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Minnesota Environmental Data on Specific Conductance & Benthic Invertebrates in Background and Impacted Waters

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Minnesota Baseline Data

In many situations, Minnesota has the baseline data needed to protect water resources. But, the commitment and courage to analyze and use that data has often been lacking.

Specific Conductance – What is it?

- Specific conductance is an accurate, low cost, easily completed measurement directly related to salinity.
- Specific conductance measures the ability of water to conduct electricity, which is increased with salinity, and the unit of measure is microSiemens per centimeter (µS/cm).
- Specific conductance can be used to identify ionic changes in surface water that adversely impact affect aquatic life.

U.S. Environmental Protection Agency Specific Conductivity Research

EPA Guidance has set a chronic aquatic life benchmark for conductivity at 300 µS/cm for coal mining regions in West Virginia and Kentucky.

EPA: this benchmark is also expected to apply to ecoregions extending into Ohio, Pennsylvania, Tennessee, Virginia, Alabama, Maryland.

EPA: methods used to derive specific conductance guidance are applicable where water is affected by calcium, magnesium, sulfate and bicarbonate ions and natural background levels have 6-10 pH and lower salinity than the discharge:

> *"[T]he salt mixture dominated by salts of SO_4^{2-} and HCO_3^- is likely to be an insurmountable physiological challenge for some species"*

Reference: EPA, A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams, Final Report, EPA/600/R-10/023F, March 2011, p. xv.

Minnesota – Data on Specific Conductance PolyMet Documents – Impacted Waters

- No data on specific conductance in PolyMet NorthMet Supplemental Draft Environmental Impact Statement.
- Some Data in found in the Barr Engineering 2011 NPDES Field Studies Report for the LTVSMC Tailings Facility.
- LTVSMC Tailings Discharge to Second Creek:
  1,206 µS/cm (2010) 1,019 µS/cm (2011)
- On average, LTVSMC tailings discharge specific conductance measured 14 times that of Bear Creek reference stream.

Reference: Barr Engineering, NPDES Field Studies Report – SD026, Reference Barr 2011i to the PolyMet NorthMet Supplemental Draft EIS.

Minnesota – Data on Specific Conductance PolyMet Documents – Less Impacted Waters

Mine site sampling for specific conductance is provided in technical documents prepared since PolyMet SDEIS was released.

Mine Site Location	**Specific Conductance**		
	Average µS/cm	Range µS/cm	Sample Number
Longnose Creek (LN-1)	80.5	36.6 - 138	8
Wetlegs Creek (WL-1)	81.7	34.6 - 124.9	8
Mine Site Unnamed Creek (WP-1)	39.5	20.9 - 72.3	6

Reference: Barr Engineering, Summary of 2013 NorthMet Groundwater and Surface Water Monitoring Data (March 28, 2014).

Citizen Specific Conductance Sampling

LOCATION	COND µS/cm	DATE	GPS N	GPS W	MINING IMPACT
Arcelor-Mittal Tailings Pond	677	9/14/14	47°36'07.93"	92°27'16.22"	X
Birch L Bob Bay	197	9/29/14	47°43.862'	91°48.808'	X
Buhl Pit L	289	9/1/14	47°29.866'	92°46.767'	X
Canisteo Mine Pit	504	8/31/14	47°18.034'	93°24.931'	X
Dark R	1334	10/13/14	47°37.800'	92°45.866'	X
Dark R	1462	10/13/14	47°37.405'	92°43.908'	X
Kinney Pit L	943	9/1/14	47°30.822'	92°43.618'	X
Miners Lake-Ely	467	8/17/14	47°54'39.37"	91°51'37.06"	X
Partridge R	554	10/5/14	47°31.218'	92°11.507'	X
Second Cr	1958	8/23/14	47°31.193'	92°11.510'	X
Second Cr	1914	10/5/14	47°30.218'	92°11.507'	X
AVERAGE CONDUCTANCE	**936**				
Bear Island R	53	8/23/14	47°48.121'	91°53.586'	
Birch Lake Dam	48	8/12/14	47°48'47.58"	91°47'06.36"	
Cloquet R	47	10/5/14	47°22.741'	91°37.529'	
Filson Cr	28	8/18/14	47°50.098'	91°40.455'	
Isabella L	24	8/16/14	47°48'13.45"	91°18'07.99"	
Kawishiwi R	42	8/24/14	47°55.693'	91°45.651'	
Saint Louis R	63	8/23/14	47°23.361'	92°07.272'	
Saint Louis R	55	10/5/14	47°28.858'	92°02.372'	
South Kawishiwi R	39	8/17/14	47°49.604'	91°42.982'	
Vermilion L	92	8/22/14	47°53'37.76"	92°13'02.92"	
West Twin L	25	8/30/14	47°54'09.54"	90°23'55.11"	
AVERAGE CONDUCTANCE	**47**				

