Foth

Memorandum

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May 2, 2022

Report for 401(a)(2) Public Hearing

TO: U.S. Army Corps of Engineers, St. Paul District
File No. MVP-1999-05528-TJH

FROM: Steve Donohue, PH, Foth Infrastructure & Environment, LLC[1]
Jack Gibbons, PG, Foth Infrastructure & Environment, LLC[1]
Andrea Martin, PE, Foth Infrastructure & Environment, LLC[1]

RE: 401(a)(2) Public Hearing on PolyMet's NorthMet Project Section 404 Permit: Mercury and Sulfate Loadings via Precipitation to the St. Louis River Watershed Upstream of the Fond du Lac Reservation in Comparison to the PolyMet NorthMet Project

1. Summary

In this report, we document our review of claims by the Fond du Lac Band of Lake Superior Chippewa (Band) that the NorthMet Project (Project) by Poly Met Mining, Inc. (PolyMet) will affect the Band's water quality on its Reservation located 116 miles downstream from the Project. Specifically, the Band alleges that the Project will contribute mercury and sulfate to the St. Louis River watershed resulting in a violation of the Band's water quality standard for mercury and will increase bioavailable methylmercury. Methylmercury formation is dependent in part on the availability of sulfate in anaerobic wetlands, whereby microbial activity reduces the sulfate and co-metabolically methylates mercury. This memorandum (memo) documents that the major sources of mercury and sulfate in the St. Louis River watershed, and therefore the primary source of bioavailable methylmercury, is driven by precipitation. As documented by the Minnesota Pollution Control Agency (MPCA), this airborne source of mercury originates from outside the borders of Minnesota (MPCA, 2013). Key points documented in this memo include:

- Current mercury loading via precipitation to the St. Louis River watershed upstream of the FDL Reservation is 56,000 grams per year (g/yr). Cumulative, Project-related impacts would reduce mercury contribution to the St. Louis River watershed by 5.2 g/yr as measured immediately downstream of the FDL Reservation (Barr, 2017).

- Current sulfate loading via precipitation to the St. Louis River watershed upstream of the FDL Reservation is 2,400 metric tons per year (t/yr). Cumulative, Project-related impacts would reduce sulfate loading to the St. Louis River watershed by approximately 1,380 t/yr as measured immediately downstream of the FDL Reservation (Barr, 2017).

[1] Resumes of all authors are provided in Attachment 2.

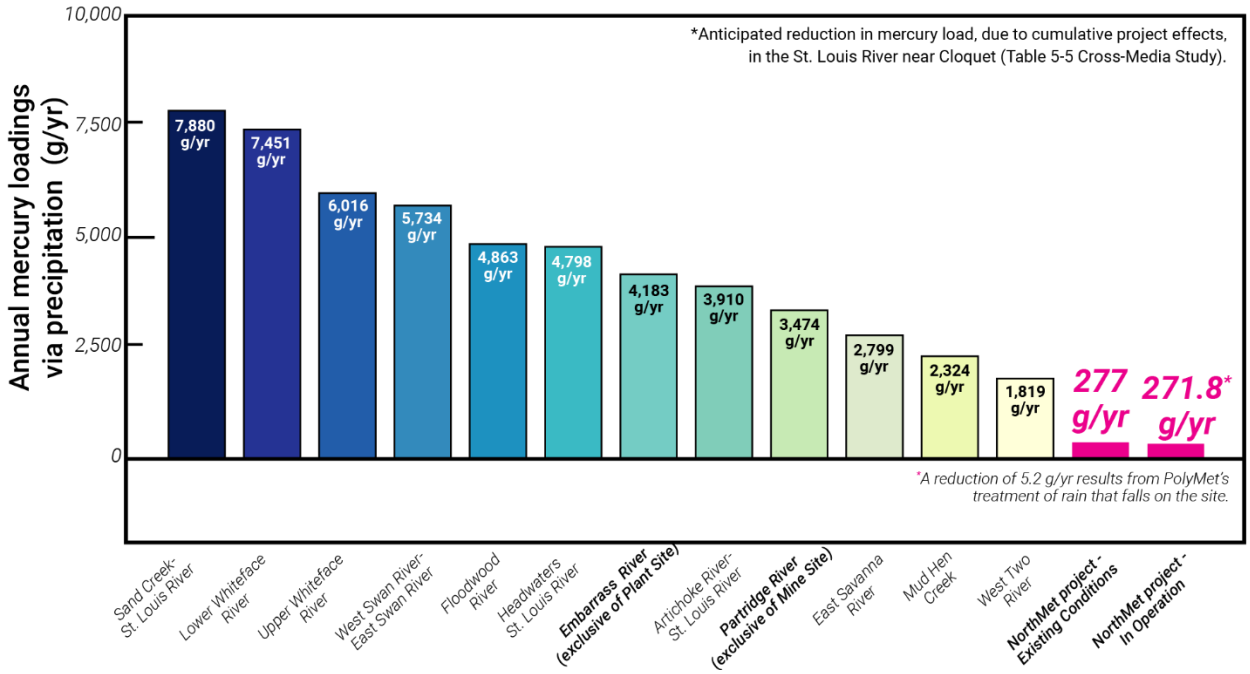
2. Mercury Loadings to the St. Louis River Watershed are Driven by Precipitation

Figure 1 (Attachment 1) shows the watersheds in the vicinity of the Project. Figure 2 (Attachment 1) shows the entire St. Louis River watershed and the location of the Project and the FDL Reservation. Figure 3 shows the contribution of mercury to the St. Louis River watershed based on the calculations described below. As noted by the MPCA (2013), mercury loadings in Minnesota are dominated from sources outside the state. In a comprehensive assessment of mercury and methylmercury occurrence within waters of the Reservation (Jacobson Hedin, 2021), the Band explicitly acknowledged that atmospheric deposition of mercury is the primary source of mercury loading to waters of the Reservation: "*Mercury* (on the Reservation)… *originates almost exclusively from off-site sources (air emissions)*" (underscore added). The Band's comprehensive assessment report from last year (2021), however, neglects to discuss any potential Project-related impact on mercury concentration in the St. Louis River as a source of concern to the Band.

Approximately 56,000 grams of mercury are annually deposited via precipitation in the St. Louis River watershed upstream of the FDL Reservation, based on an average concentration of 11.7 nanograms per liter (ng/L) of mercury in rainfall (data range from 2010 to 2020 for the Marcell Experimental Forest monitoring site; NADP MDN, 2022) and an average precipitation amount of 29.8 inches per year (MDNR, 2015). Under current existing conditions, approximately 280 g/yr are deposited on the combined Plant and Mine Site footprints (Figure 3). In operation, the Project will reduce the existing mercury load in the St. Louis River at Cloquet by approximately 5.2 g/yr (Barr, 2017).

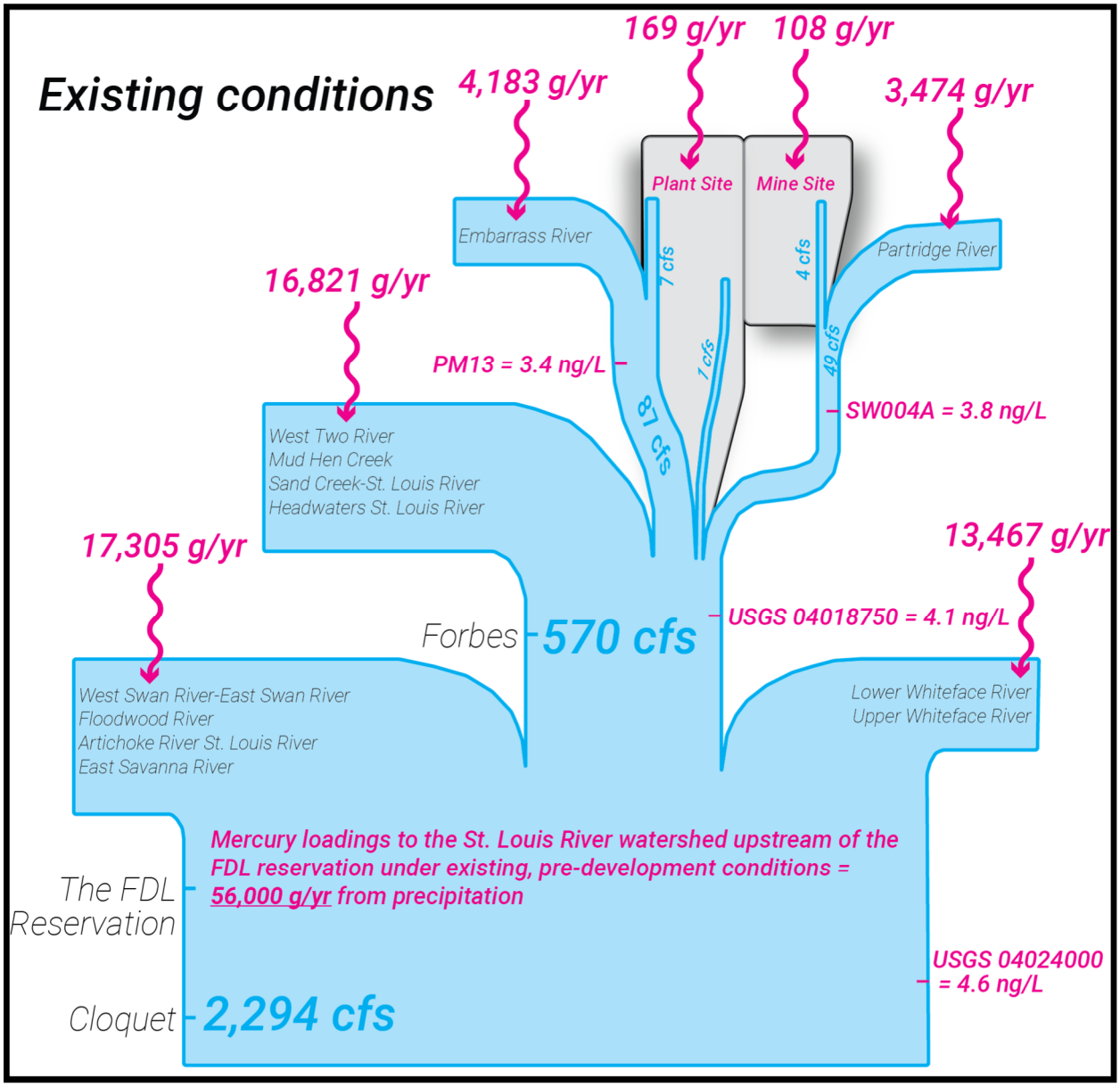
The Project, as designed and modeled, will lower mercury loading in the St. Louis River watershed at the upstream boundary of the FDL Reservation (Figure 4). Comparing concentrations for the same evaluation point between the existing conditions (Figure 4) and conditions during Project operation (Figure 5) clearly indicate that Project-related impact will not cumulatively affect the concentration of mercury at any of the evaluation points. The potential absolute change in mercury loading to the St. Louis River watershed from the Project is small relative to what is deposited naturally via precipitation, highlighting that the mercury concentrations in the St. Louis River Watershed are dominated by atmospheric factors unrelated to the Project. Precipitation is now, and will remain so during Project operation, the dominant source of mercury loading to the St. Louis River watershed.

