Paula Goodman Maccabee, Esq.
Just Change Law Offices
1961 Selby Ave., St. Paul, Minnesota 55104, pmaccabee@justchangelaw.com
Ph: 651-646-8890, Fax: 651-646-5754, Cell 651-775-7128
http://justchangelaw.com

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FILED ELECTRONICALLY

Tom Landwehr, Commissioner
Minnesota Department of Natural Resources
500 Lafayette Road
St. Paul, MN 55101

RE: Comments on PolyMet Draft Dam Safety Permits 2016-1380 and 2016-1383

Dear Commissioner Landwehr,

The following comments are submitted on behalf of WaterLegacy, a Minnesota non-profit formed in 2009 to protect Minnesota's water resources and the communities who rely on them.

WaterLegacy believes proceeding with draft PolyMet Dam Safety permits released for public review by the Minnesota Department of Natural Resources (DNR)[1] is premature and inconsistent with the obligation under Minnesota rules, "to regulate the construction and enlargement of dams, as well as the repair, alteration, maintenance, operation, transfer of ownership, and abandonment, in such a manner as to best provide for public health, safety, and welfare." Minn. R. 6115.0300.

The current PolyMet draft Dam Safety permits are inadequate and must be denied based on Minnesota statutes that only allow issuance of a permit if the commissioner concludes that the plans of the applicant are reasonable "and will adequately protect public safety and promote the public welfare." Minn. Stat. §103G.315, Subd. 3. PolyMet dam permits must also be denied based on Minnesota dam safety permit rules, which base approval or denial on "potential hazards to the health, safety, and welfare of the public and the environment." Minn. R. 6115.0410, Subp. 8. Grounds for denial of the draft PolyMet Dam Safety permits are summarized below.

1. PolyMet has not performed studies of the potential hazards that would result from dam failure at its proposed Flotation Tailings Basin (FTB) or Hydrometallurgical Residue Facility (HRF) dams. PolyMet has also failed to complete materials studies related to the risk of failure of the FTB dam and has used unfounded assumptions in place of analysis of the risk of failure of the HRF dam.

2. Draft PolyMet Dam Safety permits defer regulatory decisions that should be contained in permits and fail to provide conditions, final design requirements or specific contingencies

[1] Draft Permits for the Flotation Tailings Basin (2016-1380) ("FTB Draft Dam Permit") and the Hydrometallurgical Residue Facility (2016-1383) ("HRF Draft Dam Permit") are available on the MDNR website, respectively, at http://files.dnr.state.mn.us/lands_minerals/northmet/dam-safety/2017-0915-draft-2016-1380.pdf and http://files.dnr.state.mn.us/lands_minerals/northmet/dam-safety/2017-0915-draft-2016-1383.pdf.

needed to regulate construction, maintenance, operation and abandonment of the FTB and HRF dams to protect public health, safety, welfare and the environment.

3. Draft FTB and HRF Dam Safety permits, along with the PolyMet documents incorporated by reference in the draft permits,[2] fail to provide adequate factors of safety, to comply with Minnesota rules or to address well-founded concerns, including those of DNR's consultants, regarding fundamental design of PolyMet waste facilities.

PolyMet's FTB and HRF sulfide mine waste dams would be permanent fixtures affecting the Partridge River and Embarrass River tributaries and wetlands in the headwaters of Minnesota's St. Louis River. Dam breach or failure, release of sulfide mine tailings waste or release of toxic and concentrated hydrometallurgical waste could affect these headwaters and downstream waters of the St. Louis River, the largest U.S. tributary to Lake Superior. Waters downstream of PolyMet's proposed FTB and HRF dams include Colby Lake, the source of drinking water for the city of Hoyt Lakes, fisheries in the St. Louis River, the St. Louis River estuary, and Lake Superior. Communities potentially affected by the release of PolyMet wastes include the Fond du Lac Reservation and Duluth, Minnesota's third largest city.

More than any other mine features, the PolyMet mine tailings waste and hydrometallurgical residue dams are things that could go catastrophically wrong at the PolyMet copper-nickel mine project. The draft PolyMet Dam Safety permits fail to meet the State's fiduciary obligation to protect Minnesota citizens, drinking water, environment, fisheries, private property and human health from potential contamination and devastation. These permits must be denied.

1. Failure to Perform Critical Studies to Protect Public Safety, Health, Welfare and the Environment.

A. Flotation Tailings Basin

Tailings dams fail at a rate that is approximately 10 times higher than that of water supply reservoir dams.[3] Upstream-type dam construction, which is the type of construction proposed for the PolyMet tailings dam, poses the highest risk for both seismic and static failure, and most tailings dam failures have been associated with upstream construction.[4] These facts and the

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[2] DNR Commissioner Landwehr has confirmed in a Sept. 29, 2017 letter attached as Exhibit 1 that the draft PolyMet FTB dam permit incorporates by reference the NorthMet Project Geotechnical Data Package ("FTB Geotech.") and the NorthMet Project Flotation Tailings Management Plan ("FTB Mgt. Plan") in Appendices A and B of PolyMet's May 2017 NorthMet Dam Safety Permit Application for the Flotation Tailings Basin, available at http://files.dnr.state.mn.us/lands_minerals/northmet/dam-safety/v2/dam_safety_permit_application_flotation_tailings_basin_v2_may2017.pdf and that the draft PolyMet HRF dam permit incorporates by reference the July 11, 2016 Geotechnical Data Package – Volume 2-Hydrometallurgical Residue Facility ("HRF Geotech.") available at http://files.dnr.state.mn.us/lands_minerals/northmet/dam-safety/references/geotech_data_package_vol2_hrf_v6.pdf and the Residue Management Plan - Hydrometallurgical Residue Facility ("HRF Mgt. Plan") in Appendix A of PolyMet's May 2017 NorthMet Dam Safety Permit Application for the Hydrometallurgical Residue Facility ("HRF Permit Application") at http://files.dnr.state.mn.us/lands_minerals/northmet/dam-safety/v2/dam_safety_permit_application_hydromet_residue_facility_v2_may2017.pdf?utm_content=&utm_name=&utm_term=

[3] David Chambers, Comments on the Geotechnical Stability of the Proposed NorthMet Tailings Basin and Hydrometallurgical Residue Facility in light of the Failure of the Mt Polley Tailings Storage Facility, April 30, 2015, p. 2, (WaterLegacy FEIS Comments, Exhibit 21, incorporated by reference *infra* in footnote 5)

[4] *Id*., pp. 2-3.

recent experience of serious and very serious dam failure, all of which were detailed in WaterLegacy's comments on the PolyMet NorthMet Final Environmental Impact Statement,[5] underscore the importance of a rigorous and complete dam break analysis to evaluate design choices and mitigation strategies as well as potential hazards that may be critical to the decision whether to approve or deny dam safety permits.

Inadequate Dam Failure Analysis

The PolyMet dam break analysis upon which the draft FTB dam permit relies has a very limited scope. The sole purpose of this analysis,[6] a mere 13 pages prepared in 2012 and not updated since then, was to develop an emergency action plan to notify the property owners living in closest proximity to PolyMet's proposed tailings waste storage facility in the event of a breach. This is one of the legitimate reasons for doing a dam break analysis, and PolyMet's analysis provides information on the number of homes that could be affected by a modest dam breach to the north.[7]

However, PolyMet's dam break analysis is inadequate to answer the questions asked in Minnesota rules to determine the hazard classification of dams and the adequacy of dam safety permits. Minn. R. 6115.0410, Subp. 8. Years after catastrophic failure of tailings dams, including the Mount Polley copper tailings dam in Canada, PolyMet's meager analysis ignores the greatest threats posed by the failure of its proposed tailings waste dam: downstream water quality, public health, safety, welfare and the environment. At minimum, the following questions must be answered before any PolyMet tailings waste dam permit could be appropriately considered:

- What potential hazards would result from a PolyMet dam breach or failure involving mobilization and flow of tailings waste?
- What potential hazards would result from a PolyMet tailings dam collapse rather than an assumed breach of limited scope?
- What potential hazards to wetlands, municipal water supplies, water quality, fisheries, environment and human health would result from a PolyMet tailings dam failure?
- What potential hazards would result from a dam failure on the south side of the PolyMet FTB (Cross-Section N), adjacent to Second Creek?

PolyMet has admitted that its dam break analysis provides no information on the extent or consequences of tailings release and flow in the event of a breach - due to its limited purpose:

> Extensive additional analysis would be necessary to realistically estimate the percentage of flotation tailings left in the FTB, to evaluate flotation tailings deposition after the breach and to better understand flow properties of the liquefied flotation tailings. Such

[5] WaterLegacy's Comments ("WaterLegacy FEIS Comments") on the November 2015 PolyMet NorthMet Final Environmental Impact Statement ("PolyMet FEIS") and its associated expert reports, FEIS Exhibits 1-36, and Appendix containing Comments on the PolyMet NorthMet Supplemental Draft Environmental Impact Statement (SDEIS) with its associated expert reports and SDEIS Exhibits 1-54 provided to the DNR on CD December 14, 2015 are herby incorporated by reference.
[6] Barr Technical Memorandum, FTB Dam Break Analysis, Dec. 4, 2012, Attachment H of FTB Mgt. Plan ("FTB Dam Break Analysis").
[7] *Id*., p. 8.There would be 34 homes along Trimble Creek or breakout paths that could be affected by the modeled dam break.

