External Memorandum

To: Dave Blaha, ERM

From: Miguel Wong and Katie Wenigmann

Subject: Colby Lake Water Quality Samples

Date: April 7, 2009

Project: 23/69 0862.00 006 001

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PolyMet has not been requested to collect Colby Lake water quality data by the Minnesota Department of Natural Resources (MDNR) or Minnesota Pollution Control Agency (MPCA), nor was sampling of Colby Lake required in the final Scoping Decision Document (SDD) of the NorthMet Project. Therefore, PolyMet did not have any Colby Lake water quality data to report as average measured conditions in Tables 5-25 to 5-27 and 7-22 to 7-24of RS74A Draft-02 (Barr, September 2008). However, in fall of 2008 Barr and PolyMet concluded it would be advantageous to collect baseline water quality data for Colby Lake to validate some of the assumptions used in the deterministic water quality predictions for Colby Lake presented in RS74A Draft-02.

This memorandum presents water quality data from sampling of Colby Lake by Barr on November 19, 2008 in Table 1. The five locations proposed for sampling (LCy-1 to LCy-5) and the five locations actually sampled (LC-1 to LC-5) are shown in Figure 1. The precise locations where the sampling took place differ from the proposed sampling locations because lake conditions prevented safe access to the originally proposed sampling locations. When the sampling crew arrived on site on November 19, 2008, Colby Lake had recently frozen over. The ice prohibited travel by boat, and the ice was too thin to allow foot traffic to the proposed sampling locations. Therefore, samples were collected at five sites close to shore (see Figure 1), at locations where the depth to bottom was approximately 4 feet.

In the fall of 2008, Barr and PolyMet identified four sources of historical Colby Lake water quality data. Those sources are listed below:

- Minnesota Department of Natural Resources Copper-Nickel Study (Siegel and Ericson, 1980),

- USGS Water Quality website (http://nwis.waterdata.usgs.gov/usa/nwis/qwdata),
- MPCA's Environmental Data Access (EDA) website (http://www.pca.state.mn.us/data/edaWater/index.cfm), and
- Minnesota Power.

The historical data is presented in Tables 2 to 7. The data included in each of these sources are not exclusive to that source, except for the Minnesota Power data. Data collected from the USGS website includes some but not all of the sampling included in the Copper-Nickel Study. The MPCA's EDA data set includes data presented in the Copper-Nickel Study, data included in the USGS data set, as well as more recent data (although the recent data does not include all parameters of interest for the NorthMet Project).

Table 8 compares the November 18, 2008 sampling of the Partridge River and the November 19, 2008 sampling of Colby Lake for parameters included in both samplings. These concurrent samplings in the Partridge River and Colby Lake were coordinated to allow validation of the basic assumption used in the water quality modeling presented in RS74A Draft-02 (Barr, 2008); that is, to validate the use of baseline water quality in SW-005 as a proxy of baseline water quality in Colby Lake.

The results of the concurrent sampling indicate that the concentration of some parameters increases going downstream in the Partridge River (e.g., aluminum, copper, and nickel), while others decrease in concentration (e.g., chloride, hardness, calcium, magnesium and molybdenum). Regardless, Colby Lake and the Partridge River directly upstream from Colby Lake (SW-005) have very similar water quality, with the exception of lead. The concentration of lead measured in the Partridge River upstream of Colby Lake (SW-005) was 2.4 µg/L; lead was not detected in Colby Lake (detection limit of 0.5 µg/L).