Reference: Robert Tammen, Sampling Data (selected data from 124 sites sampled in Northeastern Minnesota, August to October 2014)

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Application of methods from EPA Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams. Bruce & Maureen Johnson, former regulatory staff, citizen scientists.

- Focus on Ecoregions 50n, 50t, northern portion of 50p.
- Specific conductance background levels and ions.
- Macroinvertebrate genera – EPA comparison & sensitivity.
- Benchmark: EPA XC95% - if 5 % of native macroinvertebrate genera are extirpated, it indicates unacceptable pollution.

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota, Draft Report (2015)

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Many Sources of Data:

- Minnesota Regional Copper-Nickel Study (1970's ecological data providing rigorous baseline assessment of a 500-square mile area where mining was contemplated)
- Minnesota Pollution Control Agency DMRs & MPCA, *St Louis Watershed Identification Stressor Report* (Draft 2013)
- Minnesota Department of Natural Resources Section of Fisheries, Fond du Lac, 1854 Treaty Authority, *Study of the St Louis River* (2006)
- Northeast Technical Services, Cliffs Erie, Phase I Site Assessment related to Dunka Mine (2002)

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Comparison EPA Appalachian Streams & Minnesota Copper-Nickel Study Background Stream Data						
		Appalachia (EPA)			Minnesota Streams	
Parameter	Unit	Median	Maximum		Median	Maximum
Conductivity	µS/cm	261	11,646		65	1198
Hardness	mg/L	91.1	1,492		31	310
Alkalinity	mg/L	66.7	560		23	190
Sulfate	mg/L	37	6,000		7.4	630
Chloride	mg/L	5.2	1,153		2	88
Calcium	mg/L	25.1	430		7.4	80
Magnesium	mg/L	6.3	204		3.8	40

Copper Nickel study in 1970's: Minnesota stream background water chemistry has lower conductance, salinity than Appalachian streams.

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota; EPA Field-Based Aquatic Life Benchmark for Conductivity; Minnesota Cu-Ni Study.

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Benthic Invertebrates Genera in Common Appalachian and Minnesota Unimpacted Streams		
Order	**MN Genera**	**Genera in Common**
Ephemeroptera	45	18
Plecoptera	29	13
Trichoptera	56	14
Odonata	25	3
Coleoptera	12	4
Megaloptera	4	3
Hemiptera	16	1
Diptera	136	36
TOTAL:	***323***	***92***

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota; EPA Field-Based Aquatic Life Benchmark for Conductivity; Minnesota Cu-Ni Study

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Chemical Comparison of Stream Background in Copper Nickel Study with Chemical Content of Cliffs Discharge Sites - Dunka Mine (2011)				
	Cu-Ni Study Median Stream Background	Cliffs Impacts 2011 Mean		
		SD005	SD007	SW001
Specific Conductance (µS/cm)	65	1,469	2,000	960
Calcium (mg/L)	7.4	131	269	84
Magnesium (mg/L)	3.8	133	153	70
Sulfate (mg/L)	7.4	1,181	1,166	445

Average specific conductance in Dunka Mine discharge sites is 1,734 µS/cm -- nearly 27 times the median Minnesota stream background level. Downstream level in Unnamed Creek (SW001) is 14.8 times background.

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota; NTS, Cliffs Erie, Phase I Site Assessment; Minnesota Cu-Ni Study.

