investigations at over 600 petroleum hydrocarbon release sites indicate the migration of dissolved constituents typically stabilize within tens to hundreds of feet from the source area."

Stantec has made no attempt to show that any of the sites have environmental settings comparable to the conditions found along the L3RP route. Stantec does not discuss how many releases have exceeded a "few hundred feet". If the sites are not comparable, the studies at those 600 sites have no value in assessing the potential impacts of the L3RP pipeline. Stantec also fails to show that these studies considered NVDOC. NVDOC is a relatively new concern which migrates faster than the BTEX and DRO plumes and is present at higher concentrations than BTEX and DRO. Without using the NVDOC data, the Stantec report is deficient.

In the fourth paragraph, Stantec states:

"After emergency response and remediation activities remove contaminated soil, natural attenuation would reduce the maximum movement of a plume of dissolved hydrocarbons to a distance on the order of a few hundred feet."

Stantec presents no site-specific data to show that this is the case for all sections of the pipeline and the speculative statement should not be in the EIS.

In the next paragraph, Stantec states that 62 percent of the pipeline crosses low-vulnerability aquifers. This statement is based on changing the MDNR classifications without supporting data, inventing a new classification using an arbitrary and unsupported criterion of a depth to ground water of greater than 40 feet, and assigning classifications based on the midpoints of one-mile segments along the L3RP route. The use of a midpoint classification has not been shown to be statistically valid and is therefore not an acceptable method of assigning classifications. Stantec has not provided any information on the number of segments that were assigned a lower susceptibility rating. The apparent reason for this is that Stantec does not want to reveal the extent to which their arbitrary classifications skew the data.

In the next to last paragraph, Stantec states that a variety of techniques are available to remediate the release. In the report, Stantec described the remedial methods, but there is no evaluation of the impact of a release on any of the several environmental settings along the pipeline route, no evaluation of the impact of moving and operating equipment at the release site, and no evaluation of the effectiveness of the remedial methods in restoring the land to the original condition, particularly in sensitive areas such as fens, wetlands, and peatlands. The conclusion in this paragraph is that natural attenuation will resolve all pollution problems. However, studies by the USGS show that the understanding of the effectiveness of natural attenuation is not fully understood. Stantec also assumes that by limiting the extent of the plume of contamination, all problems associated with the release are eliminated. Stantec fails, however, to assess the impact of the release on receptors inside the plume of contamination. The affected population is more important than the extent of the plume.

In the last paragraph of the conclusions, Stantec concludes:

"Given the generally low-susceptibility of surficial aquifers along the Project route and its alternatives and the ability of release response, remediation, and natural attenuation to limit the movement of dissolved hydrocarbons in groundwater, the Project is expected to result in no effects or localized effects on groundwater if a small release of crude oil were to occur."

This conclusion is not supported by the Stantec report. The Stantec report is based primarily on:

- an arbitrary and unsupported release rate of 28 barrels per day for an undetected pinhole release when the lower threshold for detection is 7,600 barrels per day at maximum flow;
- studies done for other sites which have not been shown to be equivalent to any of the environmental settings along the L3RP route;
- arbitrary reclassification of the vulnerability of the land along the route without any supporting data;
- a suspect "midpoint" method for determining the percentage of each classification;
- an inaccurate determination of the time required for a spill release to reach the surface;
- a misuse of PHMSA data which address the time from detection to shutting the pipeline down rather than the time from onset of the leak to detection of the leak;
- an inaccurate infiltration rate;
- an incomplete discussion of the processes involved in natural attenuation; and
- avoidance of any discussion of the specific impacts which will occur when the pipeline has a release of crude oil.

Appendix C:
Visual evidence of long-term wetland impacts from pipeline construction in Minnesota

From MN DNR, obtained through Data Practices Request April 2020

Technical comment on *Enbridge Line 3 Pipeline Replacement Project* Draft 401 Certification and Preliminary Antidegradation Assessment

Potential Impacts of Large-diameter Pipelines to Wetlands

From NE, overview of Mud Lake, Clearwater County.