Figure 3 – Mercury loadings via precipitation (g/yr) to the subwatersheds of the St. Louis River located upstream from the FDL Reservation, to the combined footprint of NorthMet's proposed Plant and Mine Sites under existing conditions and when fully operational at a location immediately downstream of the FDL Reservation.



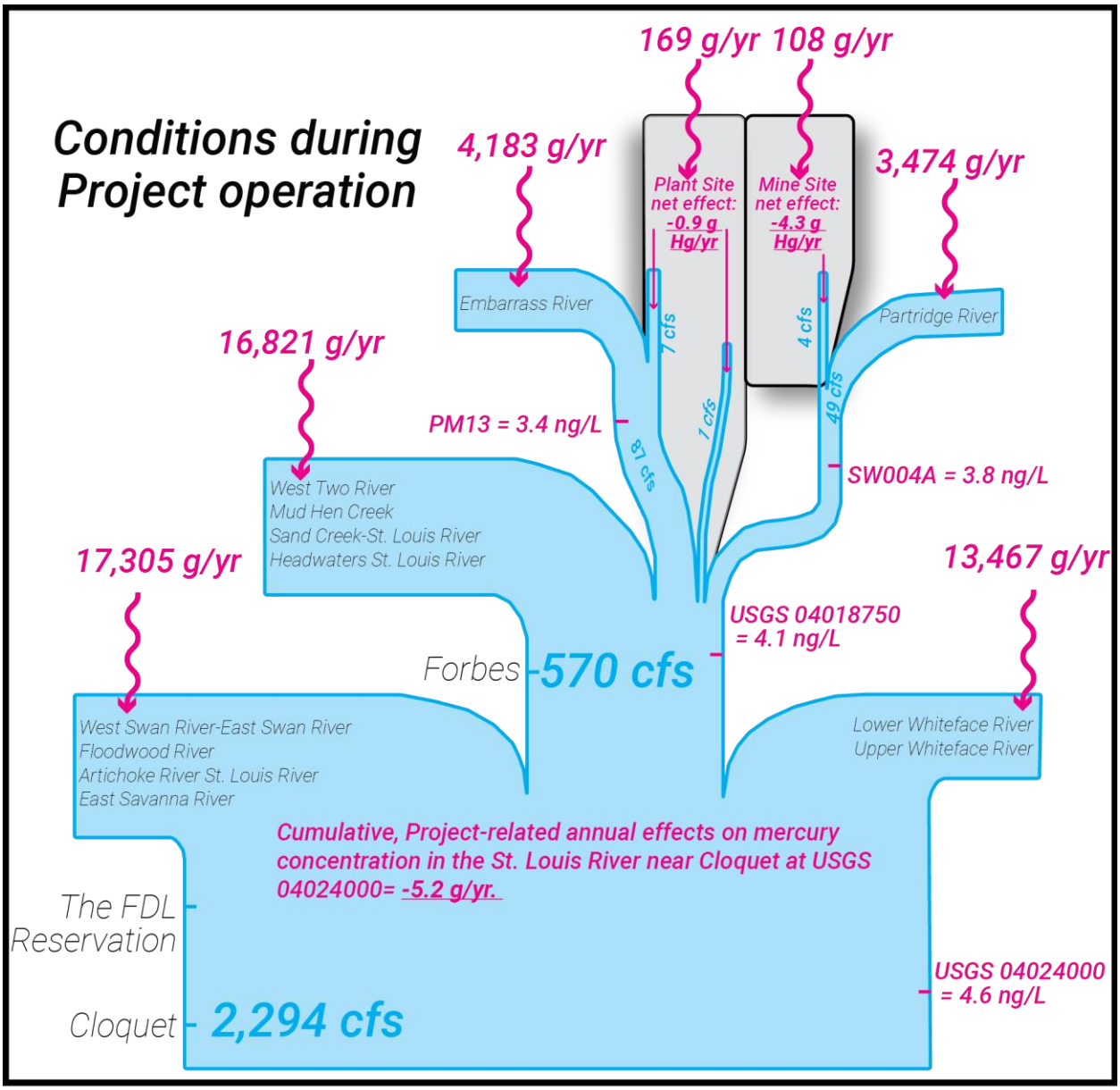
These loadings were calculated using the surface area of each watershed, an average precipitation of 29.8 inches per year (MDNR, 2015), and an average mercury concentration of 11.7 ng/L, as measured from 2010 to 2020 by the National Atmospheric Deposition Program at the Marcell Station, approximately 60 miles west of the Project (NADP NTN, 2022).

Figure 4 – Comparison of mercury loadings to various parts of the St. Louis River watersheds under existing conditions. Total mercury concentration (ng/L) in surface water at monitoring locations PM13, SW004A, USGS 04018750, and USGS 04024000 shows no change between existing and operational conditions (Table 5-5 Barr, 2017).



Notes: Wavy magenta lines represent mercury loadings via precipitation. Loading values represented on these diagrams were compiled from Tables 5-5 from Barr (2017) and the National Atmospheric Deposition Program's Mercury Deposition Network site MN16. The small, horizonal magenta tick marks along the flow path of the St. Louis River and its tributaries mark the relative general location of evaluation points and indicate the concentration of mercury at that evaluation point. Blue text indicates the approximate volume of flow at several different locations along the flow path of the St. Louis River and its tributaries to provide a sense of the magnitude of dilution from the Project. Abbreviations: cfs = cubic feet per second, FDL = the Fond du Lac Band, g = gram, Hg = mercury, L = liter, ng = nanogram, yr = year.

Figure 5 – Comparison of mercury loadings to various parts of the St. Louis River watersheds under operational conditions. Total mercury concentration (ng/L) in surface water at monitoring locations PM13, SW004A, USGS 04018750, and USGS 04024000 shows no change between existing and operational conditions (Table 5-5 Barr, 2017).