> analysis is not warranted given the objective of this dam break analysis, which is to serve as an aid in development of the facility Emergency Action Plan.[8]

PolyMet has also acknowledged the significance of questions about the volume of tailings that would be suspended and carried downstream in the event of a dam breach:

> The most significant unknown breach parameter for a tailings basin dam is how much of the tailings would be suspended and carried downstream in the event of a dam breach. Studies have shown that in many cases only 30 percent of the volume in the basin is carried downstream, however basin dam breaks have been recorded where up to 80 percent of the volume was carried downstream.[9]

Despite the importance of evaluating the release of tailings in the event of a dam breach, PolyMet's used a dam break model, the HEC-HMS computer model, which can only model water release, not tailings mobilization and flow.[10] DNR's senior dam safety engineer, Dana Dostert, while finding the dam analysis appropriate for developing a contingency notification plan, expressed concern that the only analysis done by PolyMet was for a water breach. "I have never been completely comfortable with it as it dealt with a water breach. An actual failings that mobilized tailings would be much more serious."[11]

There are several well-known software programs available to model mine tailings and other non-Newtonian liquids, including DAMBRK, FLO-2D, FLDWAV, and DAN-3D.[12] Particularly in light of the catastrophic failure and release of tailings at the Mount Polley dam in British Columbia, Canada and at the Fundão Dam in Samarco, Brazil,[13] the DNR must require that PolyMet perform new modeling of potential hazards posed by a FTB dam breach using software designed to reflect the characteristics of tailings.

Next, PolyMet's limited 2012 dam break analysis only pertains to a small break in the north side of the tailings waste dam as a result of a piping-initiated dam failure on the North Dam of Cell 2E.[14] PolyMet's analysis does not reference current FTB designs and concerns with cross-sections F, G and N and with potential liquefaction, highlighted in PolyMet reports since 2012.[15] Although the FTB would cover four-and-a-half square miles and extend for more than a mile

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[8] *Id*., p. 7.
[9] *Id.*, pp. 6-7.
[10] Model is cited *Id*., p. 2. The HEC-RAS model is described in USACE, Using HEC-RAS for Dam Break Studies, TD-39, August 2014, available at http://www.hec.usace.army.mil/publications/trainingdocuments/td-39.pdf
[11] D. Dostert, DNR Review of PolyMet's Dam Safety- Tailings Basin – Permit Application, Contingency Action Plan, undated, attached as Exhibit 2.
[12] *See e.g*. Bernedo, Predictive Models & Available Software, USSD Workshop on Dam Break Analysis Applied to Tailings Dams (2011), p. 11-24. http://www.infomine.com/library/publications/docs/bernedo2011.pdf, attached as Exhibit 3.
[13] *See* WaterLegacy FEIS Comments, *supra*, pp. 69-72, WaterLegacy FEIS Exhibits 19, 20, 21, 25, 26 incorporated by reference in footnote 5, and news articles attached in Exhibit 4 to these comments.
[14] FTB Mgt. Plan, p. 20,
[15] *See e.g.,* FTB Geotech., pp. 8, 39, 63, 91, 111, 117.

along its north side,[16] the breach width for PolyMet's dam break analysis was assumed to be less than 450 feet wide.[17]

PolyMet' dam break analysis fails discuss the potential of a more significant dam collapse in the event of tailings liquefaction. Even without a seismic trigger, PolyMet has admitted that both its own flotation tailings and the LTVSMC fine tailings and slimes beneath them could liquefy:

> A seismic triggering event (earthquake) occurs globally and instantly impacts all soils. Global static liquefaction could also be induced by high porewater pressures associated with a large storm event or if the entire slope was unintentionally steepened during construction. The potential for LTVSMC fine tailings and slimes and the Flotation Tailings to liquefy in response to triggering events is due to the fact that some of these materials are hydraulically deposited and come to equilibrium under very loose to loose conditions.[18]

For the DNR to evaluate potential FTB hazards, PolyMet must analyze the consequences of a catastrophic dam failure releasing sulfide mine tailings waste.

Next, tailings dam breach analysis must be sufficient to address statutory permitting factors pertaining to public health and the environment, not only the timing of notification to property owners whose homes lie closest to a potential breach. In order to determine potential hazards to public health, safety, welfare and the environment, as required by Minnesota statutes and rules, the DNR must require PolyMet to analyze impacts of the release of contaminated water and tailings slurry - with the chemical composition predicted for the PolyMet flotation tailings - on wetlands, drinking water supplies, surface waters, fish and wild rice downstream of the proposed PolyMet FTB. In addition, to the extent that municipal water and fish would be contaminated with heavy metals such as lead, arsenic and methylmercury in the event of dam failure, the DNR must require PolyMet to evaluate the human health and municipal economic costs of dam failure and downstream contamination.

Finally, in order to evaluate potential hazards to public health, safety, welfare and the environment, the DNR must require that PolyMet conduct a dam break analysis on the south side of its proposed FTB. PolyMet justified its sole focus on the north side as follows:

> The dam break analysis focused on the north side of the FTB, because this is the section of the dam where a break would result in the shortest warning time for potentially affected downstream properties. A breach was not considered to the east or south of the FTB because a large portion of the perimeter ties into natural ground and/or no homes are within the respective downstream flow path.[19]

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[16] *See* Figure B-1 in Attachment B to FTB Geotech., included as Exhibit 5 of these comments.
[17] FTB Dam Break Analysis, *supra*, p. 6: The average breach width was assumed to be 2.24 times the height of the dam and the depth of the breach was calculated at 134 feet. Breach width was estimated based on dam height of 200 feet stated in the FTB Dam Break Analysis, *supra*, p. 4.

[18] FTB Geotech., pp. 71-72.
[19] FTB Dam Break Analysis, *supra*, p. 4.

The south side of the proposed PolyMet FTB dam may not be as close to private homes as the north. But, PolyMet's proposed Cross-Section N, a section through the south perimeter dam of FTB Cell 1E, is immediately adjacent to Second Creek, near wetlands and near the proposed corridor for the Colby Lake Water Pipeline.[20] A dam failure at this location could have devastating consequences related to contamination of water, fish and wild rice and, potentially, municipal drinking water drawn from Colby Lake by the city of Hoyt Lakes.
The PolyMet dam break analysis, modeled without consideration of tailings mobilization or deposition, restricted to the purpose of notifying nearby property owners, limited to a small discrete breach and focusing only on one potential dam cross-section is inadequate to advise decision-makers or the public of the risks of tailings waste dam failure so that appropriate decisions may be made on hazard classification and permitting approval, denial or conditions. The DNR has a duty under Minnesota Rules and a fiduciary responsibility to require a new dam breach analysis that models tailings mobilization and flow, analyzes the results of catastrophic failure, and describes water contamination and other environmental hazards resulting from either a north or a south FTB dam failure.

Inadequate Materials Data

In addition to inadequacies in PolyMet's FTB dam breach analysis, review of the Geotechnical Data Package suggests several gaps in basic materials data needed to determine FTB dam safety. PolyMet collected only a limited amount of fine tailings for materials testing.[21] PolyMet stated it was unable to effectively measure undrained shear strength of fine tailings, so this property was estimated.[22] Due to poor quality of compression test data, some deformation analysis was also based on estimates.[23] PolyMet failed to get samples of glacial till during its 2014 investigation.[24] PolyMet secured very little boring data from the center of the tailings basin; data were limited to two test locations.[25]

With respect to its own flotation tailings, PolyMet conducted only a small number of tests on these materials and combined coarser grinds from 2005 with more recent 2009 pilot plant tailings,[26] further reducing the usefulness of permeability data. Finally, even though PolyMet was required to analyze dam safety at Cross-Section N, PolyMet states that they have done no borings down to bedrock in this cross-section adjacent to Second Creek, so depth of till to bedrock can only be assumed.[27]

Given the number of years PolyMet has pursued its mine project, it strains credulity that basic materials data needed to determine dam stability is not robust and readily available to regulators. The DNR should require PolyMet to produce and disclose reliable data on materials and site conditions before proceeding any further with draft permits.

B. Hydrometallurgical Residue Facility

[20] See Figure B-1 of Attachment B to FTB Geotech., *supra,* Exhibit 5, and Figure 4.2.3-1 of the PolyMet NorthMet FEIS, attached as Exhibit 6 to these comments to show locations of features near the south dam of the FTB.
[21] FTB Geotech., p. 37.
[22] *Id*., p. 16.
[23] *Id*., pp. 17-18.
[24] *Id*., p. 20.
[25] *Id*., p. 39.
[26] *Id*., p. 43.
[27] *Id*., p. 94.