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Benthic Invertebrate Richness - Impacted & Background Creeks		
	Unnamed Creek Dunka Mine Impact	Background Creeks (Keeley, Filson, August Nira)
Ephemeroptera families	3	6.25
Plecoptera families	1	3.75
Trichoptera families	10	9
Ephemeroptera genera	4	11
Plecoptera genera	2	5
Trichoptera genera	13	15.8
Total EPT Generic Richness	19	33.3
Total EPT Family Richness	14	19.5

Reduction in total EPT genera richness by 43% in similar waters. EPA benchmark -- 5% reduction is unacceptable pollution

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota; NTS, Cliffs Erie, Phase I Site Assessment; Minnesota Cu-Ni Study.

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

Mine site sampling for specific conductance contained in technical documents prepared since PolyMet SDEIS released.

Lower Spring Mine Creek (impaired for fish, macroinvertebrates):
1,062 µS/cm (2010) 664 µS/cm (2011)

Upper Spring Mine Creek (impaired for fish, macroinvertebrates):
2,340 µS/cm (2010) 2,006 µS/cm (2011)

Reference: Reference Barr 2011i to the PolyMet NorthMet SDEIS

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

MPCA Draft Stressor Report:

"Fish results from the upper Embarrass River (the portion upstream of the town of Embarrass) show extremely low fish counts and limited taxa richness. . . **Two of the impaired streams in this watershed zone, Spring Mine Creek and the Embarrass River, receive water originating from mine pits**. Sampling results from these streams show elevated specific conductance and sulfate concentrations." (Minnesota Pollution Control Agency 2013)

Reference: MPCA, *St Louis Watershed Identification Stressor Report* Draft, p. 11

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

MPCA Draft Stressor Report:

"Spring Mine Creek is the only stream in this watershed zone that is listed as impaired for macroinvertebrate bioassessments. . . [A]ncillary information considered in the assessment process (elevated specific conductivity readings; invertebrate samples dominated by Gammarus and Corixidae) resulted in an impairment listing. **Symptoms of impairment observed in Spring Mine Creek include a very low relative percentage of non-hydropsychid caddisfly taxa (1.6%) and imbalance in the distribution of taxa present. Over 76% of the individuals counted were from the five most abundant taxa in the sample**. Bear Creek, the potential reference stream for this watershed zone, shows more balance among taxa present, supports more intolerant taxa, and better representation from the order trichoptera." (Minnesota Pollution Control Agency 2013)

Reference: MPCA, *St Louis Watershed Identification Stressor Report* Draft, p. 26

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

St. Louis River Specific Conductivity Upper Reaches and Mining-Impacted Middle Segment			
	Specific Conductance (us/cm)		
	Mean	Minimum	Maximum
Upper Reaches Mile 193.3 to 139.6	59	41.4	101
Mining-Impacted Segment Mile 129 to 72	260	160	386

- MDNR Fisheries, Fond du Lac and 1854 Treaty Authority research - 2006.
- Benthic invertebrates identified to genus level at 22 sites along the St. Louis River; specific conductance and other chemicals sampled in 23 sites.

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota; MDNR Section of Fisheries et al., Study of the St Louis River.

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

St. Louis River Benthic Invertebrates Richness in Upper Reaches and Mining-Impacted Middle Segment		
	Mile 193.3 to 139.6	**Mile 129 to 72**
Total Richness	(59 µS/cm Mean Conductivity)	(260 µS/cm Mean Conductivity)
Family	45	44
Genera	88	72
EPT Richness		
Family	19	17
Genera	35	27

One year of data: Reduction in total genera by 18%. Reduction in EPT (Ephemeroptera, Plecoptera, and Trichoptera) genera by 22.9%. Yet more striking is the elimination of population of certain species of invertebrates in mining-impacted waters, as reflected in the next slide.

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota (2014); MDNR Section of Fisheries et al., Study of the St Louis River (2006)

Evaluation for a Field-Based Specific Conductance Aquatic Life Benchmark in Northeastern Minnesota

St. Louis River Presence/Absence of Specific Benthic Invertebrates in Upper Segment and Mining-Impacted Middle Segment		
Order, Family, Genus, Species	**Mile 193.3 TO 139.6** (**59 µS/cm** Mean Conductivity) Population # Present	**Mile 129 to 72** (**260 µS/cm** Mean Conductivity) Population # Present
Ephemeroptera		
Baetiscicae		
Baetisca sp.	129	0
Heptageniidae		
Stenacron		
Vicarium sp.	86	1
Leptophlebiidae		
Leptophlebia sp.	114	0
Hemiptera		
Corixidae		
Hesoerocorixa sp.	62	0
Plecoptera		
Perlidae		
Paragnetina sp.	10	0

Reference: B.L. Johnson & M. K. Johnson, An Evaluation of a Field-Based Aquatic Life Benchmark for Specific Conductance in Northeast Minnesota; MDNR Section of Fisheries et al., Study of the St Louis River.