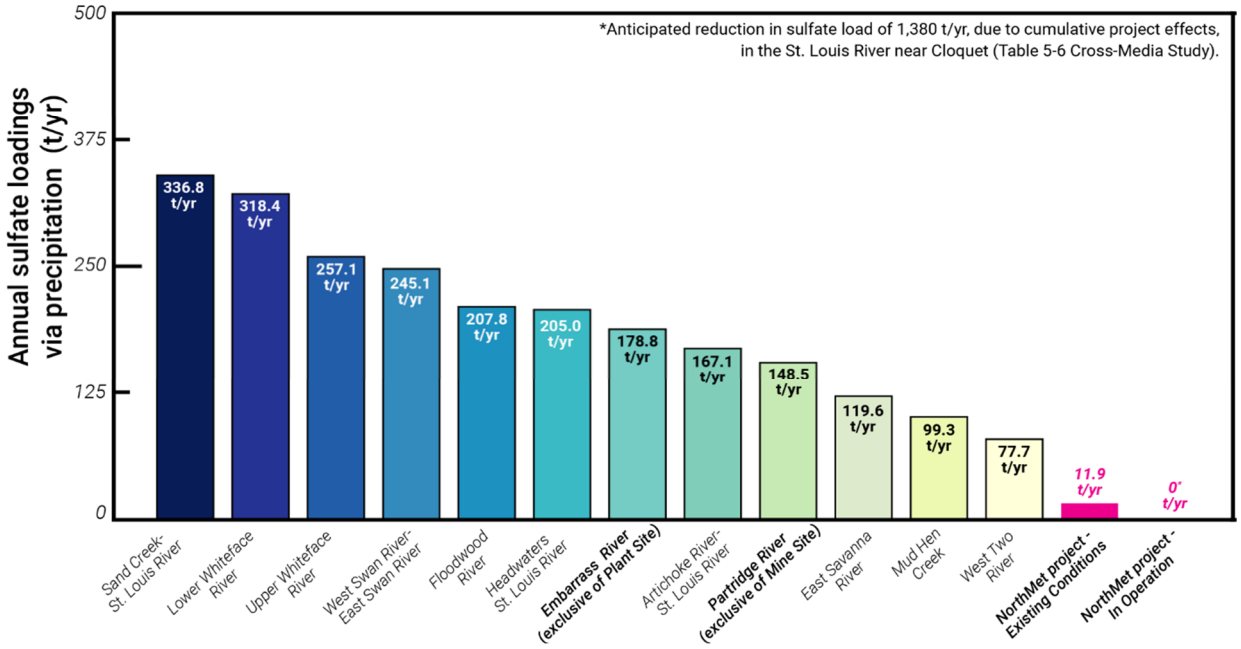
Notes: Wavy magenta lines represent mercury loadings via precipitation and straight lines represent cumulative Project-related loadings. Loading values represented on these diagrams were compiled from Tables 5-5 from Barr (2017) and the National Atmospheric Deposition Program's Mercury Deposition Network site MN16. Project-related loadings are those modeled for the 10th year of mine operation, which is the year with the highest discharge and loading rate, and year 13 emissions, the year with the highest emissions. The small, horizonal magenta tick marks along the flow path of the St. Louis River and its tributaries mark the relative general location of evaluation points and indicate the concentration of mercury at that evaluation point. Blue text indicates the approximate volume of flow at several different locations along the flow path of the St. Louis River and its tributaries to provide a sense of the magnitude of dilution from the Project. Abbreviations: cfs = cubic feet per second, FDL = the Fond du Lac Band, g = gram, Hg = mercury, L = liter, ng = nanogram, yr = year.

3. PolyMet's Project will Remove a Significant Amount of Sulfate Loading from the St. Louis River Watershed

Approximately 2,400 metric tons of sulfate are annually deposited via precipitation in the St. Louis River watershed upstream of the FDL Reservation, based on an average concentration of 0.5 milligram per liter (mg/L) of sulfate in rainfall (data range from 2010 to 2020 for the Marcell Experimental Forest monitoring site; NADP NTN, 2022) and an average precipitation of 29.8 inches per year (MDNR, 2015). Figure 6 shows the contribution of sulfate to the St. Louis River watershed based on these values. Under current existing conditions, approximately 12 t/yr of sulfate are deposited naturally via precipitation on the combined Plant and Mine Site footprints (Figures 6 and 7).

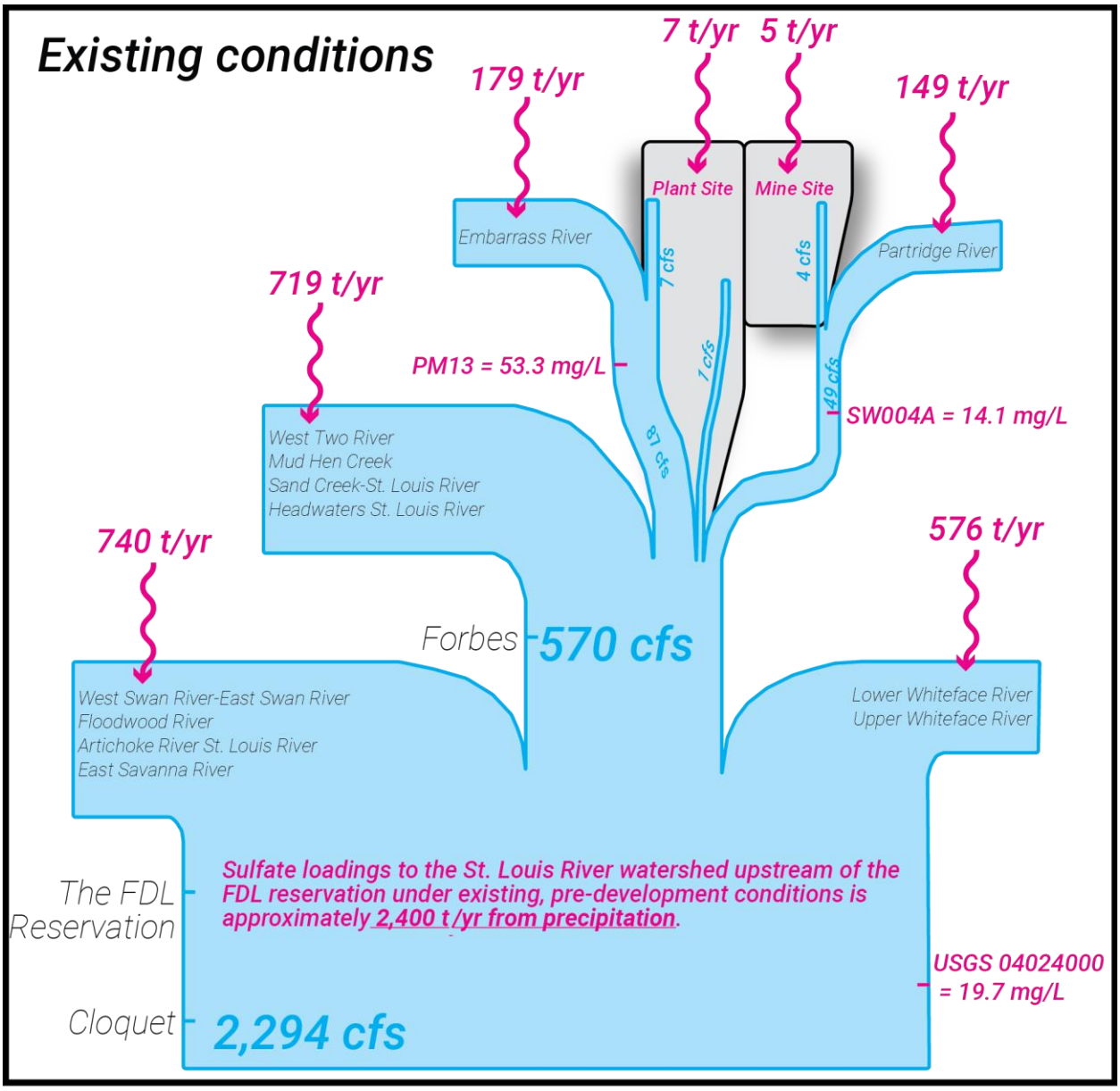
In operation, the Project will reduce the existing sulfate load in the St. Louis River at Cloquet by approximately 1,380 metric tons annually (Barr, 2017). Specific Project water management and treatment actions that contribute to the loading reduction include, but are not limited to, the following: 1) capture and treatment of mine-impacted waters, including seepage from the tailings basin; 2) collection and treatment of atmospheric deposition that falls on Project areas; and 3) use, and subsequent treatment, of Colby Lake as make-up water for the Plant. The Project, as designed and modeled, will lower sulfate loading in the St. Louis River watershed at the upstream boundary of the FDL Reservation (Figure 6). The removal of sulfate inhibits the ability of sulfate-reducing bacteria to convert inorganic mercury to methylmercury. Sulfate concentrations are slightly reduced at all evaluation points (Figure 8) as a result of specific Project water management and treatment actions.

Figure 6 – Sulfate loadings via precipitation (t/yr) to the subwatersheds of the St. Louis River located upstream from the FDL Reservation to the combined footprint of NorthMet's proposed Plant and Mine Sites under existing conditions and when fully operational at a location immediately downstream of the FDL Reservation.