The PolyMet hydrometallurgical residue facility (HRF) "dam break analysis"[28] is yet more deficient than that for the FTB. PolyMet simply declines to disclose any consequences at all of any dam breach or failure at the HRF, alleging that no potential hazards need be discussed, since various failure scenarios are "improbable" or "have a low probability" of occurrence.[29]

Engineers retained by the DNR to review HRF dam safety seem to take the potential for HRF dam failure seriously due to inadequacy of the foundation beneath the proposed HRF and the risk of liner deformation. The EOR Dam Safety Review team cautioned in May 2017, "The soft ground beneath the proposed residue facility consists of up to 30 feet of slimes, peat and tailings concentrate. This will not be an adequate foundation for the 80 foot high basin."[30] The Review further noted, "The basin will have a geomembrane or geosynthetic liner. The liner could deform and fail if the existing underlying material cannot support the material added to the basin."[31]

Modern standards for dam break analysis also contradict PolyMet's theory that decision-makers and the public need not know the consequences of dam failure if the project proponent asserts that failure is "improbable." Since the Mount Polley and Samarco tailings breaches released toxic slurries downstream, it is widely recognized within the industry that "Dam breach and inundation studies are an important aspect of dam safety procedures. . . The major benefit of dam breach studies, no matter how improbable the results may be, is that they trigger discussions on various possible measures to reduce the risk of a breach." [32] Government agencies also advise, "In the context of risk informed decision making, dam breach analyses are needed for determining the potential consequences of a failure mode's occurrence over a range of loading conditions. It can also be used as part of a dam's remedial design process in the selection of alternatives."[33]

Minnesota Rules require that PolyMet produce a meaningful dam breach analysis for its proposed HRF dam to enable regulators to determine its hazard classification. By rule, the degree of hazard is determined not by the probability of dam failure, but by the probability that potential hazards, including damage to health and indirect economic loss, would result in the event of dam "failure, misoperation, or other occurrences or conditions." Minn. R. 6115.0340.

Even a casual reading of the record pertaining to the HRF suggests that the potential hazard should the HRF dam fail is quite serious. Approximately 313,000 tons of highly concentrated residue would be deposited annually in the HRF if PolyMet were to process all nickel flotation

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[28] Barr, HRF Dam Break Analysis, July 11, 2016, Attachment L to HRF Mgt. Plan.
[29] *Id*., p. 4, "[H]ydrologic and hydraulic modeling to detail the extent of inundation from an HRF dam break is not warranted because no plausible HRF dam failure scenarios have been identified." *See also* pp. 2.
[30] EOR (Emmons & Olivier Resources) Review Team, PolyMet Dam Safety Permit Application Review, May 15, 2017, p. 5, MDNR website at http://files.dnr.state.mn.us/lands_minerals/northmet/dam-safety/memo_dam_safety_permit_review20170515.pdf
[31] *Id.*, p. 6.
[32] Martin et al., Challenges with conducting tailings dam breach assessments, 85th Annual Meeting International Commission on Large Dams (ICOLD) (July 3-7, 2017), §3.1.3, attached as Exhibit 7.
[33] FERC Engineering Guidelines Risk-Informed Decision Making, Dam Breach Analysis, Ch. R21, Draft 2014, p. 2. https://www.ferc.gov/industries/hydropower/safety/guidelines/ridm/eng-guide/chapter-R21.pdf, excerpt in Exhibit 8.

concentrate streams it plans to produce.[34] Although PolyMet insists that its concentrated residue waste would not be "hazardous," PolyMet admits that HRF waste would be acidic, and over the long term acid generation would likely be greater than neutralizing capacity.[35]

Given the concentrated and potentially toxic nature of the HRF waste, WaterLegacy finds it troubling that neither the PolyMet FEIS nor any documents supporting the DNR's draft HRF dam permit clearly set forth the constituents of the proposed HRF waste, the acidity of that waste or the mass and concentrations of sulfates and toxic metals that would be contained in that waste. Suggestive information can be gleaned from various documents as to the potential concentrations of HRF wastes.

The DNR, along with other Co-Lead Agencies for the FEIS, has stated that 164 pounds of mercury would be deposited in the HRF each year.[36] Over a 20-year mine life, up to 3,280 pounds of mercury could, thus, be deposited in the HRF. PolyMet technical reports state that hydrometallurgical residue would have sulfate levels of 7,347 milligrams per liter.[37] The FEIS also proposed that sludge from wastewater treatment would be stored in the HRF.[38] Sludge from wastewater treatment reject concentrate could contain concentrations of arsenic, lead, manganese, copper and other metals as much three orders of magnitude above applicable water quality standards.[39]

DNR's Area Fisheries Supervisor has expressed concerns about downstream hazards that would result from release of waste from the HRF, particularly over the long term:

> How long does such a liner last and what happens when it inevitably degrades as nothing lasts forever? Even if it takes 200 years, the waste will still be there and in its location would be very susceptible to leaching into nearby wetlands and groundwater. There is no mention of the expected longevity of the liner and leakage system in the long term closure description. There is mention of a monitoring plan but no mention of how the liner could be maintained or repaired or replaced. . . I don't understand how a liner could be replaced, or even repaired, under a 97 acre site with 50 feet of fill on top. . . The Hydrometallurgical Residue Facility is a concern to Fisheries because of its potential impact on water quality as the system ages.[40]

Even though a draft PolyMet HRF dam permit proposes to authorize permanent storage of concentrated and toxic waste on top of wetlands adjacent to St. Louis River tributary streams,

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[34] HRF Mgt. Plan, p. 2. The HRF would receive up to a total of 6,170,000 total tons of this waste. PolyMet FEIS, 3-117, available at http://www.dnr.state.mn.us/input/environmentalreview/polymet/feis-toc.html
[35] HRF Mgt. Plan, p. 6.
[36] PolyMet FEIS, A-414.
[37] February 2007 PolyMet RS33/RS65 Hydrometallurgical Residue Characterization, February 2007, provided to DNR in Appendix to WaterLegacy FEIS Comments as SDEIS Exhibit 27, *see* footnote 5.
[38] PolyMet FEIS, 3-53, 5-101 and Figures 3.2-12, 3.2-13, and 5.2.2-20. No HRF dam permit documents discuss whether PolyMet still plans to deposit wastewater sludge in the HRF.
[39] See PolyMet FEIS reference PolyMet 2015m, at autop. 452, data showing wastewater reject concentrate, even before it is dewatered would contain: 1,150 µg/L of arsenic (2 µg/L criterion for drinking water); 16,600 µg/L of manganese (100 µg/L HRL for drinking water); 847 of cobalt (5 µg/L surface water limit); 11,600 µg/L of copper (9.3 µg/L limit in water with 100 mg/L hardness); 1,290 µg/L of lead (3.2 µg/L limit in water with 100 mg/L hardness). Spreadsheet data is attached as Exhibit 9.
[40] E. Evarts, Area Fisheries Supervisor, DNR Request for Comments - Dam Safety - Construction - St. Louis County - Applications 2016-1383 and 2016-1380, June 19, 2017, attached as Exhibit 10.

DNR regulators have yet to require PolyMet to analyze and disclose the chemical parameters of the metals processing and other wastes the company proposes to store in the HRF. Despite plausible dam failure scenarios highlighted by its consultants and concerns of its own managers about the impacts of HRF waste release on water quality, the DNR has not required PolyMet to analyze and disclose the downstream impacts to water qualities, fisheries and public health in the event of dam failure at PolyMet's proposed HRF waste facility. As noted by WaterLegacy and others who commented on the FEIS, PolyMet's analysis and disclosures related to the HRF are long overdue. The DNR has a legal and fiduciary obligation to require PolyMet's rigor and transparency.

Inadequate Dam Stability Analysis

In addition to declining to analyze the potential hazards of HRF dam failure, PolyMet's HRF dam permit documents contain self-serving assumptions and omissions that minimize and avoid assessment of the threat of dam failure.

Although the EPA has specifically requested that PolyMet perform a liquefaction analysis for the HRF,[41] PolyMet has instead assumed that the HRF waste fill is not subject to liquefaction,[42] without specifying any properties of the underlying foundation or dam perimeter materials that would support, let alone guarantee, the validity of this assertion.[43] PolyMet's HRF wastes are liquid wastes. Even after closure, it may take years for dewatering and stability of the wastes to be attained. In fact, during closure "access to the Residue surface may be somewhat difficult, due to the fine-grained characteristics of the Residue" and the "Residue, consisting of saturated silt-size particles, would be difficult to regrade to steeper slopes as part of closure."[44]

HRF wastes would be silt-sized particles, composed of 84% silt, 15% sand and 1% clay.[45] A blanket assumption that silt materials like the HRF residues are not subject to liquefaction is unreasonable. As explained in a recent international review, "A plethora of case histories evidence that silt having low clay content is highly sensitive to liquefaction."[46] This risk could be posed long after closure should water infiltrate the HRF.

PolyMet's claims that the assumptions made for its stress-deformation analysis at closure are "conservative," but they are not. PolyMet assumes that waste residues are homogenous, that foundation settlement is complete, that there is no infiltration due to precipitation, and that pore water pressure will approach zero pounds per square foot during dewatering.[47] Infiltration, incomplete settling and non-homogeneous wastes could increase deformation stress. And achieving zero pore water pressure would require malfunction-free drainage and "hydraulic conductivity of the consolidated residue" that isn't "lower than expected."[48]

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[41] EPA PolyMet SDEIS Comments Mar. 13, 2014, p. 16 of Attachment B to WaterLegacy Letter to U.S. Army Corps June 29, 2017, attached with these comments as Exhibit 11.
[42] HRF Geotech., p. 23.
[43] *Id.*, p. 12. HRF dams would be constructed from soil borrow and bulk tailings. HRF Permit Application, p. 7.
[44] HRF Mgt. Plan., p. 33.
[45] HRF Geotech., p. 23.
[46] D. Singh *et al*., Liquefaction Susceptibility of Silty Soils, *Int'l J. of Advances in Sci. Eng. And Tech*., Vol-5, Iss-1, Jan. 2017, attached as Exhibit 12.
[47] HRF Geotech, p. 36.
[48] *Id*., at 37.