The ice road in the marshes of Mud Lake.

Ice road.

Water, ice slush and peat soil slurry refills trench, Mud Lake.

Blocks of driven-in ice on W side of ROW off trench, Mud Lake.

Ice block with plant debris and soil on bottom, Mud Lake.

Though melting occurred, soil and plant material remain on surface off trench, Mud Lake.

Trench and blocks of material laden ice prominent on the surface of Mud Lake.

Another view from N, Mud Lake.

From E side ROW looking SW across Mud Lake.

From far E side of ROW near mid-crossing, looking SW across ROW through Mud Lake.

From N, trench and piles of spoil to Mud Lake.

From W side ROW looking SE across transition from upland to wetland, Mud Lake.

Overview from N ROW crossing, Mud Lake.

Status of a portion of ditchline within DNR LC 6, Mud Lake.

View from N across Mud Lake.

Drilling mud over HDD within S side of Hay Creek.

Frac bubbling up within containment over depression of HDD.

From S, view of Hay Creek clean-up operation.

Turbidity indication of frac disturbance near frac mound at Hay Creek.

ENBRIDGE

Enbridge LSr Pipeline Project
Site Inspection

merjent

Inspector: Steve Toman

Inspection Date: 9/5/2008

Report Type: Frac-out

Agency: DNR

Compliance Level: Problem Area

Activity: Boring

County: Marshall

Begin Station: 3824+00

End Station:

Milepost Start: 845.7

Milepost End: 0

Tract Number 1: T-901

Tract Number 2:

Frac-out Location:

In stream: ☐

Upland: ☐

Near Stream: ☐

Wetland: ☑

Drill Phase: Pull-Back

Drill Pass:

Containment Measures:

None

Amount of Bentonite Dispersed:

100 Gallons within wetland W-845D, 500 Gallons within wetland W-845E

Control Measures Implemented to Continue Drilling:

The frac-out in wetland W-845D occurred during the last moments of the pipe pullback. The pullback was completed. No additional drill mud was released once the pullback stopped.

DNR Waterbody:

Wetland and/or Non-DNR Waterbody: W-845D

Inspection Notes:

A frac-out occurred during the guided bore beneath the south bar ditch of 250th St. NW. Communication confusion resulted, due to earlier frac-outs that occurred during this bore. Environmental Inspector Aric Donajkowki was present when a 500-gallon frac-out emerged from the road surface and within the north bar ditch of wetland W-845E. A short time later a 100-gallon frac-out occurred within wetland W-845D.
The contractor assumed that proper agency notification was occurring with Aric's presence. However, Aric was not present during the W-845D frac-out occurrence.