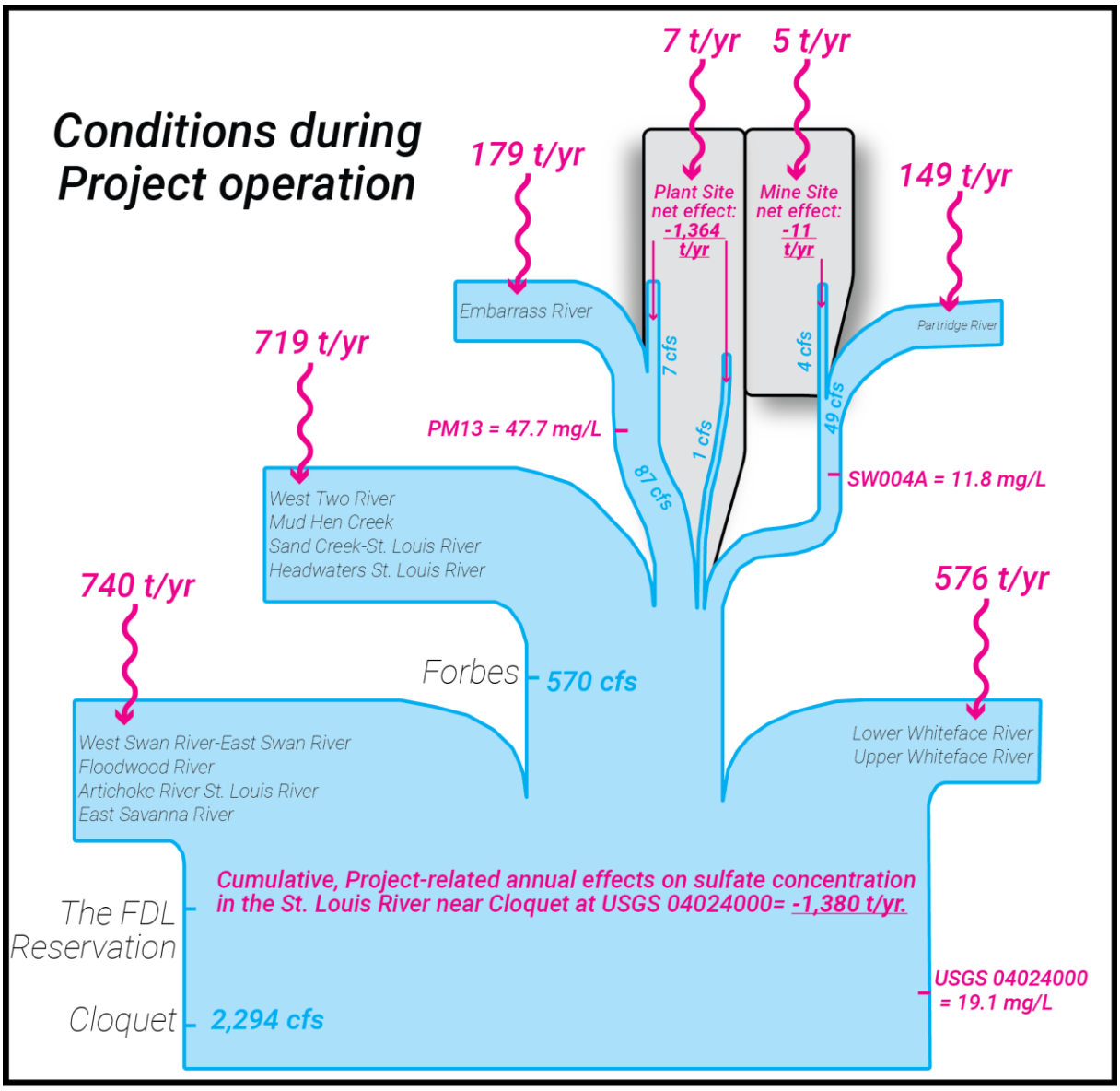
These loadings were calculated using the surface area of each watershed, an average precipitation of 29.8 inches per year (MDNR, 2015), and an average sulfate concentration of 0.5 mg/L, as measured from 2010 to 2020 by the National Atmospheric Deposition Program at the Marcell Station, approximately 60 miles west of the Project (NADP NTN, 2022).

Figure 7 – Comparison of sulfate loadings to various parts of the St. Louis River watersheds under existing conditions. Total sulfate concentration mg/L in surface water at monitoring locations PM13, SW004A, and USGS 04024000 decrease during project operation (Table 5-6, Barr, 2017).



Notes: Wavy magenta lines represent sulfate loadings via precipitation. Loading values represented on these diagrams were compiled from Table 5-6 from Barr (2017) and the National Atmospheric Deposition Program's National Trends Network site MN16. The small, horizonal magenta tick marks along the flow path of the St. Louis River and its tributaries mark the relative general location of evaluation points and indicate the concentration of sulfate at that evaluation point. Blue text indicates the approximate volume of flow at several different locations along the flow path of the St. Louis River and its tributaries to provide a sense of the magnitude of dilution from the Project. Abbreviations: cfs = cubic feet per second, FDL = the Fond du Lac Band, t = metric ton, yr = year.

Figure 8 – Comparison of sulfate loadings to various parts of the St. Louis River watersheds under operational conditions. Total sulfate concentration mg/L in surface water at monitoring locations PM13, SW004A, and USGS 04024000 decrease during project operation (Table 5-6, Barr, 2017).



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4. Conclusions

Key conclusions of this memo are:

- Precipitation is the dominant source for mercury loading to the St. Louis River watershed. As designed, the Project will reduce, via Project water management and treatment actions, the mercury load in the St. Louis River at Cloquet, immediately downstream of the FDL Reservation.

- The project will reduce, from existing conditions, sulfate loadings to the St. Louis River at Cloquet, immediately downstream of the FDL Reservation, by approximately 1,380 t/yr during Project operation. Any reduction in sulfate loading will inhibit methylmercury production both within peat-bearing wetland communities adjacent to the Project but also within diverse riparian wetland communities downstream in the St. Louis River watershed.

5. References

Barr Engineering Company, 2017. *Cross-Media Analysis to Assess Potential Effects on Water Quality from Project-Related Deposition of Sulfur and Metal Air Emissions*. October 31, 2017.

Jacobson Hedin, Kari, 2021. *Fond du Lac Reservation Nonpoint Source Assessment Report*. February 2021.

Minnesota Department of Natural Resources, 2015. *NorthMet Mining Project and Land Exchange, Final Environmental Impact Statement*. November 2015.

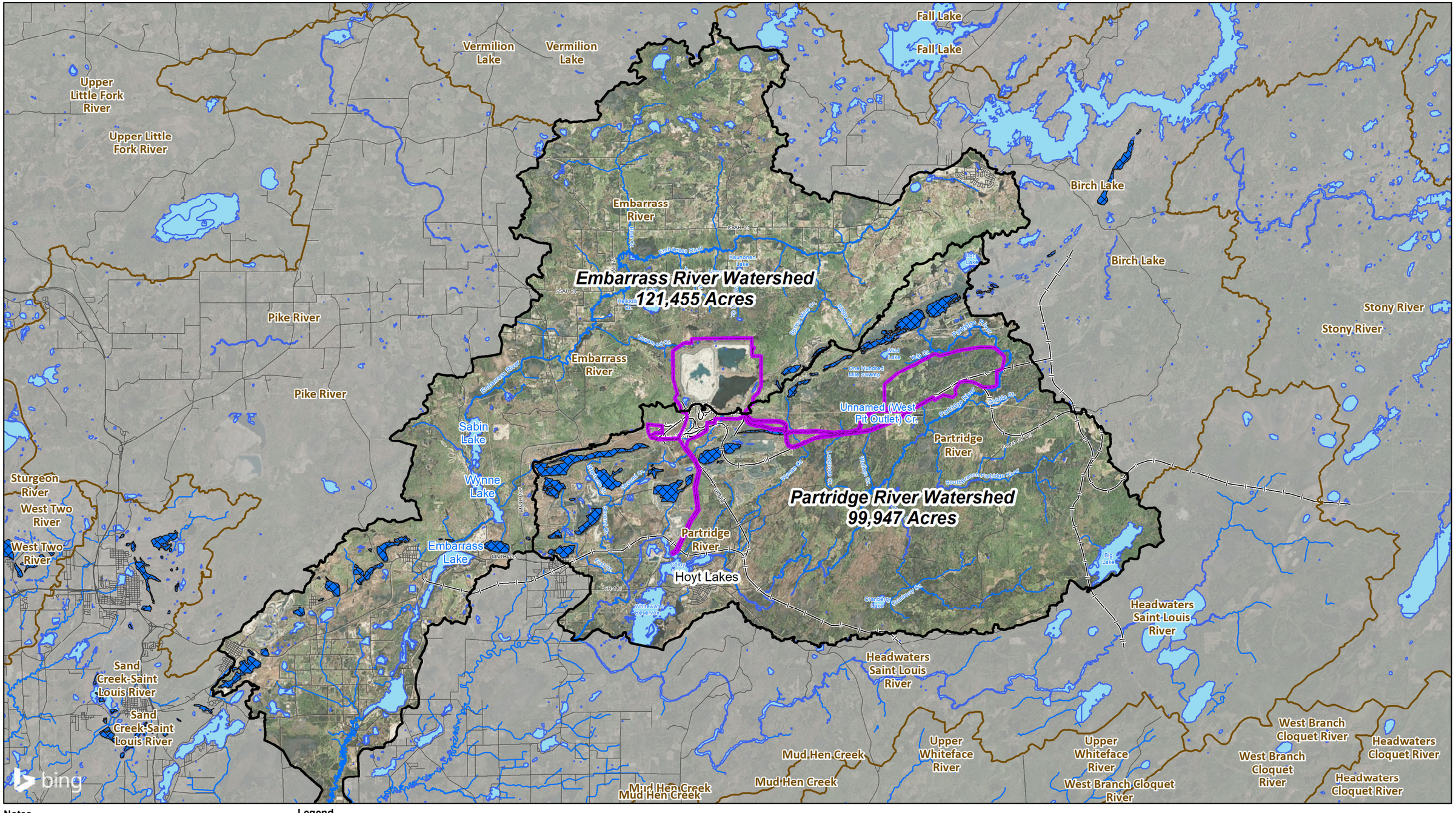
Minnesota Pollution Control Agency, 2013. Mercury State of the Knowledge. Minnesota Pollution Control Agency. October 29, 2013. 31 pp.

National Atmospheric Deposition Program: Mercury Deposition Network, Site MN16, 2022. Accessed on January 12, 2022. <https://nadp.slh.wisc.edu/sites/mdn-MN16/>.