Finally, although geologists recognize that, when a fault is inferred by the Minnesota Geological Survey, it means that the fault is present, PolyMet continues to insist that the fault beneath the proposed HRF facility may not exist.[49] PolyMet then assumes that the HRF drainage system will suffice to relieve any excess power water pressure that could develop along the fault.[50]

Although extensive blasting will be required at the edge of the HRF facility to break apart rock outcroppings, with "the potential to cause pore water spikes and permanent deformation," "tension cracks" in the HRF, and cumulative permanent deformation,[51] PolyMet suggests that analysis of the risk of deformation from blasting be deferred until some later day after permits have been issued and HRF construction is underway. "The potential blasting configuration for the construction of the HRF and its effect on the inferred fault is beyond the scope of this document."[52]

On September 15, 2017, the DNR released the draft PolyMet HRF dam safety permit to the public. PolyMet's HRF dam permit application contained no analysis of the potential hazards of dam failure, no characterization of the toxicity of wastes to be contained by the proposed HRF dam, and a self-serving set of assumptions to minimize the risks of residue liquefaction and stress deformation of liners beneath the HRF. Testing or specification for the properties of HRF wastes remained incomplete, and PolyMet admitted that effects of HRF waste liquefaction, precipitation infiltration, pore water pressure along the HRF fault, or deformation from blasting were beyond the scope of HRF dam safety analysis. The HRF Geotechnical Data Package used for PolyMet's 2016 HRF dam safety application didn't even incorporate results of PolyMet's 2014 geotechnical investigations.[53] PolyMet's HRF dam safety permit application was and continues to be woefully incomplete.

WaterLegacy has learned that on September 26, 2017, after the HRF draft dam permit was released, Gale-Tec Engineering detailed to DNR's consulting engineers at EOR steps that would now be taken to analyze HRF liner deformation due to regulatory concerns. Their letter read:

> We understand that the MPCA and MnDNR are currently reviewing the Polymet Dam Safety Permit and Permit to Mine and have expressed concerns about the design of the Hydromet. Residue Facility, which has been proposed to be constructed within a low area the previously served as the LTVSMC Emergency Discharge Basin. The permitting agencies are concerned about potential different settlement caused by the basin construction and potential distress to the double composite liner system that has been proposed to unlay the facility and minimize the potential for environmental contamination.[54]

This engineering review will be helpful, but it is not sufficient.

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[49] *Id.*, at 39. For discussion of MGS inferred faults at the FTB and HRF, see expert review of J. D. Lehr (2014), pp. 14-15, provided to DNR in Appendix to WaterLegacy's FEIS Comments, referenced in footnote 5.
[50] HRF Geotech., p. 39.
[51] *Id.*, 48-49.
[52] *Id.*, at 49.
[53] *Id.*, at 12.
[54] S.M. Gale and N.M. Lichty, Letter to C. Olivier, Proposal for Geotechnical Engineering Review of Polymet Hydromet. Residue Facility Foundation Design, Sept. 26, 2017, attached as Exhibit 13.

Since the draft environmental impact statement in 2010, the DNR has allowed PolyMet to proceed with plans for its flotation tailings basin and hydrometallurgical residue facility with inadequate geotechnical information, incomplete chemical characterization of wastes, deficient analysis of potential dam failure hazards, misleading and self-serving assumptions, dismissal without analysis of mitigation alternatives, and incomplete and continually changing presentation of proposed designs.[55] In the draft EIS, supplemental draft EIS and final EIS, it was represented to the public that complete data and engineering design would be available before permitting.[56] That day has arrived, but the appropriate research, specificity and transparency have not.

It is long past time for the DNR to require PolyMet to produce the necessary data, final design and analysis described in these comments and identified by its engineers and consultants. Draft dam safety permits must be deferred or denied until that date finally arrives.

2. Inadequate Regulation and Incomplete Design in Draft PolyMet Dam Permits

Minnesota has no experience with copper-nickel mining wastes and little experience with dams that serve as a closed system, collecting all surface drainage and seepage and returning it to the waste contained by the dam.[57] When the Minnesota Pollution Control Agency (MPCA) required that surface runoff and leachate be collected and pumped back to the top of an LTV Steel Mining Company coal ash heap at Taconite Harbor, the wastes liquefied and collapsed.[58] The modest level of pumping from surface seep collection systems back into the LTVSMC basin has increased the phreatic surface,[59] a factor that increases dam failure risk.

Historic DNR dam safety permits provide an insufficient and inadequately protective blueprint for permits that would prevent dam failure and potential water quality, health and environmental hazards at the proposed PolyMet FTB and HRF, both of which propose to permanently contain sulfide mine wastes. WaterLegacy believes that it is highly likely that neither the proposed PolyMet FTB dam nor the proposed PolyMet HRF dam can be permitted consistent with protecting dam stability and water quality. The location of the proposed FTB tailings on top of the existing LTVSMC tailings basin precludes the stability of liners needed for dry stack tailings. Designs proposed for the PolyMet FTB waste facility are unlikely to meet both the requirements for dam safety and pollution control through subaqueous disposal, if they can meet either.

The location of the proposed HRF waste storage is unsuitable for a facility storing highly concentrated and toxic liquid wastes, even if it might be demonstrated at some point that they are not "hazardous" under RCRA. Even solid waste facilities cannot be located on top of wetlands and unsuitable soils upstream of drinking water supplies. PolyMet's lack of experience and the paucity of detail provided in the documents supporting its application for the HRF dam permit should indicate to any conscientious regulator that permitting this facility is not a risk worth taking.

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[55] *See* WaterLegacy comments to U.S. Army Corps of Engineers and exhibits, June 29, 2017, *supra*, Exhibit 11.
[56] *See e.g.*, PolyMet FEIS 2-12, 3-15, 3-118, 3-140, 5-179, 5-201, 5-657.
[57] Although the 1981 Dam Safety permit to the Erie Mining Co. for the North East Extension of its taconite tailings basin, permit 81-2000, attached as Exhibit 14, proposed a closed system for seepage or treatment of any waters released in paragraph XIX, that permit condition was never enforced.
[58] *See Arrowhead Electric Coop. v. LTV Steel Mining Company*, 568 N.W. 2d 875 (Minn. App. 1997).
[59] FTB Geotech, p. 14.

Minnesota state agencies may not be ready yet to conclude that neither PolyMet's proposed FTB dam nor its HRF dam would provide adequate protection against potential hazards to public health, safety, welfare and the environment. However, we trust that Minnesota state regulators believe that, before that decision is made, any PolyMet sulfide mine dam permits under review must be specific and enforceable, and must reflect final designs. Minn. R. 6114.0410, Subp. 6.

The draft PolyMet dam permits for both the FTB and the HRF are insufficiently specific and enforceable. They defer questions of materials testing, design, construction, operations, closure and long-term maintenance. They reflect incomplete designs, even as to the most fundamental features of dam construction. They fail to provide enforceable safety requirements, to assure compliance with conditions for dam safety, or to require that adverse findings will trigger protective contingencies. They fail to define the wastes that the dams would contain or to provide the level of detail on long-term maintenance, monitoring and inspections required to determine financial assurance. The omissions and deficiencies noted below are suggestive; they are not an exhaustive list of our concerns regarding the draft PolyMet dam permits.

A. Flotation Tailings Basin (FTB) Draft Dam Safety Permit (2016-1380)

Materials Testing: These comments have previously described deficiencies in testing of LTVSMC tailings and PolyMet flotation tailings. The stability of the FTB dam rests on properties of these materials. Permit conditions should ensure FTB dam stability by requiring that PolyMet demonstrate specific properties of LTVSMC tailings, such as a minimum undrained shear strength, and attainment of factors of safety under all scenarios. Although the draft PolyMet FTB dam permit requires additional testing of LTVSMC tailings, it contain no specific materials or safety factor requirements and provides no criteria for the DNR to disapprove testing or delay construction.[60]

Permit conditions should similarly ensure stability by precluding dam construction until updated pilot testing of PolyMet tailings confirms specific modeled properties. The FTB permit should then require that, immediately upon the start of processing, tests of flotation tailings must demonstrate the specific properties upon which PolyMet's models relied for performance and all factors of safety must be met. Findings that flotation tailings have less favorable material properties than prescribed should trigger specific design changes that reduce the risk of dam failure. However, the draft PolyMet FTB dam permit requires no additional pilot testing before construction, contains no materials or safety factor requirements, and provide no consequences other than a reporting requirement if properties of flotation tailings are different from those "expected" by PolyMet.[61]

Capacity: PolyMet has stated that its copper-nickel mine project will generate approximately 11.27 million short tons of flotation tailings annually (approximately 10,000,000 in-place cubic yards annually) and that the tailings waste facility it has proposed and modeled has the capacity to store tailings for 20 years of operation.[62] Permit conditions should limit the tailings capacity for which the PolyMet FTB dam is approved and restrict the permit's application to PolyMet's

[60] FTB Draft Dam Permit, ¶29.
[61] *Id*., ¶41.
[62] FTB Mgt. Plan, p. 2.

flotation tailings to avoid use of the dam beyond its intended purpose. The draft PolyMet FTB dam permit contains no limits on the volume or type of tailings to be stored behind its dams.