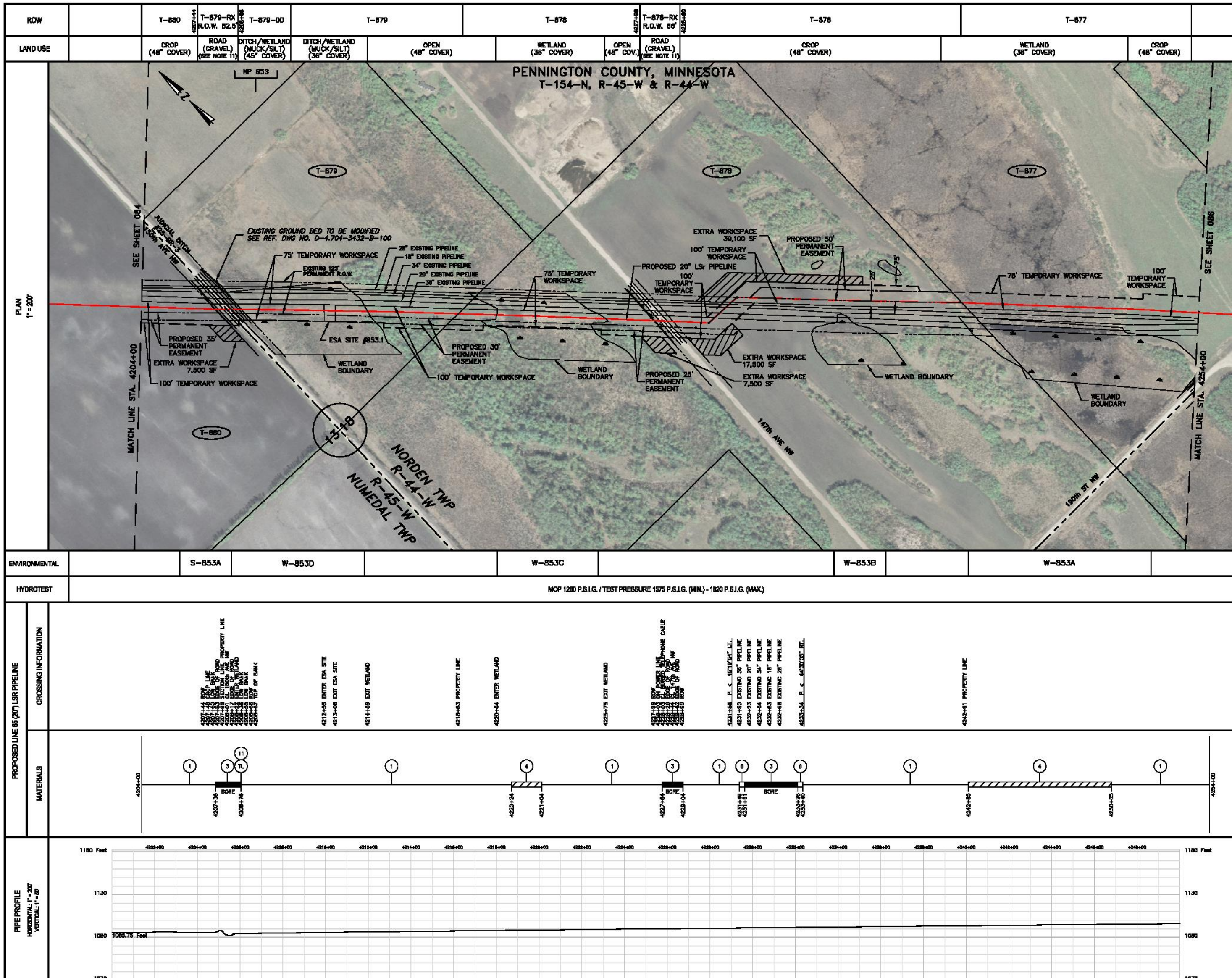
Frac-out containment could have been better. Inadequate sand bags were available for the containment of the frac-out and no vacuum truck was present. All the frac-outs have now been cleaned up.

MP 845.80, Frac-out, W-845D, view southeast.

MP 845.80, Frac-out cleanup, W-845D, view east.

MP 845.70, Wetland W-845E and road surface frac-out, view southeast.

MP 845.70, Wetland W-845E, Frac-out cleanup, view east.



NO.	LSR (20") PIPELINE MATERIAL SUMMARY	QTY.
1	20" O.D. x 0.250" W.T. x API-5L X-70, ERW,	3749 LF
	14 MILS FBE	
3	20" O.D. x 0.312" W.T. x API-5L X-70, ERW,	427 LF
	40 MILS A.R. FBE	
4	20" O.D. x 0.312" W.T. x API-5L X-70, ERW,	800 LF
	18 MILS FBE W/ 3" CONC. COATING	
6	INDUCTION BEND(S) 20" O.D. x 0.312" W.T. x	24 LF
	API-5L X-70, ERW, 14 MILS FBE	
11	TEST LEAD(S)	1 EA