National Atmospheric Deposition Program: National Trends Network, Site MN16, 2022. Accessed on January 12, 2022 <https://nadp.slh.wisc.edu/sites/ntn-MN16/>.

The Fond du Lac Band of Lake Superior Chippewa, 2021. *Notification of Objection to NorthMet Mine Project, U.S. Army Corps Proposed Permit MVP-1999-05528-TJH*. August 3, 2021.

Attachment 1
Figures 1 and 2



Notes

1. Basemap from Esri and its data suppliers.
2. Watershed boundaries correspond to state and USGS databases and water quality modeling subdivisions.
3. This map depicts watershed boundaries and water basins, does not depict potential impacts.
4. NHD features are created from MDNR 24K Streams and 1:24,000 USGS quadrangle maps. Due to previous disturbance, data sources may show watercourses that no longer exist.

Legend

- Roads
- Dunka Road
- Existing Private Railroad
- Rivers and Streams[2]
- Existing Pit Lakes
- Lakes and Open Water
- Facility Boundary
- Embarrass and Partridge River Watersheds
- USGS HUC-10 Watershed

PolyMet Mining

Foth

N

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION

PREPARED BY:	JVG	DATE:	FEB.'22
REVIEWED BY:	AKM	DATE:	FEB.'22
APPROVED BY:	AKM	DATE:	FEB.'22

POLYMET MINING

FIGURE 1

PARTRIDGE RIVER AND EMBARRASS RIVER WATERSHEDS

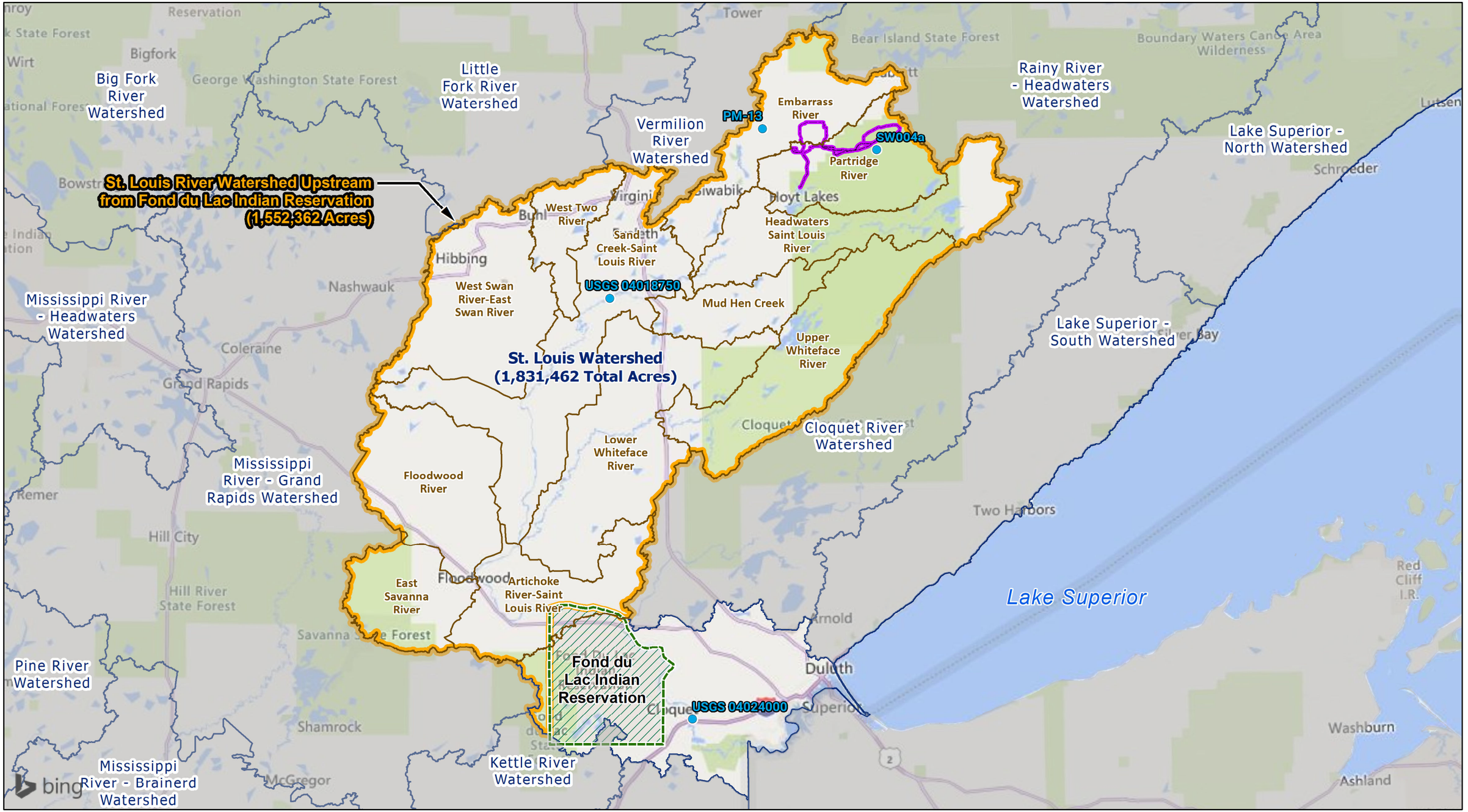
Scale: 0 1.5 3 Miles

Drafted by: BJW1

Date: FEBRUARY 2022

Project No: 21P239

Path: Q:\PolyMet Mining\21P293\GIS\mxd\Litigation Support\Atmospheric Sources of Mercury Memo\Figure 1 - Watershed Boundaries.mxd Date: 2/22/2022



NOTES:
1. Basemap from Esri and its data suppliers.
2. Watershed boundaries correspond to state and USGS databases and water quality modeling subdivisions.
3. This map depicts watershed boundaries and water basins, does not depict potential impacts.

LEGEND

- Monitoring Location
- Fond du Lac Indian Reservation
- St. Louis WatershedUpstream from Fond du Lac Indian Reservation
- Major Watershed Boundary
- USGS HUC-10 Watershed

N

Foth Infrastructure & Environment, LLC				POLYMET MINING
REVISED	DATE	BY	DESCRIPTION	**FIGURE 2**
				ST. LOUIS WATERSHED BOUNDARY WITH FOND DU LAC INDIAN RESERVATION
PREPARED BY:	JVG	DATE:	FEB.'22	
REVIEWED BY:	AKM	DATE:	FEB.'22	Scale: 0 5 10 Miles — Date: FEBRUARY 2022
APPROVED BY:	AKM	DATE:	FEB.'22	Drafted by: BJW1 — Project No: 21P239

Path: Q:\PolyMet Mining\21P293\GIS\mxd\Litigation Support\Atmospheric Sources of Mercury Memo\Figure 2 - StL Watershed.mxd Date: 2/22/2022

Attachment 2
Resumes

Stephen V. Donohue, P.H.

Vice President - Mining

Education
M.S. University of Wisconsin-Madison
B.S. Natural Science, University of Wisconsin-Madison

Professional Registrations/Certifications
- Professional Hydrologist - WI
- Professional Soils Scientist - WI

Litigation Highlights
- 2007 – Contested Case Hearing: Flambeau Mine (Rio Tinto) Certificate of Completion for Reclamation.
- 2008 – Contested Case Hearing: Eagle Mine (Rio Tinto) Mining Permit/ Environmental Impact Assessment and Groundwater Discharge Permit.
- 2012 – Clean Water Act Citizens Lawsuit: Plaintiff Action in Federal Court Against Flambeau Mining Company (Rio Tinto) alleging water quality impairment of Flambeau River
- 2018 – Contested Case Hearing: Back Forty Mine (Aquila Resources) Mining Permit/Environmental Impact Assessment.
- 2019 – Contested Case Hearing: Back Forty Mine (Aquila Resources) Wetlands Permit. Case Pending.

Key Expertise
- 30 years of professional experience, much of it focused on permitting complex mining projects in the Great Lakes region

Steve Donohue, P.H., has over 30 years of experience with expertise in permitting complex metallic mining projects. Mr. Donohue has led project teams on high-profile projects integrating feasibility studies, environmental permitting, mine closure, compliance and environmental impact analyses. He has worked with his clients to develop mine development, regulatory, and permitting strategies that incorporate the technical, legal, and public relations needs of the project. Mr. Donohue has provided litigation support to his clients. Mr. Donohue served as Rio Tinto's Lead Witness for the Eagle Project Contested Case Hearing and served as Aquila Resources' lead witness in the Contested Case Hearing for the Back Forty Project. Part of his responsibilities to his clients includes significant public involvement through multiparty meetings with public interest groups and regulatory agencies. He is routinely involved in educating state and federal legislators on behalf of his clients. Mr. Donohue's expertise in his profession has been recognized through his appointment to the Board of Trustees for the American Exploration and Mining Association and through his three appointments by Wisconsin Governors Thompson, McCallum, and Doyle to the Wisconsin Examining Board of Professional Geologists, Hydrologists, and Soil Scientists. Mr. Donohue is a past Chairperson of the Hydrology Section and the Joint Board.