Table 1. Summary of Colby Lake Sampling on November 19, 2008

Location	Units	LC-1	LC-2	LC-3	LC-4	LC-5	Min	Max	Average
Field Data									
Dissolved Oxygen	mg/L	12.82	14.43	14.28	12.60	--	12.60	14.43	13.53
Oxidation Reduction Potential	mV	70.2	77.6	79.0	50.2	75.0	50.2	79.0	70.4
pH	--	7.69	7.46	7.27	7.37	7.10	7.10	7.69	7.38
Specific Conductivity at 25°C	umho/cm	117	86	104	138	91	86	138.0	107.2
Water Temperature	°C	1.49	0.42	0.55	6.09	0.13	0.13	6.1	1.74
General Parameters									
Alkalinity, bicarbonate as $CaCO_3$	mg/L	25.7	25	33.2	29.4	25.7	25	33.2	27.8
Alkalinity, total	mg/L	33.2	25	28.9	29.4	25.7	25	33.2	28.4
Chemical Oxygen Demand	mg/L	79.6	86.6	87.6	80.2	81.5	79.6	87.6	83.1
Chloride	mg/L	2.28	1.98	2.17	2.25	2.18	1.98	2.28	2.17
Fluoride	mg/L	0.1	<0.1	0.1	0.14	<0.1	0.05	0.14	0.088
Hardness, total	mg/L	61.7	44.4	54.6	68.5	45	44.4	68.5	54.8
Nitrate + Nitrite	mg/L	0.17	0.37	0.25	0.19	0.48	0.17	0.48	0.292
Nitrogen, ammonia as N	mg/L	<0.1	0.33	<0.1	<0.1	0.1	0.05	0.33	0.12
Phosphorus, total	mg/L	0.013	0.012	0.012	0.014	0.010	0.010	0.014	0.012
Solids, total dissolved	mg/L	119	108	116	128	104	104	128	115
Solids, total suspended	mg/L	1.2	1.6	1.2	10.4	<1	0.5	10.4	3.0
Sulfate	mg/L	18.7	10.1	14.4	31.7	10.8	10.1	31.7	17.14
Carbon, total organic	mg/L	29.1	30.6	31.1	27.3	29.4	27.3	31.1	29.5
Metals (total)									
Aluminum	µg/L	179	243	203	214	202	179	243	208
Antimony	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	0.25	0.25	0.25
Arsenic	µg/L	<2	<2	<2	<2	<2	1	1	1
Barium	µg/L	7.4	6.9	7	7.6	5.7	5.7	7.6	6.9
Beryllium	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	0.1	0.1	0.1
Boron	µg/L	61.1	<50	<50	72.1	<50	25	72.1	41.6
Cadmium	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	0.1	0.1	0.1
Calcium	mg/L	13.2	8.95	11.4	15.4	9.1	8.95	15.4	11.6
Chromium	µg/L	<1	<1	<1	<1	<1	0.5	0.5	0.5
Cobalt	µg/L	0.22	0.27	0.21	0.42	<0.2	0.1	0.42	0.24
Copper	µg/L	2.6	1.8	2.3	3.5	1.6	1.6	3.5	2.36
Iron	µg/L	1,140	1,250	1,160	1,110	1,050	1,050	1,250	1,142
Lead	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	0.25	0.25	0.25
Magnesium	mg/L	6.97	5.36	6.35	7.29	5.42	5.36	7.29	6.278
Manganese	µg/L	45.6	64.4	38.9	43.7	28.2	28.2	64.4	44.16
Mercury	µg/L	0.0048	0.006	0.0054	0.0054	0.0052	0.0048	0.006	0.00536
Mercury methyl	µg/L	0.00049	0.00047	0.00046	0.00045	0.00042	0.00042	0.00049	0.00046
Molybdenum	µg/L	0.47	0.3	0.3	0.39	0.29	0.29	0.47	0.35
Nickel	µg/L	2.6	2.3	2.3	3.1	2	2	3.1	2.46
Potassium	µg/L	1,040	840	970	1,000	850	840	1,040	940
Selenium	µg/L	<1	<1	<1	<1	<1	0.5	0.5	0.5
Silver	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	0.1	0.1	0.1
Sodium	µg/L	3,420	2,900	3,290	3,480	3,140	2,900	3,480	3,246
Strontium	µg/L	90.3	40	65.9	128	40.6	40	128	72.96
Thallium	µg/L	0.46	<0.4	<0.4	<0.4	<0.4	0.2	0.46	0.25
Titanium	µg/L	<10	<10	<10	<10	<10	5	5	5
Vanadium	µg/L	<1	<1	<1	<1	<1	0.5	0.5	0.5
Zinc	µg/L	<6	<6	<6	<6	<6	3	3	3
Metals (dissolved)									
Aluminum, dissolved	µg/L	135	171	160	154	166	135	171	157.2
Cobalt, dissolved	µg/L	<0.2	<0.2	<0.2	0.4	<0.2	0.1	0.4	0.16
Copper, dissolved	µg/L	2.7	1.8	2.9	4.1	2	1.8	4.1	2.7
Iron, dissolved	µg/L	858	872	889	813	852	813	889	857
Nickel, dissolved	µg/L	2.1	1.8	1.9	2.9	1.7	1.7	2.9	2.08
Zinc, dissolved	µg/L	<6	<6	<6	<6	<6	3	3	3

Table 2. Summary of Copper-Nickel Study data collected at Colby Lake (LCy-1) in 1976 and 1977