SCALE IN FEET

1. ENBRIDGE ENERGY EMERGENCY NUMBER: 1-800-858-5253
2. CONTRACTOR IS REQUIRED TO HAVE UTILITIES LOCATED BEFORE THEY DIG. CALL 811 OR THE STATE UTILITY LOCATE SERVICE APPLICABLE TO THE STATE IN WHICH CONTRACTOR IS WORKING.
3. ALL DIMENSIONS SHALL BE FIELD VERIFIED.
4. ALL HORIZONTAL AND VERTICAL DIMENSIONS ARE IN FEET, UNLESS OTHERWISE SPECIFIED.
5. HYDROTEST: CONTRACTOR SHALL SUBMIT A HYDROTEST PLAN FOR COMPANY (ENBRIDGE ENERGY) APPROVAL BEFORE PERFORMING A HYDROTEST.
6. CONTRACTOR SHALL ADDITIONALLY COMPLY WITH THE REQUIREMENTS SPECIFIED IN THE REFERENCE DRAWINGS NOTED ON THIS ALIGNMENT SHEET.
7. QUANTITY OF SET ON WEIGHTS IS APPROXIMATE. THE ACTUAL QUANTITY OF SET ON WEIGHTS SHOULD BE DETERMINED BY THE GIVEN FIELD CONDITIONS.
8. WETLAND STATIONING IS APPROXIMATE ONLY. ACTUAL WETLAND BOUNDARIES WILL BE STAKED BY THE APPROPRIATE COMPANY ENVIRONMENTAL PERSONNEL.
9. CONTRACTOR SHALL COMPLY WITH ALL REQUIREMENTS OF THE PROJECT AGRICULTURAL MANAGEMENT PLAN (AMP) AND ENVIRONMENTAL MANAGEMENT PLAN (EMP).
10. PIPELINE IS HORIZONTALLY STATIONED AND PIPELINE LOCATION IS BASED ON MINNESOTA STATE PLANE (NORTH ZONE) COORDINATE SYSTEM, NAD 83, U.S. SURVEY FEET UNITS.
11. AS A MINIMUM, THE DEPTH OF COVER UNDER ROAD DITCHES SHALL BE 54", AND UNDER THE ROAD SURFACE SHALL BE 60", UNLESS SHOWN OTHERWISE.

DWG. NO.	REFERENCE DRAWING TITLE

NO.	REVISION - DESCRIPTION	BY	DATE	CHK'D	APP'D
A	ISSUED FOR REVIEW	GIE	12-15-07	LR	RH
B	GENERAL REVISIONS	GIE	2-08-08	LR	RH
C	ISSUED FOR CONSTR. PLANNING	GIE	3-31-08	LR	RH
D	ISSUED FOR CONSTRUCTION	GIE	5-16-08	LR	RH

SCALE	DATE	DESIGNED	DRAWN	CHK'D	APP'D	APP'D
1"=200'	11/19/07	GIE	GIE	LR	RH	

ENBRIDGE

LSr PIPELINE
PROPOSED 20" LINE
M.P. 852.9 TO M.P. 853.8
PENNINGTON COUNTY, MINNESOTA

DRAWING NUMBER	ROUTE SHEET
D-65-5.92-1386-085-D-100	085

Clearwater River Crossings, Beltrami County, a designated trout stream. Indicates long-term changes in the floodplain and river channels. Photo 6 was taken on Nelson Dam Road in the upper right corner of this photo. Milepost

Close-up of the Clearwater River Crossing, Beltrami County.

ATV traffic up and down Clearwater River bluffs through slope-breakers constructed to prevent erosion on Terrace III project.