Relevant Experience

Rio Tinto/Kennecott Exploration Company, Tamarack Project. In 2017, Foth was retained to assist Rio Tinto in the completion of the Conceptual Study for the potential development of the Tamarack copper-nickel resource in northeastern Minnesota. Steve led the Foth team's work effort on this project which included an assessment of all regulatory requirements, critical data needs including hydrologic studies for subsequent stage-gated study phases, costing and a risk assessment related to water resources, regulatory, social, and developmental risks.

Highland Copper Company, Copperwood Project. In 2017, Foth was retained as a Lead Environmental Consultant to lead the effort to secure permit amendments for the Copperwood Project in the Upper Peninsula of Michigan. In 2018, Foth secured the Amended Mining Permit and Air Permit for the reconfigured/ optimized project.

Aquila Resources Inc., Back Forty Project. In 2015, Aquila Resources acquired ownership of the Back Forty Project and financing to support permitting and feasibility studies for the development of the project. Foth was awarded the prime contract to lead the engineering and science-based work for the permitting and environmental review effort. Steve is the principal in charge of this effort. Tasks completed under Steve's direction included completion of the Environmental Impact Assessment including all baseline reports, geochemical characterization of mine waste materials, completion of the tailings and waste rock storage facility design, completion of mine water management plan including process level engineering of the wastewater treatment plant, completion of hydrologic modeling, completion of the Mine Permit Application, Air Permit Application, NPDES Permit Application, and Wetlands Permit Application. Steve worked as a strategic business partner with Aquila on the planning of the project to aid in the securing of finance agreements to fund the project. Steve recently served as the lead expert witness for the contested case hearing challenging the Mine Permit. In this capacity, Steve provides testimony related to the Mine Permit and Environmental Impact Assessment and in particular testimony related to the adequacy of hydrologic baseline studies and groundwater modeling studies.

Stephen V. Donohue, cont.

Professional Affiliations & Organizations

- Past Chair of the Wisconsin Examining Board of Professional Geologists, Hydrologists, and Soil Scientists - Past Chair of the Hydrology Section
- Society for Mining, Metallurgy and Exploration
- Prospectors & Developers Association of Canada
- American Exploration & Mining Association – Great Lakes Mining Committee
- Board of Directors - Mining Minnesota
- Board of Trustees for the American Exploration and Mining Association

Publications/Presentations

- Donohue, S.V., 2018. Prospects for Renewal of the Mining Industry in Wisconsin. Society for Mining, Metallurgy & Exploration. Annual Conference & Expo. February 25 -28, 2018. Minneapolis, Minnesota.
- Donohue, S.V. and F. Ongaro, 2017. Policies, Politics, and Projects: Are the Midwest States Inviting Investment? American Exploration & Mining Association. 123rd Annual Conference. December 4 -8, 2017. Reno, Nevada.
- Eykholt, G.R., J.B. Manchester, S.V. Donohue & J.C. Cherry (2009), "Heat and Mass Balance Modeling of a Subaqueous Tailings Disposal Facility," Tailings and Mine Waste '08, Taylor & Francis Group, London, pp. 35-48.
- Manchester, J.B., G.R. Eykholt, S.V. Donohue & J.C. Cherry (2009), "Water Chemistry and Metal Cycling in a Subaqueous Tailings Disposal Facility," Tailings and Mine Waste '08, Taylor & Francis Group, London. Pp. 49-62.
- Council, G.W., P.F. Anderson, S.V. Donohue. Crandon Mine Permit Application: A Modeling Odyssey. Modflow 2001 and other Modeling Odysseys Conference September 11-14, 2001.
- Donohue, S.V. May 5, 2000. Development of a Surface Water Mitigation Strategy for the Proposed Crandon Mine in Forest County, Wisconsin. Upper Peninsula Section SME Meeting.

Twin Metals Minnesota (Antofagasta). Twin Metals Minnesota is seeking to develop a large underground copper-nickel mine near the Boundary Waters Canoe Area Wilderness in northern Minnesota. The regulatory process will involve oversite by numerous state and federal agencies including the MDNR, MPCA, USACE, BLM, USFS, and USEPA. In 2015 Foth was awarded the contract as the Lead Environmental Consultant and was also selected to lead the hydrogeologic and water resources studies. In these roles, Foth will serve as one of the primary consultants to TMM for NEPA, MEPA, and permitting efforts. Steve is the principal in charge of Foth's contract obligations and serves in an advisory capacity to TMM for project activities including hydrologic studies.

Flambeau Mining Company. Principal-in-Charge for the project to engineer and construct an improved stormwater management system for runoff from the Industrial Outlot including the construction of a passive treatment wetland for attenuation of copper.

Flambeau Mining Company Lawsuit. In January 2011, the Wisconsin Resources Protection Council and others filed a federal lawsuit against Flambeau Mining Company alleging violations of the Clean Water Act. Having worked with Flambeau Mining Company for more than 25 years, Foth was retained to provide expert witness testimony on behalf of Flambeau Mining Company. Steve served as a lead witness on behalf of Flambeau Mining Company on issues related to site hydrology, hydrogeology, and water chemistry. The federal judge's ruling found that the Flambeau Mine was an exemplary operation and had not impaired water in the Flambeau River as alleged by the plaintiffs.

PolyMet Mining, Inc. For the better part of a decade, PolyMet Mining Inc. has been working on securing a positive EIS and permitting decision on the proposed NorthMet Project in northern Minnesota. Adjacent to the iron range, the NorthMet Project represents the first copper-nickel development in the state of Minnesota. In January 2012, Foth was retained to provide input to the consulting team working to address agency concerns about the project. Foth has also been tasked with providing peer review of hydrologic modeling studies and assisting in the preparation of the Permit to Mine Application, analysis of Financial Assurance and other critical documents leading to a permissibility decision by the regulatory agencies. Steve serves as principal-in-charge of this effort.

Kennecott Eagle Project. Principal-in-Charge and project manager for the permitting effort for the Kennecott Eagle Project in Marquette County, Michigan. Tasks included the development of a permitting plan for the project and development of permitting documents including the Mine Permit Application, Environmental Impact Assessment, Groundwater Discharge Permit Application, Air Permit Application, State Surface Use Lease Application, Soil Erosion, and Sediment Control Permit, Storm Water Permits, Septic Permit, Potable Well Permit, and Local Permit Application. Permit applications included design of the development rock storage area, facility plan, stormwater management plan, contact water storage basins, wastewater treatment plant, treated water infiltration system, reclamation plan, and financial assurance requirements. Project permits were issued in December 2007. Worked as a consultant with Kennecott's legal team on the preparation of litigation strategy, and preparation of expert witness testimony in support of environmental permits issued by the state of Michigan. All environmental permits and the impact analysis were successfully defended in court.

Stephen V. Donohue, cont.

- Donohue, S.V., G.W. Sevick, G.J. Berg, G. Reid. 1999. "Development of a Surface Water Mitigation Strategy for the Proposed Crandon Mine in Forest County, Wisconsin." Sudburg '99 Mining and the Environmental II Conference.
- Anderson, P.F., G.W. Council, R.T. Hagemeyer, S.V. Donohue. 1998. "Numerical Simulation of the Effect on Groundwater and Surface Water of the Proposed Crandon Mine." Presented at the American Water Resources Association Wisconsin Section 22nd Annual Meeting, Green Lake, Wisconsin. March 5-6, 1998.
- Donohue, S.V., P.F. Anderson, G. W. Council. 1998. "Project Overview of Groundwater Studies for the Proposed Crandon Mine." Presented at the American Water Resources Association Wisconsin Section 22nd Annual Meeting, Green Lake, Wisconsin. March 5-6, 1998.
- Donohue, S.V. 1997. "Geographical Information Systems (GIS): Emergence of a Cost-effective Management Tool." Presented at the New World of Environmental Regulation...Challenges for the Future Conference sponsored by DeWitt, Ross & Stevens, S.C. and Foth & Van Dyke, De Pere, Wisconsin. April 9, 1997.
- Donohue, S.V., P.F. Anderson, G.W. Sevick. 1997. "Crandon Mining Groundwater Studies." Presented at the Society of Environmental Toxicology and Chemistry-Midwest Chapter 5th Annual Meeting, Green Bay, Wisconsin. April 2-4, 1997.
- Donohue, S.V., G.W. Sevick. 1997. "Studies on Groundwater Lake Interactions near the Proposed Crandon Mine Site in Forest County, Wisconsin." Presented at the Society of Environmental Toxicology and Chemistry-Midwest Chapter 5th Annual Meeting, Green Bay, Wisconsin. April 2-4, 1997.
- Cheng, X.X., S.V. Donohue, S.J. Laszewski, S.G. Lehrke. 1993. Temporal and Spatial Non-Uniformity of Recharge in Northern Illinois. American Geophysical Union Spring Meeting.

Kennecott Humboldt Project. Principal-in-Charge for the permitting effort for the Kennecott Humboldt Project in Marquette County, Michigan. Tasks included the development of a permitting plan for the project, baseline studies, and development of permitting documents including the Mine Permit Application, Environmental Impact Assessment, National Pollution and Discharge Elimination System Permit Application, Air Permit Application, Soil Erosion, and Sediment Control Permit, Stormwater Permits, Septic Permit, Potable Well Permit, and Local Permit Application. Mine Permit Application included evaluation of historic mine impacts, reclamation plan, and financial assurance requirements.