Factors of Safety: The final section of these comments argues that PolyMet's proposed factors of safety for the FTB dam are not sufficiently protective. Or Once an appropriate level of safety is set, permit conditions should specify minimum factors of safety applicable to drained, undrained and liquefaction scenarios and require periodic modeling of factors of safety based on dam conditions. Permit conditions should trigger immediate action, potentially limiting processing as well as changing dam operations, should modeled factors of safety fail to meet minimum standards or drop by more than a trivial percentage. The PolyMet draft FTB dam permit neither specifies a minimum factor of safety nor ensures, given the many uncertainties in PolyMet's analysis, that the dam as constructed will meet expected safety levels.

Dam & Buttress Construction: PolyMet has admitted that excavation of bulk tailings for use in FTB dam construction, even if they are "mostly" LTVSMC coarse tailings, will contain "inclusions of LTVSMC fine tailings and a small amount of slimes."[63] Permit conditions should preclude inclusion of slimes and fines in dam construction materials and require that rock fill or other suitable materials be used for dam construction should LTVSMC tailings fail to meet this requirement. The draft PolyMet FTB dam permit does not discuss the properties of materials that will be used in dam construction.

DNR's consulting engineers have recommended complete removal of peat deposits near the toe of the existing tailings basin dam so that the new PolyMet dam buttress would have a solid footing.[64] Documents supporting PolyMet's application for an FTB dam permit state that various dam cross-sections require a buttress to achieve a 1.1 minimum factor of safety.[65] In the case of Cross-Section N on the south side of the tailings waste basin adjacent to Second Creek, for example, a blanket buttress almost 400 feet wide would be required to meet even a 1.1 minimum factor of safety.[66] Permit conditions should require the complete removal of peat soils prior to buttress construction and specify design requirements for buttresses to meet factors of safety under worst-case liquefaction conditions. The draft PolyMet dam permit requires written approval of plans from the DNR prior to buttress construction, but does not require specific measures, such as peat removal, or state the design requirements or minimum safety factors required for dam construction.[67]

Beach and Freeboard: DNR's consulting engineers commented that FTB dam stability analysis was based on maintaining a beach length of 625 feet to minimize the risk of erosion at the edge of the basin and that some of PolyMet's models did not seem to correctly account for a potential rise in water levels.[68] The draft PolyMet FTB dam permit sets a clear requirement that the permittee "maintain a normal beach length of at least 625 feet and a normal freeboard of at least 9 feet." However, this condition should be clarified to require: 1) that the permittee immediately inform DNR when beach and freeboard requirements are less than the permitted values; 2) that

[63] FTB Geotech., p. 39.
[64] EOR Review Team, PolyMet Dam Safety Permit Application Review, *supra*, p. 4.
[65] FTB Geotech., p. 111.
[66] *Id.*, pp. 93, 111.
[67] FTB Draft Dam Permit, ¶30.
[68] EOR Review Team, PolyMet Dam Safety Permit Application Review, *supra*, p. 4.

the permittee, rather than some unspecified party must undertake corrective actions; and 3) the nature of steps that must be taken to restore these parameters as quickly as feasible.[69]

Bentonite and Dry Closure: As discussed in more detail in the final section of these comments, DNR staff and consulting engineers have serious concerns about the performance of bentonite to prevent water infiltrating the FTB dam and about the risk that bentonite will increase slope erosion. They have also questioned the stability and long-term maintenance of the FTB with wet ponding, as opposed to dry closure. Before a FTB dam permit can be considered, let alone approved, final evaluations must be completed and decisions made as to which, if any, designs will ensure dam safety and water pollution control. Permit conditions must then specify the mitigation design to be used, the specifications it must attain, and the contingencies that would be triggered if specifications are not met.

The draft PolyMet FTB dam permit makes no decision on the use of bentonite. It defers the question of whether bentonite is a suitable mitigation design to unspecified pilot/field tests prior to construction. Even then, the draft permit fails to specify how pilot/field tests must be done, the findings they must demonstrate, or the consequences for design and permitting if such findings cannot be made.[70] With respect to dry closure, the draft PolyMet FTB permit kicks the can even farther out into the future. The draft dam permit proposes that PolyMet construct its dam, fill the flotation tailings basin with hundreds of millions of tons of tailings waste and, only then, explore and submit updated "future closure options, such as a dry cap or other technologies that may improve closure conditions."[71] This permitting approach does not comply with law.

Dam Operations and Perpetual Maintenance: Dam operation, maintenance, inspection and monitoring, whether to control water levels, repair erosion or maintain the drainage and pumping system, can be determinative of dam safety. This concern is elevated once processing operations cease. PolyMet's Contingency Action Plan only specifies protections while operations are ongoing:

> During operations, personnel will be on-site 24 hours a day, 7 days per week. Personnel will therefore be able to review conditions and monitor for changing conditions. Additionally, monitoring instrumentation is planned to be automated by a remote monitoring system, which includes thresholds and automated alarms data trends toward or falls outside of pre-established thresholds.[72]

Post-closure, PolyMet only proposes an annual inspection of vegetation and erosion repair, snow removal during winter to allow access, and reconstruction of eroded dam crest, slope or toe – presumably when found during an annual inspection.[73]

DNR staff engineers and consulting engineers have questioned PolyMet's understanding of necessary maintenance tasks post-closure. EOR and Spectrum Engineering have emphasized perpetual maintenance of PolyMet's FTM dam design will require "perpetual operation,

[69] FTB Draft Dam Permit, ¶48.
[70] FTB Draft Dam Permit, ¶31.
[71] FTB Draft Dam Permit, ¶45-46.
[72] Contingency Action Plan for the Flotation Tailings Basin, May 15, 2017, p. 13 in Attachment F to the FTB Mgt. Plan.
[73] FTB Mgt. Plan, p. 41.

maintenance, and capital replacement of the pumping system to maintain appropriate tailings water levels (pumping in or pumping out)," "major capital improvements like bentonite re-application (say every 10-20 years)," structural issues, monitoring, and a third party dam safety consultant, in addition to maintenance costs for regular erosion repair, tree/vegetation replacement and regrading.[74] Managing the water level, in particular, would be needed to prevent pond overflow or drying out and oxidizing of tailings.[75]

Permit conditions should incorporate a detailed and prescriptive written Operation, Maintenance and Inspection Plan that addresses operations, closure and post-closure perpetual maintenance. Post-closure and perpetual maintenance should be detailed to include contingency action in the event of dam failure, remote monitoring, on-site inspection at spring melt and during heavy precipitation events as well as frequent inspections, management of water levels, periodic capital improvements, and structural repair of erosion, as well as maintenance of vegetation.

The PolyMet draft FTB dam permit would allow PolyMet to propose an Operations and Maintenance Plan for DNR approval without public review – long after permitting is complete and financial assurance is set. No content requirements are specified for the Plan, which could be changed by DNR without a permit amendment.[76] The draft FTB dam permit would require PolyMet to "maintain the dimensions and elevations of the dam as described herein" but does not actually describe the dimensions or elevations that must be maintained.[77] Although the draft FTB dam permit requires "perpetual maintenance" of the integrity of the tailings basin, no permit condition specifies that maintenance requires water management, capital replacement of the pumping system, periodic investment for bentonite replacement, erosion repair, monitoring, inspections, third party safety evaluation, or vegetation management.[78]

Observational Method: The draft PolyMet FTB dam permit proposes the "Observational Method" to give the permittee the "flexibility to modify the design as new information is obtained during the multi-year construction of the tailings basin dam," and states that "changes in the design, construction, operation or maintenance of the facilities authorized by this permit" at the "sole discretion of the DNR."[79] WaterLegacy is concerned that this version of an "Observational Method" undermines the permitting process and the opportunity for public review. In addition, as the preceding discussion has detailed, the PolyMet FTB tailings design and draft permit are inadequate to support an observational approach:

> "The EOR Review Team agrees that the Observational Method can and should be used during construction, but it is not a substitute for careful initial design. The EOR Team concluded that the permit application lacks the detail and description of contingencies for the Observational Method to be effective. If monitoring data indicate a potentially unsafe condition during construction, then the alternate construction methods and designs (contingencies) must be already in place so that they can be implemented immediately."[80]

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[74] Emails, Spectrum Engineering, EOR & DNR, PolyMet Tailings Dam Comments Appendix 6, May 31-June 1, 2017, attached as Exhibit 15.
[75] *Id.*
[76] FTB Draft Dam Permit, ¶33-34.
[77] *Id.*, ¶34.
[78] *Id.*, ¶47.
[79] *Id.*, ¶ 36.
[80] EOR Review Team, PolyMet Dam Safety Permit Application Review, *supra*, p. 3

B. Hydrometallurgical Residue Facility Draft Dam Safety Permit (2016-1383)

Characterization of HRF Storage Materials: As explained in the first section of these comments, the chemical parameters of proposed PolyMet hydrometallurgical residue waste have yet to be characterized and disclosed to regulators and the public. The record is unclear whether PolyMet will deposit other materials, such as coal ash and sludge from treatment facilities, along with nickel processing HRF wastes. Yet, even the consideration of permitting for the HRF dam is contingent on the supposition that the wastes to be contained by the dam will not be hazardous.[81] Permit conditions must specify: 1) that wastes to be contained by the HRF dams shall not be hazardous, as defined under Minnesota laws,[82] whether singly or in combination; 2) the specific waste streams that may be deposited in the HRF; 3) the testing that PolyMet must supply to the DNR, the MPCA and the public demonstrating that wastes are not hazardous prior to depositing them in the HRF; and 4) that if any wastes are found to be hazardous whether prior to or subsequent to deposit in the HRF, they must be removed from the site and deposited in a licensed hazardous waste facility. The draft PolyMet HRF dam permit contains no conditions at all as to the nature, composition or testing of HRF wastes.