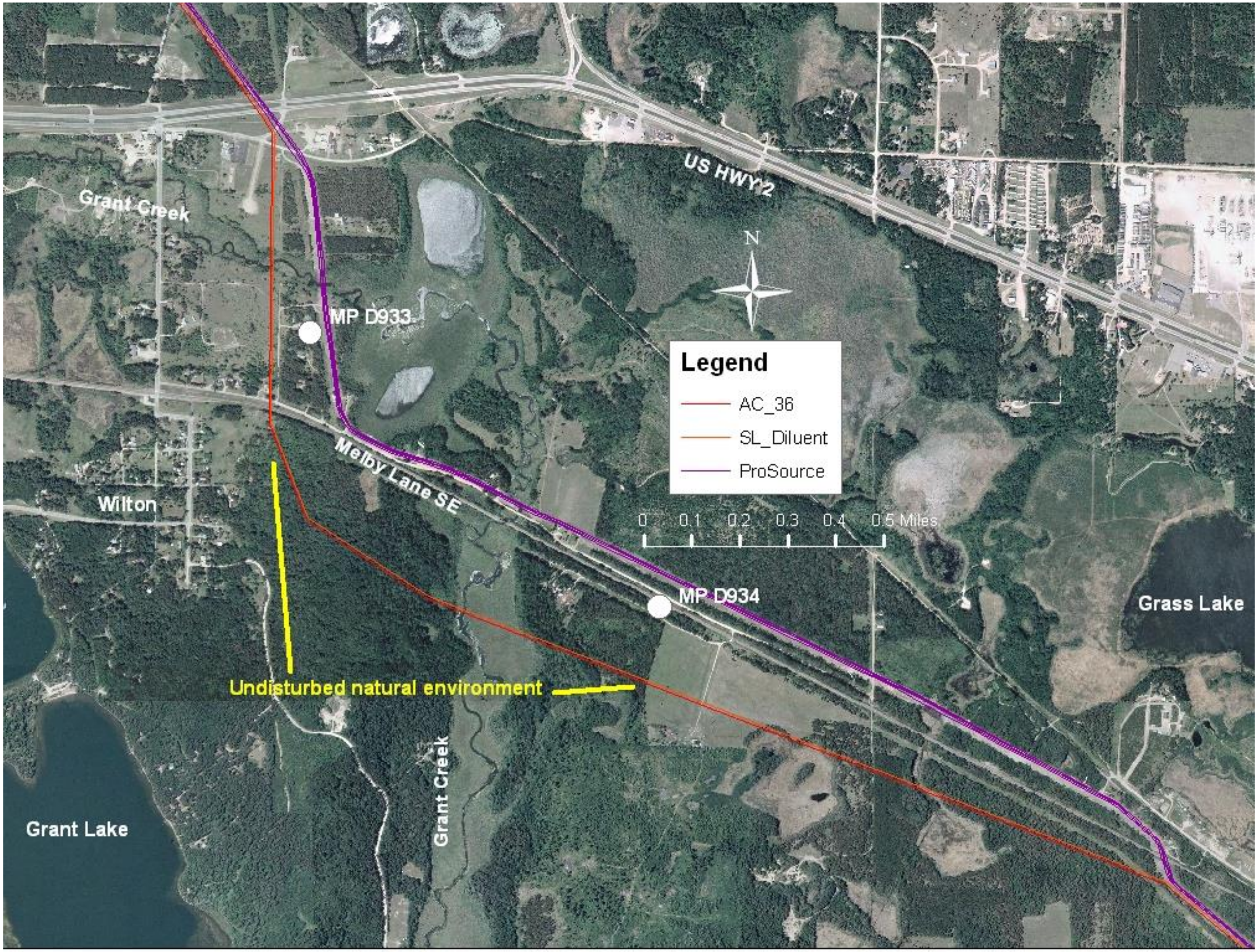
Clearwater River floodplain indicating permanent changes to wetlands from the existing corridor as well as slope erosion and sparse re-vegetation from Terrace III. Top of bluff is about 60 feet above the Floodplain.

Clearwater River, bottom of E bluff. Cement barriers used to impede ATV access to the ROW after an access road was recently constructed for pipeline repair.