Parameter	Unit	Min	Max	Median	Coefficient of Variation (%)	No. of Samples
Alkalinity	mg/L	16	38	34	29	6
Aluminum	µg/L	220	400	310	41	2
Arsenic	µg/L	0.4	2.1	1.4	66	3
Cadmium	µg/L	0.03	0.2	0.04	89	6
Cobalt	µg/L	0.2	0.5	0.3	46	3
Copper	µg/L	1.6	4.8	3.8	32	6
Color	SPU	35	360	88	82	6
Iron	µg/L	190	2300	410	91	6
Lead	µg/L	0.2	1.7	0.6	64	6
Mercury	µg/L	0.08	0.4	0.14	60	6
Nickel	µg/L	1	5.7	2	69	6
pH		6.8	7.8	7.2	5	6
Secchi Disk	meters	0.6	6	1.8	78	6
Spec. Conductance	umho/cm	74	328	169	48	6
Sulfate	mg/L	8.7	55	28	53	6
Total N	µg/L	870	2230	1065	44	4
Total P	µg/L	1	34	14	67	6
TOC	mg/L	11	35	17	49	6
Zinc	µg/L	1	35.3	2	154	6

Table 3. Summary of Copper-Nickel Study data collected at Colby Lake (LCy-2) in 1976 and 1977

Parameter	Unit	Min	Max	Median	Coefficient of Variation (%)	No. of Samples
Alkalinity	mg/L	33	37	36	6	4
Aluminum	µg/L	180	470	190	59	3
Arsenic	µg/L	--	--	--	--	--
Cadmium	µg/L	0.02	0.2	0.04	88	4
Cobalt	µg/L	0.2	0.5	0.3	29	4
Copper	µg/L	3.2	7.3	4.2	35	4
Color	SPU	60	170	78	52	4
Iron	µg/L	340	510	355	21	4
Lead	µg/L	0.2	1.4	0.6	73	4
Mercury	µg/L	0.08	0.4	0.12	70	4
Nickel	µg/L	0.8	6	2	84	4
pH		6.8	7.5	7.0	4	4
Secchi Disk	meters	1.2	2.1	1.6	23	4
Spec. Conductance	umho/cm	170	389	192	51	4
Sulfate	mg/L	22	140	47.5	81	4
Total N	µg/L	880	910	985	2	2
Total P	µg/L	17	24	20	15	4
TOC	mg/L	11	20	14	26	4
Zinc	µg/L	1.2	4.4	2	58	4

Table 4. Summary of USGS data collected at Colby Lake (LCy-1) in 1976

Parameter	Units	Min	Max	Average	No. of Samples	Remark
Ammonia	mg/L	0.04	0.06	0.05	3	
Cadmium	µg/L	--	--	--	1	Presence verified but not quantified
Calcium (filtered)	mg/L	11	21	14.67	3	
Calcium (unfiltered)	mg/L	12	14	13	2	
Chloride	mg/L	6.6	7.8	7.07	3	
Cobalt	µg/L	--	--	--	1	Not Detected (< 0.3 µg/L)
Color	Pt-Co	65	90	75	4	
Copper	µg/L	--	--	--	1	Presence verified but not quantified
Dissolved Oxygen	mg/L	4.3	8.5	7.1	4	
Fluoride	mg/L	0.1	0.7	0.33	3	
Hardness	mg/L	41	83	59.33	3	
Iron (filtered)	µg/L	250	310	280	3	
Iron (unfiltered)	µg/L	390	600	486.67	3	
Lead	µg/L	--	--	--	1	Presence verified but not quantified
Magnesium (filtered)	mg/L	3.2	7.3	5.43	3	
Magnesium (unfiltered)	mg/L	5.3	5.8	5.55	2	
Manganese	µg/L	50	90	73.33	3	
Mercury	µg/L	--	--	--	1	Not Detected (< 0.5 µg/L)
Nickel	µg/L	--	--	--	1	Presence verified but not quantified
Nitrate + Nitrite	mg/L	0.19	0.36	0.29	3	
Orthophosphate	mg/L					Not Detected (< 0.01 mg/L)
pH		6.5	7.4	6.9	4	
Potassium	mg/L	1.3	1.4	1.35	2	
Phosphorus	mg/L	0.01	0.03	0.02	3	
Silica	mg/L	5.8	7.5	6.5	3	
Sodium	mg/L	3.6	3.9	3.75	2	
Specific Conductance	uS/cm	110	183	133.5	4	
Sulfate	mg/L	22	52	33.33	3	
Turbidity	NTU	1.0	3.7			
Zinc	µg/L	--	--	--	1	Presence verified but not quantified