Foundation: The first and final sections of these comments detail broad concerns regarding the unsuitable foundation beneath PolyMet's proposed hydrometallurgical residue facility. If permitting the HRF is even to be considered, permit conditions should explicitly require the removal of all wetlands and soft soils from the HRF site and the establishment of a sound foundation prior to construction. The draft PolyMet HRF dam permit neither requires removal, rejects the "foundation preload" proposed by PolyMet, sets any specific standards for what PolyMet must "confirm" in order to move forward with its preferred and less expensive plan for the HRF foundation, nor even sets a timeframe for decisions.[83] The most basic determinations on standards and design for the HRF foundation would be indefinitely deferred with no substantive requirements.

Dam construction: PolyMet's HRF dam permit application and supporting materials provide little specificity regarding dam construction. PolyMet's application states that HRF perimeter dams will be constructed using soil borrow and bulk tailings selected from locations at PolyMet's discretion.[84] The perimeter dams may "possibly" also include quarried rock.[85] Permit conditions should state where quarried rock construction is required and specify the materials, dimensions and properties of all dam construction materials. The draft HRF dam permit notes that MPCA must approve dam designs since the HRF would store liquid waste.[86] However, the draft permit provides no specifications for dam construction materials or dam design, other than to say that changes in HRF designs must be reported to the DNR in an annual report.[87]

The draft HRF dam permit requires an unusual level of detail in the annual report PolyMet must submit to DNR, including HRF photographs, graphical presentations of instrumentation

[81] *See e.g*. HRF Mgt. Plan, p. 6.
[82] See Minn. Stat. §116.06, Subd. 11 for the definition of hazardous wastes.
[83] HRF Draft Dam Permit, ¶ 25-26.
[84] HRF Permit Application, p. 7, Table 3-2.
[85] HRF Mgt. Plan, p. 7.
[86] HRF Draft Dam Permit, ¶45.
[87] *Id*., ¶33.

"including but not limited to data from pond level monitors, piezometers, inclinometers, extensiometers, and settlement plates at the HRF," and a brief discussion of any monitoring results that "appear to be irregular or out of tolerance."[88] Rather than serving as reassurance, this condition suggests that no standards for regularity or tolerance have been set, and that the likely performance and even the appearance of the HRF are quite uncertain.

Freeboard and Water Management: The HRF would be located adjacent to the FTB waste facility, so precipitation and snow melt conditions would be the same. The HRF, unlike the FTB facility, seems to have no emergency overflow mechanism to prevent overtopping or dam failure during a massive precipitation event or in the event of disruption or blockage of the return water pipeline.[89] Permit conditions should specify emergency water management contingencies for the HRF and require that the HRF maintain at least a 9-foot freeboard as well as an appropriate beach.[90] The draft PolyMet HRF dam permit proposes a freeboard of only 6 feet, no beach, and no mechanism to correct abnormal conditions that reduce freeboard below the permitted value.[91]

Blasting: Concerns about the impacts of blasting at the HRF on the underlying fault and the risk of liner deformation are discussed in the first section of these comments. Permit conditions should require that all blasting to loosen, break or reshape HRF rock outcroppings must be done prior to construction of the HRF dam, and that effects of blasting on the existing fault and cracks that might affect dam stability must be analyzed and repaired before HRF dam liners are installed or HRF wastes deposited. The draft PolyMet dam permit does not mention blasting or the fault beneath the HRF and does not address this source of cumulative deformation.

Factors of Safety: The HRF dam would contain liquid wastes, the dam perimeter would be constructed of soil and tailings, and the foundation beneath HRF dam liners may be compacted wetlands, soft soils and tailings concentrates. Permit conditions should specify the factors of safety required for HRF dam slope stability and that these factors of safety must be computed under worst-case liquefied conditions and using project-specific shear testing.[92] The draft PolyMet HRF dam permit neither requires factors of safety nor specifies how attainment of safety factors should be calculated.

Dam Operations and Perpetual Maintenance: The proposed PolyMet HRF dam will require perpetual monitoring and maintenance. The accumulation of solids in the return water pumping system will require continual monitoring and maintenance to prevent clogs with suspended particles.[93] Inspections will also be needed to observe evidence of "dam structure deformation (e.g., slope bulging or crest settlement)," evidence of "leakage, overland runoff or erosion" and possible evidence of "piping/subsurface erosion downstream of the dam."[94] After closure, there is a potential for "clogging, blockage, or damage" to the closure inlet box, because pipes are

[88] *Id.*
[89] *See* HRF Dam Break Analysis, *supra*, pp. 2-3.
[90] Freeboard of 6 feet required in FTB Draft Dam Permit, ¶48. Beach length is referenced in HRF Draft Dam Permit, ¶ 31 as part of a future Operations Plan, but none is required as a permit condition.
[91] HRF Draft Dam Permit, ¶44. Supporting documents also describe no mitigation design to address overflow.
[92] HRF general slope stability results reported by PolyMet appear to consider only drained shear strengths. Infinite slope stability results are based on "commonly reported" data, not project-specific shear testing. HRF Geotech., pp. 46, 48.
[93] HRF Mgt. Plan, p 21.
[94] *Id*., p. 25.

through embankments in closure.[95] Without insulation, any break or disruption could lead to a frozen water return pipeline.[96]

Documents provided by PolyMet to support its application for an HRF dam permit propose that the HRF will be inspected daily and weekly during operations and that monitoring points will be surveyed twice per year to determine horizontal and vertical deformation of the HRF dams.[97] However, PolyMet's plan for HRF maintenance is meager and short-lived:

> The frequency of monitoring will decrease and monitoring will eventually cease once the cover system has been completed, once vegetation has become established, and once it is confirmed that there are no areas where surface runoff is becoming channelized and causing erosion of the facility dams.[98]

Permit conditions for the HRF dam should incorporate a prescriptive written Operation, Maintenance and Inspection Plan that addresses operations, closure and post-closure perpetual maintenance, including residue spigotting, water management, redundant piping systems, emergency contingencies, and geotechnical specifications and monitoring requirements. Permit conditions should specify requirements at closure and post-closure to demonstrate structural integrity, properties of materials after dewatering, the means and efficacy of sealing the HRF from water infiltration, and the level to which liner leakage must be limited. HRF permit conditions should also provide for perpetual inspections and maintenance, including surveys for deformation, testing for infiltration and leaks. HRF permit conditions should detail the triggers and contingent actions, ranging from repairs to excavation of wastes, in the event leaks or containment failures during operations, closure or post-closure threaten public health, safety, welfare and the environment.

The PolyMet draft HRF permit would allow PolyMet to submit its Operation, Maintenance and Inspection Plan for DNR approval without public review – long after permitting is complete and financial assurance is set in the permit to mine.[99] Although the topics for the Plan are set forth, the permit sets no standards that the Plan must meet and provides no basis for DNR's approval or denial of the Plan.[100] The draft HRF permit requires a permit amendment for any repair that would "change the hydraulic capacity or structural character of the dam," but the permit contains no conditions for either the hydraulic capacity or structural character of the dam.[101]

Under the draft HRF permit, PolyMet would not submit a closure plan until 2 years before the end of planned operations; and no conditions are specified that must be met at closure.[102] The draft HRF permit states that the DNR Commissioner may set requirements to ensure that the permittee "will remain financially responsible for carrying out the activities required for perpetual maintenance, and that adequate funding for perpetual maintenance continues to

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[95] B. Johnson, DNR, NorthMet Project Geotech/Hydromet Mgt. Plans, July 5, 2016, attached as Exhibit 16.
[96] *Id.*
[97] HRF Mgt. Plan, pp. 25, 28.
[98] *Id.*, p. 36.
[99] HRF Draft Dam Permit, ¶ 31.
[100] *Id.*
[101] *Id.*, ¶32
[102] *Id.*, ¶ 42.

exist."[103] However, it lacks requirements for closure and perpetual maintenance of the HRF that could be used to determine financial assurance in the permit to mine.

Draft Dam Safety permits for the PolyMet FTB and HRF fail to meet legal requirements for final design submittal, reasonableness, or regulation to protect public health, safety, welfare and the environment. They must be rejected.

3. Failure to Protect Public Health, Safety, Welfare and the Environment

Draft PolyMet FTB and HRF dam permits, along with their supporting documents, fail in several important requests to address concerns raised or even to follow recommendations of the DNR's own senior staff engineers and consulting engineers. As reflected throughout these comments, WaterLegacy believes that investigations must be required, risks must be analyzed, standards must be specified, designs must be finalized and alternatives must be required to protect public health, safety, welfare and the environment. Even in the face of PolyMet's resistance, the DNR must require protective factors of safety, designs, technologies and practices that ensure dam stability and water quality. If for this particular project and proposed waste disposal locations, no mitigation alternatives can achieve this dual requirement, the DNR must be prepared to deny PolyMet dam safety permits.