HudBay/Aquila Resources, Back Forty Project. Principal-in-Charge for the permitting and environmental impact analysis for the Back Forty Project in Stephenson County, Michigan. This work commenced in 2009 when Foth was retained as the Prime Consultant to lead the permitting process. Foth was tasked with developing permitting strategy in consultation with HudBay's outside legal counsel and participating in community education programs. Other tasks include subsurface geotechnical investigations for tailings facility design, bedrock hydrogeologic studies, reviewing commissioned baseline environmental reports, geochemical characterization of waste rock and tailings, preparation of mining permit application, preparation of environmental impact assessment, design of water treatment system, design of waste rock and tailings storage facilities, preparation of water discharge permit application, preparation of air permit application and coordination with regulatory agencies.

Twin Metals, Minnesota. Principal-in-Charge of Foth team that completed scoping study on the use of open-pit mine site for tailings management. Project effort evaluated environmental liabilities associated with various options for using the open pit for tailings disposal. Both subaqueous and dry stack placement methods were evaluated. Conceptual level cost estimates for construction, operation, and closure were prepared.

Confidential Client. Principal-in-Charge of Foth team that completed scoping study on the use of open-pit mine site for tailings management. Project effort evaluated environmental liabilities associated with various options for using the open pit for tailings disposal. Both subaqueous and dry stack placement methods were evaluated. Conceptual level cost estimates for construction, operation, and closure were prepared.

Centerra Gold (Mongolia). Principal-in-Charge for Foth team completing various tasks for Centerra Gold's mining operations in northern Mongolia. Tasks have included completion of a Detailed Environmental Impact Assessment for the proposed Gatsuurt mine and a Detailed Environmental Impact Assessment for modifications of the mill facility at the existing Boroo Mine. Other studies at Gatsuurt include geochemical characterization, hydrogeologic investigations, waste rock storage facility design, and reclamation and water treatment planning.

Confidential Client Legislative Assistance. Work for the confidential client to assist with drafting a new state mining law regulating metallic mining.

- Donohue, S.V., S.J. Laszewski, F.J. Doran. 1992. Risk of Increased Contamination of a Dolomite Aquifer from Pumping Induced Drawdown, Fifth International Solving Groundwater Problems with Models Conference, Association of Groundwater Scientists and Engineers, Dallas, Texas. February 11-13, 1992.
- Kung, K-J.S., and S.V. Donohue. 1991. Improved Solute Sampling Protocol in a Sandy Vadose Zone Using Ground-Penetrating Radar, Soil Science Society of America, J. 55: 1543-1545.
- Donohue, S.V., X.X. Cheng, K-J.S. Kung. 1990. Improving Solute Sampling Protocols in Sandy Soils by Using Ground-Penetrating Radar, Third International Conference on Ground-Penetrating Radar, U.S. Geological Survey, Denver, Colorado. May 14-18, 1990.

Kennecott Tamarack Project. Principal-in-Charge of the baseline studies for the Kennecott Tamarack Project in Aitkin County, Minnesota. The Tamarack Project is high-grade nickel and copper peridotite intrusion west of Duluth, Minnesota. In 2006, Foth was commissioned to begin environmental studies on the project in anticipation of future environmental review and permitting requirements. To date, Foth has initiated studies on surface water hydrology, groundwater hydrology, hydraulic characterization of the Quaternary deposits and bedrock system at the potential mine site, geochemical characterization of potential development rock and regulatory coordination.

Crandon Mine Project. Project Manager for the formerly proposed Crandon Mine Project in northeast Wisconsin. Responsible for management of the permitting budget and activities of Foth Infrastructure & Environment professional staff and numerous sub-consultants, and overall coordination and integration of technical studies into permitting documents. Key project elements included preparation of an environmental impact report, development of mitigation plan for mine dewatering impacts on lakes and streams, groundwater quality performance assessment for proposed tailings facility, development of management plan for reflooded underground mine, feasibility studies for tailings and development of rock storage areas, socioeconomic analysis and addressing complex regulatory issues for a project that experienced significant public opposition. Attended and participated in numerous meetings with the Wisconsin Department of Natural Resources, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Geological Survey, Native American Tribes, legislative officials, concerned environmental organizations, and the Governor's Science Advisory Council on Metallic Mining.

Kennecott Flambeau Mine Project. Principal-in-Charge for ongoing environmental monitoring of the closed and reclaimed Flambeau Mine in Ladysmith, Wisconsin. The project received in 2007 a Certificate-of-Completion for reclamation of the main mine site. Recent work includes support for ongoing litigation.

Groundwater Quality Assessment for Mine Closure. Lead Groundwater Hydrologist for a project to evaluate future groundwater quality compliance after backfilling and reclamation of a copper mine operated by Flambeau Mining Company in Ladysmith, Wisconsin.

Renard Island Closure Plan. Project Manager for the development of a closure plan for a confined disposal facility in the Bay of Green Bay. The CDF is contaminated with heavy metals and PCBs. The closure plan assessed capping options and the contaminant flux from the island under different closure scenarios.

Cedar Creek. Principal-in-Charge for the Amcast Industrial Corporation Cedarburg Superfund Project in Cedarburg, Wisconsin. The project included site characterization of PCB-contaminated environmental media and feasibility study on remedial alternatives including dredging and capping of contaminated sediments.

RCRA Closure Plan. Project Manager for preparation of an RCRA closure plan for Modern Plating Corporation in Freeport, Illinois. The feasibility study included conceptual design plans for the disposal of metal plating sludge and contaminated soils in a double-lined and capped landfill referred to as a Corrective Action Management Unit or CAMU. The closure plan also addressed the development of site-specific soil and groundwater cleanup objectives.

North American Exploration Projects. Principal-in-Charge of hydrologic monitoring programs for clients conducting exploration projects in North America in support of Order-of-Magnitude studies at potential mine sites.

Andrea K. Martin, P.E.

Lead Environmental Engineer

Role:

Education
B.S., Chemical Engineering, Michigan Technological University, 1981
M.S., Environmental Science & Policy, University of Wisconsin Green Bay, 2005

Professional Registrations/Certifications
- Registered Member – Society for Mining, Metallurgy & Exploration
- Executive Committee Member and 2021-2022 Chair– Society for Mining, Metallurgy & Exploration Environmental Division
- Professional Engineer – Wisconsin, Illinois, Michigan, Minnesota

Honors/Awards
- 2013 Recipient of SME President's Citation Award for Local Section Service.

Previous Employment
- Years of previous experience: 16
- Chicago Bridge & Iron Company

Key Expertise
For Mining and Other Industrial Projects:
- Environmental and General Permitting
- Environmental Impact Assessment
- Air Quality Programs
- Water Management Programs
- Regulatory Documentation and Reporting
- Remediation and Superfund Permitting
- Process Safety Management/Risk Management Plan
- General Regulatory Strategy and Review

Ms. Martin has over 30 years of experience in engineering, with 25 years in the environmental regulatory arena. Andrea concentrates on environmental issues associated with industrial, mining, and remediation projects, including preparation of permit applications, reports for Environmental Impact Statements and Assessments, compliance program development and maintenance, and interfacing with regulatory agencies. Air and water related permitting for industrial, mining, and CERCLA sites have been a primary focus. Andrea specializes in analysis of air deposition impacts including evaluation of impacts to water, soils, and other comparative criteria. Andrea has provided expert testimony for several mining related permits. She has strong skills in comprehensive document development and technical writing. Besides preparing project deliverables, Andrea serves many projects in oversight role as a Technical and Overall Document Reviewer. Previously, Andrea worked for a construction company where she gained design, engineering, estimating, and plant start-up experience. Andrea received her Bachelor of Science degree in Chemical Engineering from Michigan Technological University and a Master of Science degree in Environmental Science & Policy from University of Wisconsin-Green Bay. She holds Professional Engineer's licenses in Wisconsin, Michigan, Illinois, and Minnesota. Andrea is active in Society for Mining, Metallurgy & Exploration (SME), Executive Committee Member of the Environmental Division, and is currently Wisconsin Section Chair. She is an SME Registered Member and a Qualified Person pertaining to NI 43-101 for the environmental sections.

Relevant Experience

Aquila Resources Back Forty Project (2010 to present). Lead on Environmental Impact Assessment and NPDES and Dam Safety Permit applications and amended permit applications; contributor to the Air Permit and Mine Permit Applications; lead on recent amended permit applications. Development of these applications included expertise in mill processes, emissions inventory, water balance, preliminary conceptual wastewater treatment design, and understanding of applicable regulations. As the Project permitting has advanced, Andrea testified in one successful contested case hearing resolving the 2016 Mining Permit; provided on-site support in the wetland permit contested case; and will continue involvement in ongoing litigation.

Tamarack Project, Mine Project Development. Oversight of quarterly and annual monitoring reports on groundwater and surface water baseline data collection. Involved in the miscellaneous reports supporting the project since 2008 including the 2017 Conceptual Study and wetland permit applications for drilling activities.

Served as Qualified Person for NI 43-101 reports in the environmental sections and provided additional support for mining clients.