Table 5. Summary of USGS data collected at Colby Lake (LCy-2) in 1976

Parameter	Units	Min	Max	Average	No. of Samples	Remark
Ammonia	mg/L	0.05	0.06	0.55	2	
Cadmium	µg/L	--	--	--	1	Presence verified but not quantified
Calcium (filtered)	mg/L	13	17	15	2	
Calcium (unfiltered)	mg/L	14	33	23.5	2	
Chloride	mg/L	6.3	9.4	7.85	2	
Cobalt	µg/L	--	--	--	1	ND (< 0.3 µg/L)
Color	Pt-Co	65	75	68.33	3	
Copper	µg/L	--	--	--	1	Presence verified but not quantified
Dissolved Oxygen	mg/L	8.5	8.5	8.5	3	
Fluoride	mg/L	0.1	0.1	0.1	2	
Hardness	mg/L	56	71	63.5	2	
Iron (filtered)	µg/L	330	440	385	2	
Iron (unfiltered)	µg/L	450	490	470	2	
Lead	µg/L	--	--	--	1	Presence verified but not quantified
Magnesium (filtered)	mg/L	5.7	7	6.35	2	
Magnesium (unfiltered)	mg/L	5.7	7	6.35	2	
Manganese	µg/L	50	60	55	2	
Mercury	µg/L	--	--	--	1	ND (< 0.5 µg/L)
Nickel	µg/L	--	--	--	1	Presence verified but not quantified
Nitrate + Nitrite	mg/L	0.28	0.29	0.285	2	
Orthophosphate	mg/L	0.01	0.01	0.01	2	
pH		6.8	6.9	6.83	3	
Potassium	mg/L	1.4	1.5	1.45	2	
Phosphorus	mg/L	0.02	0.03	0.025	2	
Silica	mg/L	5.9	5.9	5.9	2	
Sodium	mg/L	4.3	4.3	4.3	2	
Specific Conductance	uS/cm	120	146	132.67	3	
Sulfate	mg/L	22	22	22	2	
Turbidity	NTU	1	2	1.67	3	
Zinc	µg/L	--	--	--	1	Presence verified but not quantified

Table 6. Summary of Colby Lake data available from MPCA's EDA website from 1976 to 2007

Parameter[1]	Unit	Min	Max	Average	Median	No. of Samples
Alkalinity, Total	mg/l CaCO3	16	51	35.6	37.0	21
Aluminum	µg/L	180	610	307	240	10
Arsenic	µg/L	<0.5	2.1	1.36	1.55	4
Cadmium	µg/L	0.02	0.20	0.054	0.030	15
Calcium (as CaCO3)	mg/l CaCO3	21	104	57.1	54.9	14
Carbon, Total Organic	mg/l	10	35	19	19	16
Chloride	mg/l	1.8	9.3	6.1	8.2	17
Chlorophyll a	µg/l	1.0	4.8	2.7	2.7	12
Cobalt	µg/l	<0.3	1.40	0.42	0.15	6
Copper	µg/l	1.6	8.0	4.85	4.40	15
Depth, Secchi	meters	0.60	2.75	1.19	1.0	29
Dissolved Oxygen	mg/L	0.1	10.3	5.2	6.0	109
Fluoride	mg/l	0.13	0.40	0.26	0.26	10
Hardness, Ca + Mg	mg/l CaCO3	40	150	91.2	88	14
Iron	µg/l	190	2500	836	510	15
Lead	µg/l	0.20	0.91	0.49	0.53	14
Magnesium	mg/l	19	51	34.1	33.5	14
Manganese	µg/l	63	2100	282	82.5	14
Mercury	µg/l	<1	0.36	0.19	0.13	9
Nickel	µg/l	<1	9.0	2.73	2.0	13
Nitrogen (NH3) + (NH4)	mg/l	0.08	0.27	0.153	0.120	10
Nitrogen, Kjeldahl	mg/l	0.29	1.30	0.81	0.77	19
Nitrogen, (NO2) + (NO3)	mg/l	<0.01	1.5	0.225	0.060	14
Nitrogen, Nitrite (NO2)	mg/l	<0.01	0.04	0.013	0.005	10
pH		6.3	8.8	7.1	7.1	109
Phenols (mixture)	µg/l	<2	2.5	1.38	1.00	4
Pheophytin-a	µg/l	0.43	3.52	1.49	1.30	12
Phosphorus as P	mg/l	<0.001	0.059	0.020	0.019	35
Orthophosphate as P	mg/l	0.001	0.007	0.004	0.005	10
Oxygen Reduction Potential	mV	-12	447	309	311	76
Potassium	mg/l	1.4	2.2	1.71	1.71	10
Selenium	µg/l	<0.8	<0.8	<0.8	<0.8	2
Silica	mg/l	5.3	13.0	7.77	7.0	14
Sodium	mg/l	4.7	8.0	6.34	6.22	10
Solids, Dissolved	mg/l	130	240	170	150	5
Solids, Total Suspended	mg/l	0.8	7.2	2.82	2.0	23
Solids, Volatile	mg/l	<1	1.6	1.16	1.20	7
Specific Conductance	uS/cm	0	399	120	104	108
Sulfate (SO4) as SO4	mg/l	8.7	140	52.9	48.5	14
Turbidity	NTU	1	7	2.7	2.2	17
Zinc	µg/l	0.96	50	6.86	2.80	15