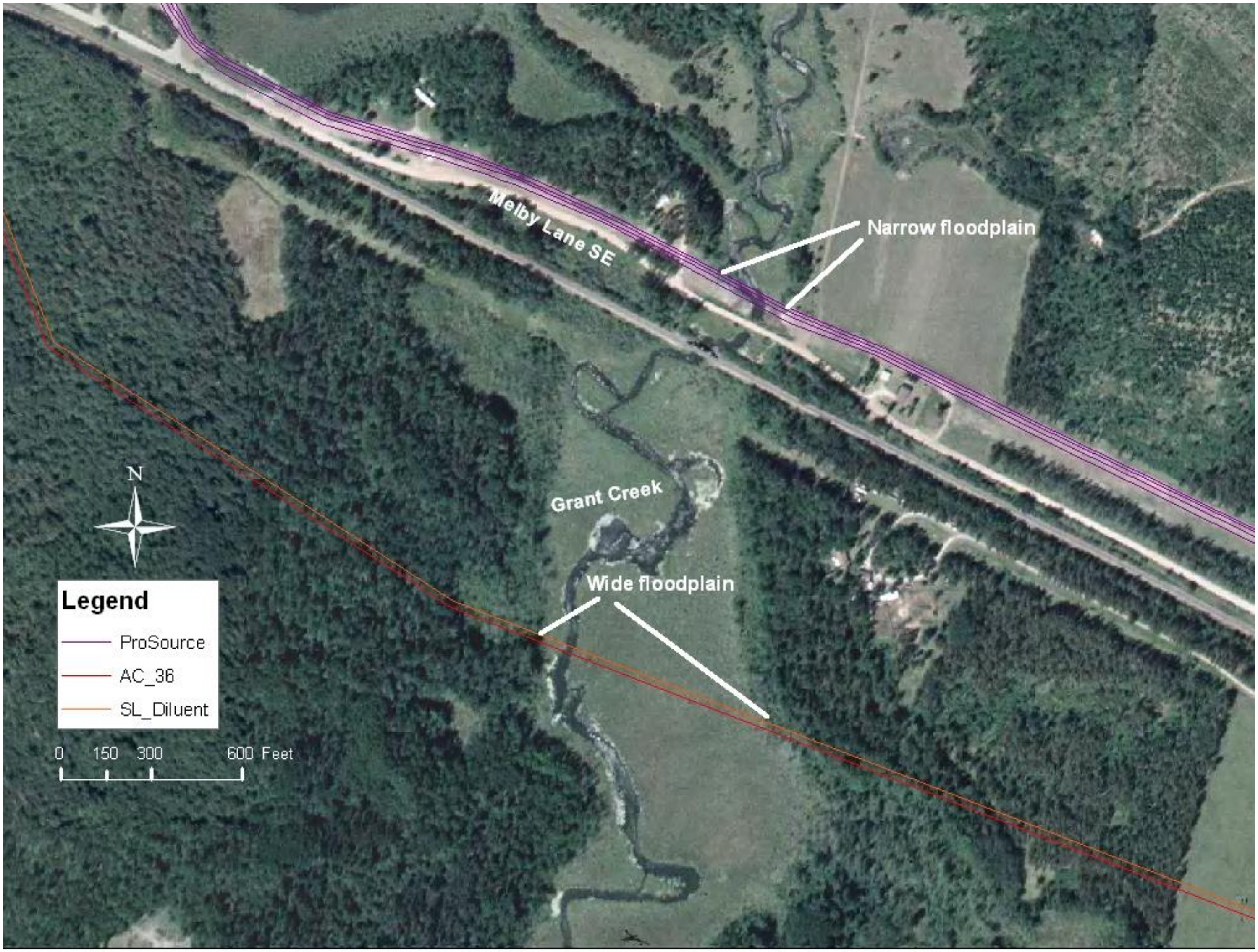
Site is adjacent to Clearwater River by railroad grade, which is now a motorized OHV recreational trail. Boulders placed at base of slope to impede ATV off-trail use.

Grant Creek pipeline corridor crossing at approximately MP 929.8. OHV trail is on railroad grade.