PolyMet Mining, Inc. (2011 to 2015). Technical Lead on several significant documents including analysis of environmental impacts due to air emissions from the project. Performed overall technical review and coordination on large analyses and applications underway to permit the project. Provided ongoing strategic consulting on a variety of issues as the project team responds and substantiates its investigative studies, design, and operations planning.

Twin Metals Minnesota. Prepare miscellaneous alternative analyses assisting in navigating environmental review process and permitting.

Andrea K. Martin, cont.

Publications/Presentations

- Martin, Andrea. "Regulations: What's in Store for Aboveground Tank Management." Materials Evaluation. July 1994.
- Martin, Andrea, and John Badrock, Robert Coutu, Norman Johnson. "Bulk Heating Cleans Paraffinic Bottoms from Crude Tanks." Oil & Gas Journal. February 1995.
- Martin, Andrea. "A Perspective of Mining Emissions and Cumulative Impact Analysis". Society for Mining, Metallurgy & Exploration, 85th Annual Meeting of the SME Minnesota Section, Duluth Minnesota. April 17-18, 2012.
- Martin, Andrea. "Adaptive Environmental Management Plans and Practices". Responsible Mining: Case Studies in Managing Social & Environmental Risks in the Developed World (Chapter 25). 2015.
- Martin, Andrea. "Adaptive Environmental Management Plans and Practices: Managing Environmental Impacts at Mines". 2014 Society for Mining, Metallurgy & Exploration Annual Meeting & Exhibit, Salt Lake City, Utah.
- Martin, Andrea. "A Perspective on Mercury: Air Emissions, Water Discharges, the Environment, and Regulations". 2015 Society for Mining, Metallurgy & Exploration Annual Meeting and Exhibit, Denver, Colorado.
- Martin, Andrea. "Major Contributors to Mine Water Treatment Design for Nonferrous Mines." 2017 Society for mining, Metallurgy & Exploration Annual Meeting and Exhibit, Denver, Colorado.
- Martin, Andrea. "The Impact of Native American Concerns on Mine Development and Operation." 2018 Society for Mining, Metallurgy & Exploration Annual Meeting and Exhibit, Minneapolis, Minnesota.
- Martin, Andrea. "Litigation: Strategies to Strengthen the Case for Your Permit." 2019 Society for Mining, Metallurgy & Exploration Annual Meeting and Exhibit, Denver, Colorado.

Honors/Awards

- 2013 Recipient of SME President's Citation Award for Local Section Service

Kennecott Eagle Project, Copper Nickel Mine, New Project (2005 to 2009). Lead on air permit application, construction storm water application. Contributed to Mining Permit Application, Environmental Impact Assessment, and overseeing biological and archaeological study preparation. Testified at administrative hearing assisting in upholding the issuance of the permits. Assisted with state lease negotiations. Established and maintained productive relationships with regulatory agency personnel. Prepared many analyses and responses supporting various permit applications.

Kennecott Humboldt Mill Project, Ore Processing Mill, Brownfield Refurbishment (2007 to 2009). Lead on air permit application, NPDES permit application, construction storm water permit application. Contributed to Mining Permit Application, Environmental Impact Assessment, Cumulative Impact (Air Deposition) Analysis. Prepared many analyses and responses supporting various permit applications.

Antofagasta-Duluth Metals Joint Venture (2009 to 2010). Due diligence on property transaction. Provided technical information as part of due diligence efforts for a confidential international mining company that was considering a joint venture on a base metal mining project in the upper Midwest. Foth's tasks included reviewing ongoing environmental studies that have been commissioned by the current owner of the prospective mine site and review of conceptual mine plans, permitting requirements, and identification of potential fatal flaws in the project.

Copperwood Resources Inc., Mine Project Development. Amended permit applications were prepared by Foth. Co-lead the air permit application preparation.

Northern States Power of Wisconsin Permit and Compliance Lead on Superfund Remediation Project, Ashland Wisconsin. Provided permit equivalency evaluation and permit application preparation for miscellaneous permits pursued with the city of Ashland. Acted as liaison between the City and the Foth Envirocon Joint Venture. Lead air permit compliance of Medium Temperature Thermal Desorption system of subcontractor.

Confidential Client. Project Manager on Process Safety Management Program Development project. Provided coordination and management to the client-Foth team developing a PSM program for a newly constructed process. The process technology originates from outside the United States, presenting additional translation and regulatory challenges.

Wisconsin Storm Water Permitting for Nonmetallic Mining. Developed management tools and methods to address permitting and compliance requirements for industrial and non-industrial sand and aggregate facilities. Strategized on methods to manage multiple facilities efficiently and cost-effectively through standardization.

Canadian Pacific Railway Litigation Project. Part of a team tasked with reviewing legacy sites undergoing litigation. Researched historical documentation to evaluate each site's contamination status and assess the timeframe of activities pertinent to the law suit issues.

Illinois Manufacturing Facility. Reviewed regulatory and environmental status, updated, and obtained permits in a manufacturing facility under EPA scrutiny with potential lawsuits, violations, and severe penalties.

Andrea K. Martin, cont.

Memberships

- Chair of Wisconsin Section Society for Mining, Metallurgy & Exploration

Birds Eye Foods, Inc., Fruit Processing Facility (2011-2012). A Lead on groundwater discharge permit application for a major modification of facility wastewater treatment facility. Served as a permit liaison during the construction and startup of the facility. Developed the Discharge Management Plan.

Modern Plating Corporation, Plating Facility. Lead on RCRA Part B Permit Renewal Application. Oversaw preparation and certified the application.

Variety of Foth Clients, Lead Client Contact. Performed environmental compliance work including preparation of air permit applications and permitting management tasks in a variety of states, annual reporting, plan preparation for spill control and storm water pollution prevention, numerous environmental compliance evaluations.

Lead preparer and certifier of SPCC Plans.

John (Jack) Gibbons, Ph.D., P.G.

Project Environmental Scientist

Education
Ph.D. Geology – University of Arizona
M.S. Geology and Geological Engineering – Colorado School of Mines
B.A. Geology and Economics – Carleton College

Professional Registrations/Certifications
- Professional Geologist (P.G.), Minnesota, #59842, 2021

Membership
- Society of Economic Geologists
- Mesabi Range Geological Society (President 2021 to 2022, Vice President 2020 to 2021, and Treasurer 2019 to 2020)

Key Expertise
- Hydrogeochemical modeling in PHREEQC and Geochemist's Workbench.
- USEPA Stage 2A Data Validation.
- Statistical analysis.
- SQL database design and management.
- Scripting in R and Python.

Previous Employment
- MineraLogic LLC (October 1st, 2018 to September 30th, 2021)
- University of Arizona (September 1st, 2012 to August 30th, 2018)
- BHP Billiton (June 1st, 2013 to August 30th, 2013 and June 1st, 2015 to August 30th, 2015)
- Duluth Metals (February 1st, 2011 to August 30th, 2012)
- Colorado School of Mines (September 1st, 2008 to January 30th, 2011)
- Arcadis (July 1st, 2007 – December 31st, 2008)

Jack Gibbons is a professional geologist with over five years of hydrogeochemical modeling and quality control and data validation experience. His hydrogeochemical modeling expertise includes pit lake chemistry, baseline groundwater assessment, evaluation of amended pit backfill chemistry, seepage characterization, and mineral speciation of kinetic test leachate. He has designed and implemented surface and groundwater quality control programs and has supported data validation programs that adhere to the USEPA Stage 2A guidelines.

Relevant Experience

Modeling of groundwater at a proposed underground copper-nickel mine to support environmental permitting, Twin Metals Minnesota, Twin Metals project, Ely, Minnesota, 2021. The client was seeking to perform scoping of groundwater issues to identify key items that would further focus pre-permitting baseline characterization. Groundwater data was modeled in Geochemist's Workbench to both characterize different hydrogeochemical populations and to identify areas of potential mixing between discrete groundwater aquifers. The project's deep bedrock groundwater quality was also compared with groundwater monitoring records from similar underground mines, i.e., base metal mines located within the Canadian shield, to support development of a predictive groundwater quality model.

Hydrogeochemical modeling to confirm efficacy of limestone amendment to pit backfill at a closed copper-gold mine, Rio Tinto, the former Flambeau mine site, Ladysmith, Wisconsin, 2021. The client was seeking to confirm that the limestone amendment to a backfilled open pit copper-gold mine was continuing to function as a pH buffer. A hydrogeochemical model was developed in PHREEQC to verify that groundwater was continuing to remain saturated with respect to several magnesium and calcium carbonate phases. The model confirmed that slow dissolution of the limestone amendment was providing sufficient concentrations of cations and alkalinity to the groundwater to mitigate any potential future metal leaching and acid-rock drainage (ML/ARD).

Automate data validation workflow to rapidly screen historic groundwater datasets, US Department of Energy, various global nickel sulfide mines, 2020. The project needed to rapidly screen historic geochemical datasets of varying quality prior to incorporating them within a large, multi-project relational database. A script was developed in R to provide both quantitative and graphical means to automate data screening. The script incorporated quantile-quantile plots, Spearman's rank-order correlation charts, and Shewhart control plots into an R-markdown document to provide a rapid means to screen for common data quality issues. This high-level technique successfully identified unit conversion, incorrect parameter reporting, and data omission errors that were irregularly distributed across many of the datasets.