[1] All metals are total.

Table 7. Summary of data provided by Minnesota Power (May 2002 to May 2003)

Parameter	Units	Min	Max	Average	Median	Samples (Detections)
Aluminum, dissolved	µg/L	43.5	142.0	72.8	52.8	4 (4)
Aluminum, total	µg/L	61.1	264.0	170.5	182.0	12 (12)
Antimony, total [1]	µg/L	<3.0	<3.0	<3.0	<3.0	3 (0)
Arsenic, total	µg/L	<2.0	2.3	1.4	<2.0	3 (1)
Barium, total	µg/L	<10.0	29.1	15.7	13.1	3 (2)
Beryllium, total [1]	µg/L	<0.2	<0.2	<0.2	<0.2	3 (0)
Boron, total	µg/L	53.7	100.0	79.4	84.5	3 (3)
Cadmium, total [1]	µg/L	<0.2	<0.2	<0.2	<0.2	3 (0)
Chromium, total	µg/L	<1.0	1.7	1.3	1.6	3 (2)
Cobalt, dissolved [1]	µg/L	<1.0	<1.0	<1.0	<1.0	4 (0)
Cobalt, total	µg/L	<1.0	1.9	0.7	<1.0	12 (2)
Copper, dissolved	µg/L	<5.0	13.9	7.5	6.8	4 (2)
Copper, total	µg/L	<5.0	14.5	8.3	9.4	12 (8)
Iron, total	µg/L	650	3,030	2,103	2,630	3 (3)
Lead, total [1]	µg/L	<1.0	<1.0	<1.0	<1.0	3 (0)
Magnesium, dissolved	mg/L	5.3	14.1	8.5	7.3	4 (4)
Magnesium, total	mg/L	4.4	17.5	11.0	10.8	12 (12)
Manganese, total	µg/L	30	280	123	60	3 (3)
Molybdenum, total [1]	µg/L	<5.0	<5.0	<5.0	<5.0	3 (3)
Nickel, total	µg/L	<5.0	5.3	3.4	<5.0	3 (1)
Selenium, dissolved [1]	µg/L	<2.0	<2.0	<2.0	<2.0	4 (0)
Selenium, total [1]	µg/L	<2.0	<2.0	<2.0	<2.0	12 (0)
Silver, total [1]	µg/L	<1.0	<1.0	<1.0	<1.0	2 (0)
Thallium, total [1]	µg/L	<2.0	<2.0	<2.0	<2.0	3 (0)
Tin, total	µg/L	<10.0	<10.0	<10.0	<10.0	2 (0)
Titanium, total	µg/L	<10.0	<10.0	<10.0	<10.0	2 (0)
Zinc, total	µg/L	<10.0	36.1	17.5	11.5	3 (2)