Federal Standards Applicable to Specific Conductance

- CWA §404(C): EPA authorized to prohibit dredge or fill if discharge will have an unacceptable adverse effect on fishery areas (among other uses).

- No discharge of dredged or fill material permitted if it is not the Least Environmentally Damaging Practicable Alternative (LEDPA) or if it causes or contributes to violations of any applicable water quality standard of a State (or tribe with treatment as a state); or if the nation's waters would be significantly degraded. 40 C.F.R. §230.10(a) and (b).

- Use of EPA Guidance on Specific Conductance, Memo Improving EPA Review of Coal Mining Operations under the CWA approved, both for Section 404 and Section 402 NPDES permitting. National Mining Association v. McCarthy, 758 F.3d 243 (D.C. Cir. 2014)

Reference: Clean Water Act, Code of Federal Regulations, EPA Memo Improving EPA Review of Appalachian Surface Coal Mining Operations Under the Clean Water Act, National Environmental Policy Act, and the Environmental Justice Executive Order (July 2011)

Minnesota Standards Applicable to Specific Conductance

- "Toxic pollutants" in Minnesota means pollutants that will cause "death, disease, behavioral abnormalities. . . physiological malfunctions, including malfunctions in reproduction, or physical deformation." Minn. Stat. §115.01, Subd. 20.
- Minnesota rules protect the aquatic community from toxic effects, defined to mean "the protection of no less than 95% of all the species in any aquatic community." Minn. R. 7050.0217, Subp. 1, 2.
- Minnesota's specific conductance limit of 1,000 µS/cm for irrigation, in Minn. R. 7050.0224, Subp. 2, does not protect aquatic biota.
- However, under Minnesota rules, narrative standards require that the "aquatic habitat . . . shall not be degraded in any material manner" and that "lower aquatic biota" shall not be seriously impaired of their species composition altered materially. Minn. R. 7050.0150, Subp. 3.
- In Minnesota, the most restrictive standard applies whether that standard is numeric or narrative. Minn. R. 7050.0150, Subp. 2.

Fond du Lac Narrative Standards Applicable to Specific Conductance

Toxicity: "Reservation waters shall be free from substances entering the waters as. a result of human activity in concentrations that are toxic." FDL WQS §301(e.)

Non-degradation:
"No further water quality degradation which would interfere with or become injurious to existing or designated uses shall be permitted." FDL WQS §104 (a)(1).

"A significant Lowering of Water Quality is defined as: 1) the projected or observed diminished chemical or biological integrity of Reservation surface waters . . or, 2) a new or increased loading of a pollutant from any regulated existing or new facility, either point source or nonpoint source." FDL WQS §104(b)(1).

Reference: Water Quality Standards of the Fond du Lac Reservation, Ordinance #12/98 as amended.

Northeast Minnesota – Conclusions Specific Conductance

Data is sufficient - specific conductance at 300 µS/cm poses an insurmountable challenge for sensitive macroinvertebrate species in Northeast Minnesota, including the St. Louis River watershed.

Data is sufficient – agencies should analyze specific conductance impacts before any mining project in Northeast Minnesota is granted a Clean Water Act Section 404 permit or an NPDES permit.

Additional research is needed – to determine whether 5% genera extirpation occurs at a level *below* 300 µS/cm in Northeast Minnesota ecoregions, as suggested by lower baseline specific conductance in Minnesota Copper-Nickel Study and other Minnesota data.

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Thank you to the U.S. Environmental Protection Agency for hosting the June 9, 2015 meeting with non-governmental organizations to discuss baseline environmental data in the Lake Superior Basin and for Agency consideration of available baseline data in Minnesota to apply EPA guidance and methodology developed in Appalachia to protect aquatic life in Minnesota ecoregions 50n, 50t, and the northern portion of 50p from elevated specific conductance.

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