A. Factors of Safety

Prior sections of these comments have raised concerns about PolyMet's failure to conduct a thorough dam stability analysis of the HRF and about the lack of specificity in the draft FTB and HRF dam permits as to the factors of safety applicable to PolyMet's dams. DNR documents reflect that the selection of factors of safety for the PolyMet dams has been contentious. In 2010, when PolyMet proposed a safety factor of 1.05, the U.S. Environmental Protection Agency recommended that DNR use a safety factor of 1.5:

> EPA's principle concern with this work relates to the factors of safety used to design the new tailings pond. . . *Steve Hoffman was asked about observations at other sites, and noted that the industry standard, driven by companies, is generally is migrating to a safety factor of 1.50.*[104]

After several months of internal discussion, DNR's senior dam safety engineer concluded:

> DNR should accept the 1.20 value as the acceptable Factor of Safety for Liquefaction (F_{Liq}). This is the recommended value from the MSHA "2009 Engineering and Design Manual, Coal Refuse Disposal Facilities" (EDM). There are several additional sources that recommend the 1.20 value, including internal DOW Dam Safety guidance documents. This F_{Liq} should be applicable for both seismic events and pore water pressure.[105]

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[103] *Id.*, ¶ 43.
[104] Review and Conference Call Record, EPA review of NorthMet Project Flotation Management Plan (FTMP), Nov. 29, 2010, p. 3, attached as Exhibit 17.
[105] DNR Memo, Dana's recommended direction on PolyMet, Feb. 23, 2011, attached as Exhibit 18.

The Co-Lead Agencies agreed in May 2011 that the factor of safety should meet or exceed 1.50 for drained strength, 1.30 for undrained non-liquefiable materials and 1.20 for static as well as seismic liquefaction.[106] PolyMet was not "receptive" to performing a safety analysis for the FTB for the case where full liquefaction would be triggered.[107]

Recently, the Federal Energy Regulatory Commission (FERC) set Safety Guidelines for dam engineering. For dams with either a high (Class I) or significant (Class II) hazard potential, FERC recommended a minimum factor of safety of 3.0 under usual loading conditions, 2.0 under unusual loading conditions and 1.3 for seismic liquefaction conditions after an earthquake.[108] Even if cohesion is not relied on for dam stability, FERC recommended a minimum factor of safety of 1.5 in the worst static case and 1.3 for seismic liquefaction post earthquake.[109]

WaterLegacy believes that factors of safety for both the FTB and HRF dams must be reviewed and updated to apply current protective standards, increasing the factors of safety for proposed PolyMet sulfide mine waste dams.

Even applying a 1.10 factor of safety for liquefied conditions, which falls below the recommendation of DNR's senior engineer as well as below FERC safety guidelines, PolyMet's proposed FTB does not meet this minimum safety factor. Under liquefied conditions triggered by erosion, the calculated factor of safety at the FTM dam is 1.07, which is below the 1.10 minimum safety level prescribed for the PolyMet FTB.[110] We don't know how likely it is that erosion would trigger liquefaction, although this is one of the scenarios with which DNR's consulting engineers are concerned. However, should this trigger occur, there is nearly a 1 in 50 chance that the FTB dam would fail.[111]

DNR must set an more protective factor of safety for the FTB and HRF dams, particularly in the case of static liquefaction, require that PolyMet thoroughly and candidly evaluate compliance with this new safety factor and preclude further permitting activity unless and until dam designs meet or exceed all applicable factors of safety.

B. FTB Dry Tailings Designs & Closure Plans

WaterLegacy's comments on the PolyMet FEIS, along with attached exhibits and expert opinions, have expressed concern about the proposed storage of wet slurry tailings at the PolyMet FTB, particularly in light of the catastrophic failures of the Mount Polley dam in British Columbia, Canada and the Fundão Dam in Samarco, Brazil.[112] A panel of experts analyzed the cause of the Mount Polley tailings impoundment failure and made the following key recommendation in their Independent Report:

> [T]he future requires not only an improved adoption of best applicable practices (BAP), but also a migration to best available technology (BAT). Examples of BAT are filtered,

[106] Geotechnical Stability IAP Summary Memo NorthMet Project EIS, May 18, 2011, p. 1, attached as Exhibit 19.
[107] T. Radue. Barr Eng., Email to DNR, PolyMet Follow-Up, Jan. 14, 2013, attached as Exhibit 20.
[108] FERC, Hydropower Safety Guidelines Engineering Guide, Ch. III, p. 3-26, Mar. 4, 2016, attached as Exhibit 21.
[109] *Id*., p. 3-27.
[110] FTB Geotech, pp. 109, 117.
[111] *Id*., p. 114.
[112] WaterLegacy's FEIS Comments, pp. 69-72, 84-86, incorporated by reference in footnote 5.

> unsaturated, compacted tailings and reduction in the use of water covers in a closure setting.[113]

The *Mount Polley Independent Report* explained the "intrinsic hazards associated with dual-purpose impoundments storing both water and tailings" and stated, "BAT has three components that derive from first principles of soil mechanics: 1. Eliminate surface water from the impoundment. 2. Promote unsaturated conditions in the tailings with drainage provisions. 3. Achieve dilatant conditions throughout the tailings deposit by compaction."[114]

This analysis is now widely shared within the industry. A summary article from the 2017 annual meeting of the International Commission on Large Dams (ICOLD) concluded:

> One possible measure includes reduction of pore water from the tailings mass, which can improve the rheological characteristics so that the stored tailings solids are non-flowable as described by Adams et al (2017). . . For each of the presented case studies, it was the large volume of water in the TSF that exaggerated the downstream inundation extent. In the recent Mount Polley tailings dam breach incident, it has been acknowledged that the foundation failure of the dam would have resulted in a dam crest deformation and potentially some tailings slumping, but not in a catastrophic breach and release of the stored TSF content.[115]

Others have simplified, "[T]he presence of large quantities of stored water is the primary factor contributing to most of the recent tailings storage failures. The risk of physical instability for a conventional tailings facility can be reduced by having good drainage and little (if any) ponded water. Simply put, 'no water, no problem.' "[116]

Minnesota rules for non-ferrous mining also require elimination of substantially all water in tailings, particularly at closure. A reactive mine waste storage facility[117] must be designed either to modify or store wastes so that they are no longer reactive or "during construction to the extent practicable, and at closure, permanently prevent substantially all water from moving through or over the mine waste." Minn. R. 6132.2200, Subp. 2, Item B.

DNR's consultants and staff engineers have expressed reservations about PolyMet's current plans to maintain a pond at the top of the flotation tailings storage facility. The EOR review team concluded, "Dry closure (no water ponding) requires a greater initial investment, but has much lower ongoing maintenance costs and less long-term environmental risk."[118] DNR's senior

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[113] Independent Expert Engineering Investigation and Review Panel, *Report on Mount Polley Tailings Storage Facility Breach,* Jan. 30, 2015, p. iv, provided as Exhibit 25 to WaterLegacy FEIS Comments, *supra*. Online at https://www.mountpolleyreviewpanel.ca/sites/default/files/report/ReportonMountPolleyTailingsStorageFacilityBreach.pdf

[114] *Id*., p. 121.

[115] Martin et al., Challenges with conducting tailings dam breach assessments, 85th Annual Meeting International Commission on Large Dams (ICOLD), July 3-7, 2017, *supra*, Exhibit 7.

[116] Water Management Considerations for Conventional Storage, http://www.tailings.info/technical/water.htm, last visited on Oct. 15, 2017.

[117] "Reactive mine waste" is defined as waste that is "shown through characterization studies to release substances that adversely impact natural resources." Minn. R. 6132.0100, Subp. 28. Sulfates in tailings waste and metals, such as nickel, that leach from tailings even under circumneutral conditions, would adversely impact natural resources.

[118] EOR Review Team, PolyMet Dam Safety Permit Application Review, *supra*, p. 5

dam safety engineer explained the reason dry closure was recommended for the PolyMet FTB; "The geomorphological issues are essentially why I favor dry closure."[119]

Consulting engineers at EOR and Spectrum Engineering agree that PolyMet's plan to seal the FTB embankment with bentonite would be geomorphologically unstable.[120] Donald Sutton, who previously identified the bentonite seal a "hail Mary type of concept" that "will exacerbate erosion and slope failure and will eventually fail,"[121] explained in a May 31, 2017 email to EOR and DNR the risks of catastrophic dam failure and tailings release under PolyMet's current plan:

> The stair step FTB embankment sealed with bentonite is geomorphologically unstable and will erode, potentially cutting back into the pooled water, releasing the water and saturated tailings. Initially, surface water will collect in the horizontal ditch/ponds along the toes of lifts 1 and 5, and infiltrate into the embankment via the underdrain and the coarse LTV tailings beneath lift 1. Later, after the bentonite soil erodes from the slopes, the ditches will fill, plugging the underdrain, forcing the water to overflow the bench and cause head cutting in the non-cohesive tailings. If the FTB is to remain as a permanent structure without perpetual maintenance, then I recommend that the embankments be designed using established geomorphologic land reclamation principals. Otherwise there is a high probability that the embankments will eventually fail due to erosion, and catastrophically release the saturated tailings.[122]

The PolyMet FEIS relied on the plan for bentonite amendment of the pond on top of the tailings and of the exposed beach areas of the dam to claim that there would be a barrier limiting oxygen diffusion into the tailings and oxidation of sulfide minerals, which "would reduce pollutants generated from the tailings basin."[123] However, DNR's EOR and Gale-Tec consulting engineers have opined. "The effectiveness of injecting bentonite through the pond water is subject to concern with regard to reliability of the infiltrations reduction."[124]All FEIS modeling predictions of water quality at the tailings basin were predicated on the assumption that bentonite measures would be implemented and that they would effectively reduce water pollution volumes and concentrations. Regulators can no longer rely on these predictions.