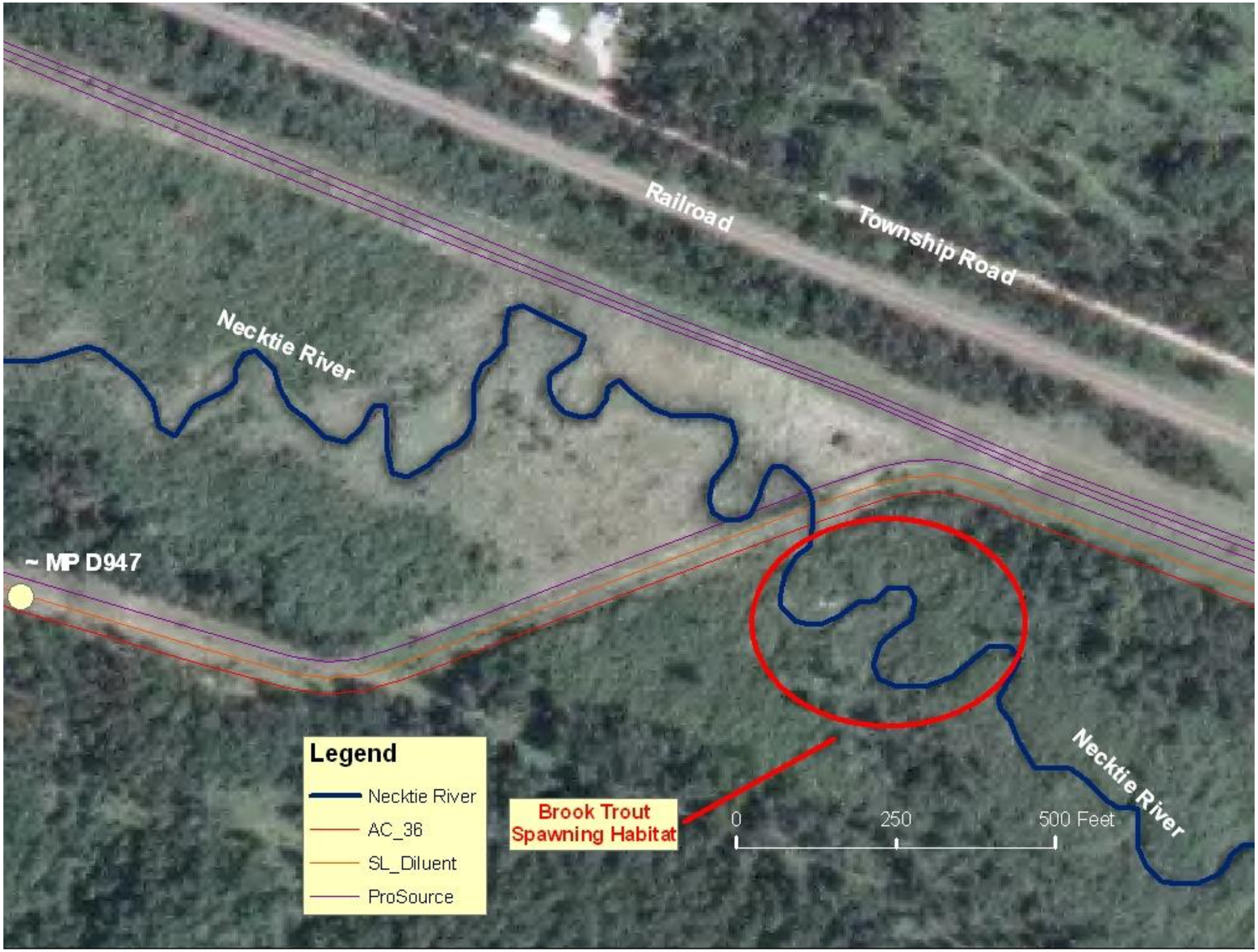
Close-up of Grant Creek pipeline corridor looking N toward OHV trail on railroad grade, indicating OHV off-trail destruction of stream banks and vegetation



New corridor proposed through undisturbed natural area and new Grant Creek crossing, a revision of the June 2007 filing. Approximately MP 932.5 through MP935.3



Close-up view of new Grant Creek crossing and corridor, portion of Photo 9 area.



Enbridge crossing of Necktie River, a designated trout stream indicating brook trout spawning habitat adjacent to the crossing, MP 927.