There may be lined dry stack tailings storage facility designs that would comply with Minnesota non-ferrous mining rules, provide dam stability with appropriate factors of safety, and also protect water quality. But PolyMet's proposed wet slurry tailings storage, long-term water ponding, and bentonite amendment proposal on top of the existing LTVSMC tailings basin is unlikely to meet any of these basic requirements. PolyMet's FTB dam permit proposal must be rejected.

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[119] Emails, Spectrum Eng., EOR & DNR, PolyMet Tailings Dam Comments Appendix 6, May 31- June 1, 2017, *supra* Exhibit 15.
[120] *Id*.
[121] D. Sutton, Spectrum Engineering, Memo, (FTB) HydroMet and Stockpiles - review of Barr responses to comments, Feb. 24, 2012, attached as Exhibit 22.
[122] Emails, Spectrum Eng., EOR & DNR, PolyMet Tailings Dam Comments Appendix 6, May 31- June 1, 2017, *supra* Exhibit 15.
[123] PolyMet FEIS, *see e.g*. ES-23, ES-25, 3-4, 3-13.
[124] Gale Tec Eng., EOR, DNR Review of PolyMet's Dam Safety – HydroMet Facility – Permit Application, undated 2017, p. 6, attached as Exhibit 23.

C. Hydrometallurgical Waste Residue Location and Facility

Hazardous waste disposal facilities may not be established or constructed within a wetland or in a location where the topography, geology, hydrology, or soil is unsuitable for the protection of the ground water and the surface water. Minn. R. 7045.0460, Subp. 2. PolyMet maintains that HRF wastes will not meet either federal or state criteria for "hazardous wastes," but this may not be accurate given the way in which Minnesota law defines hazardous waste.[125] Even if the wastes planned for disposal in the HRF were not hazardous, Minnesota law applies the same prohibitions to prevent locating an industrial waste disposal facility on a wetland or area made unsuitable due to topography, geology, hydrology, or soils. Minn. R. 7035.1600, Items D, G.

In Minnesota, only a hazardous waste facility can accept liquids, and these must be removed or solidified at closure. Minn. R. 7045.0532, Subp. 7. Liquids may not be accepted by solid waste facilities and are generally not acceptable for deposit in industrial waste disposal facilities. Minn. R. 7035.3535, Subp. 1, Items F, G; Minn. R. 7035.1700, Item V(1).

It is not clear what Minnesota rules could be interpreted to permit location of the PolyMet hydrometallurgical waste residue facility on top of wetlands and unsuitable soils or what Minnesota rules might allow disposal of 6,170,000 total tons of liquid waste in a facility that is not licensed for hazardous wastes.

It is, however, clear that there are important reasons why disposal of hydrometallurgical waste residues and other PolyMet liquid or semi-liquid wastes on top of wetlands and unsuitable soils should not be permitted. As previously noted, DNR's consulting engineers have explained that the soft ground beneath the proposed residue facility consists of up to 30 feet of slimes, peat and tailings concentrate, which provide an inadequate foundation for the 80 foot high basin.[126] The engineers have underscored, "[T]his system is susceptible to rupture as a result of strains in the geomembrane or synthetic clay liner."[127] "The liner could deform and fail if the existing underlying material cannot support the material added to the basin."[128]

Possible remediation alternatives have been identified, including: 1) PolyMet's preferred pre-load of the soft materials with rock and soil to compress them; 2) installing wick drains to allow water to flow out of the existing material; or 3) removing the existing materials and soft soils before constructing the HRF. DNR's consultants have not dismissed the preload/wick drain concept; they have required that it be re-evaluated due to questions about its performance.[129] However, it is undisputed that existing wetlands and soft soil materials will rebound after the

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125 Minnesota Statutes state: " 'Hazardous waste' means any refuse, sludge, or other waste material or combinations of refuse, sludge or other waste materials in solid, semisolid, liquid, or contained gaseous form which because of its quantity, concentration, or chemical, physical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Categories of hazardous waste materials include, but are not limited to: explosives, flammables, oxidizers, poisons, irritants, and corrosives." Minn. Stat. §116.06, Subd. 11. The 3,280 pounds of mercury proposed for disposal in the HRF could, without more, mean that HRF waste is "hazardous."

126 EOR Review Team, PolyMet Dam Safety Permit Application Review, *supra*, p. 5.

127 *Id*., Attachment 2 - Comment Tables, autop. 34.

128 *Id*., p. 6.

129 *Id*.

preload is removed.[130] DNR's consulting engineers caution that even after a preload "it is likely that differential settlement will occur over the length of the liner system, especially after the material becomes normally consolidated again during HRF construction. This variability may cause an excessive amount of strain in the liner system."[131]

PolyMet has consistently characterized use of wick drains as optional.[132] PolyMet has also resisted the alternative of excavating and replacing the HRF foundation materials as "potentially impractical" and has questioned whether excavating the layer of wetlands and soft soils may result in instability of the FTB South Dam.[133]

Since the alternative of excavating wetlands and unsuitable soft soils hasn't been analyzed, WaterLegacy doesn't know which, if any, of PolyMet's concerns are well founded. However, considering the risks of dam failure and toxic leakage if liquid wastes are stored in an unsuitable location managed by an inexperienced operator, WaterLegacy believes that the mitigation alternative for HRF wastes most consistent with Minnesota rule compliance and protection of public health, safety, welfare and the environment would be to require that PolyMet dispose of HRF wastes and wastewater treatment sludge off-site and deny the dam permit for PolyMet's proposed HRF facility.

Contested Case Request

Minnesota law gives the DNR the discretion to order a Chapter 14 contested case proceeding for dam safety permits.[134] Once appropriate design parameters are set and analysis done, whether the DNR proposes to approve or deny FTB and HRF dam safety permits, a contested case proceeding would allow public transparency and the development of a record to address disputed factual issues.

Since many issues pertinent to dam safety permits, such as requirements for perpetual maintenance that determine financial assurance, and the need for removal of water from reactive mine waste, overlap issues that might be raised for a permit to mine, WaterLegacy recommends that contested case proceedings for PolyMet dam safety permits and the PolyMet permit to mine be coordinated and heard by the same trier of fact.

Conclusion

WaterLegacy appreciates DNR's ongoing efforts to engage experts and require additional analysis of PolyMet's proposals and computations.

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[130] HRF Geotech., p. 34.
[131] EOR Review Team, PolyMet Dam Safety Permit Application Review, *supra*, Attachment 2 - Comment Tables, autop. 34.
[132] HRF Geotech., pp. 6, 14; HRF Mgt. Plan, p. 10
[133] HRF Geotech., p. 41.
[134] *See e.g. In the Matter of Hibbing Taconite Mine and Stockpile Progression and Williams Creek Project Specific Wetland Mitigation*, 2014 Minn. ENV LEXIS 94, OAH Docket No. 11-2004-31655 ORDER DENYING MOTION (BY CLIFFS) TO DISMISS OAH APPEAL (December 15, 2014), pp. 19-20; Beck, Gossman & Nehl-Trueman, *Minnesota Administrative Procedure*, § 4.2 at 47 (2d. ed. 1998 & Supp. 2008); *In the Matter of Rances Barthelemy*, OAH Docket No. 80-1008-31374, AMENDED ORDER ON CROSS MOTIONS FOR SUMMARY DISPOSITION (2014) ("When an agency is not required by law or constitutional principles to initiate a contested case, it is permitted to offer a 'gratuitous hearing'").

However, based on the draft PolyMet FTB and HRF permits, the documents prepared by PolyMet to support its permit applications, and the issues raised by the DNR's engineers and consultants as well as by other experts, we believe that compliance with Minnesota statutes and rules would require the denial of both the FTB and HRF dam permits. Due to failures in PolyMet's investigations, insufficient permit requirements and safety factors, incomplete designs and substantial unresolved questions about design adequacy, the Commissioner cannot at this time determine that PolyMet's proposals are reasonable, that PolyMet has demonstrated the lack of other suitable feasible and practical sites for waste disposal, that the stability of the FTB and HRF dam will be maintained under all pertinent conditions, or that the dams will comply with prudent, current environmental practice throughout its existence.[135]

Fundamentally, approval of draft dam permits for the PolyMet flotation tailings basin and hydrometallurgical residue facility would fail to protect public health, safety, and welfare and the environment.[136]

Respectfully submitted,

Paula Goodman Maccabee
Advocacy Director/Counsel for WaterLegacy

Enclosure: Exhibits 1-23

cc: Minnesota Pollution Control Agency
U.S. Army Corps of Engineers
U.S.D.A. Forest Service
U.S. Environmental Protection Agency
Fond du Lac, Grand Portage and Bois Forte Bands of the Lake Superior Chippewa

[135] *See* Minn. R. 6115.0410, Subp. 8, Items A, D and F.
[136] Minn. Stat. §103G.315, Subd. 3; Minn. R. 6115.0410, Subp. 8. Minn. R. 6115.0300.