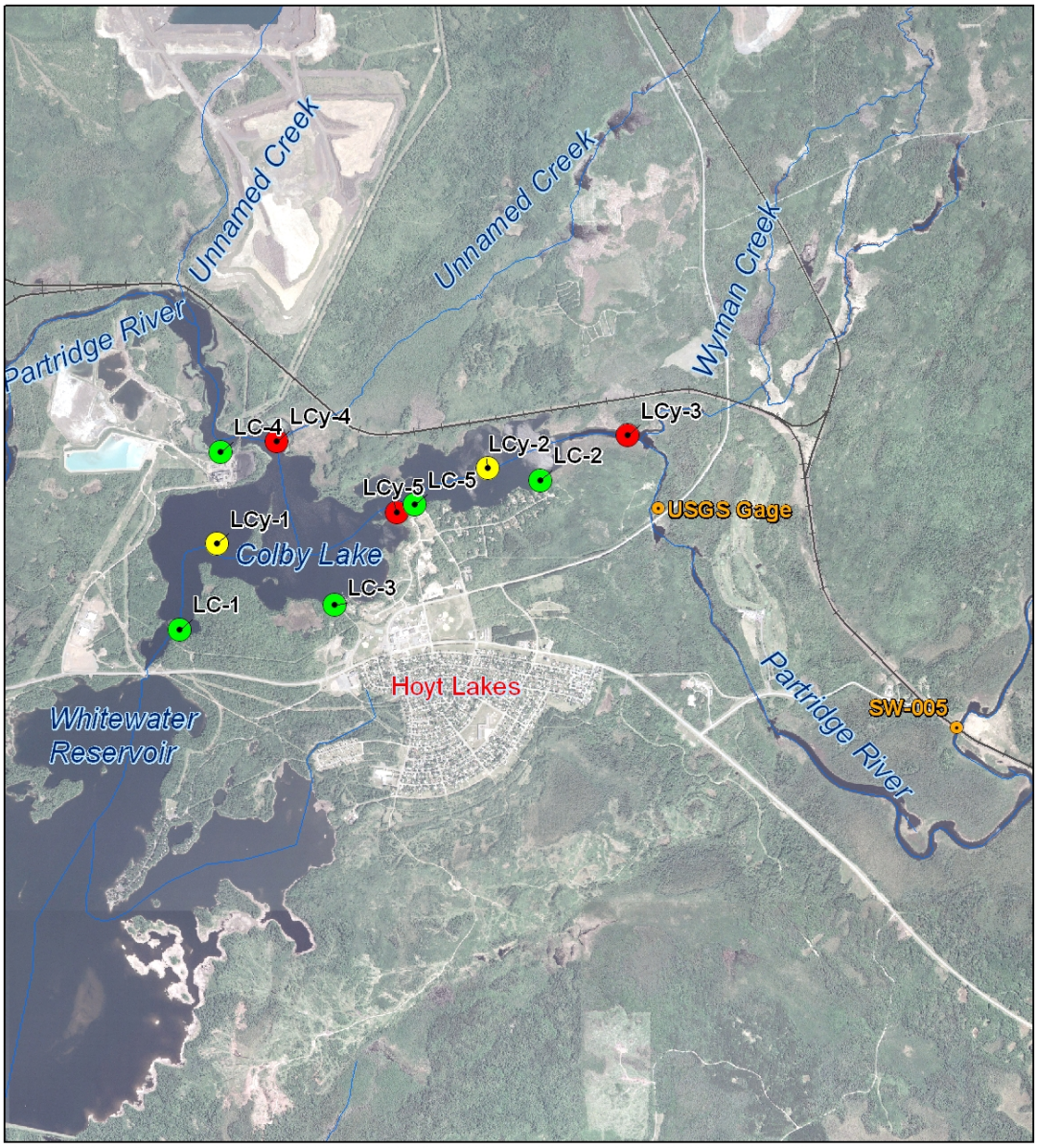
[1] Constituent analyzed for but not detected in any sample.

Table 8. Comparison of November 2008 Colby Lake and Partridge River Water Quality Sampling

Parameter	Units	Partridge River [1]				Colby Lake [2]	
		SW-003	SW-004	SW-005	Partridge River WQ Standard (Class 2B, 3C, 4A, 4B, 5 and 6)	Average of 5 Samples	Colby Lake WQ Standard (Class 1B, 2Bd, 3C, 4A, 4B, 5 and 6)
General Parameters							
Alkalinity, total	mg/L	74.5	58.2	23.4		28.4	
Chloride	mg/L	9.43	7.51	2.17	230	2.17	230
Hardness, total	mg/L	106	84.9	42.4	500	54.8	500
Phosphorus, total	mg/L	0.011	0.009	0.012	0.03	0.012	0.03
Solids, total dissolved	mg/L	136	128	107		115	(500)
Solids, total suspended	mg/L	2	*0.5*	8		3.0	
Sulfate	mg/L	26.4	20	8.42		17.1	(250)
Carbon, total organic	mg/L	7.4	14.7	28.5		29.5	
Metals (total)							
Aluminum	µg/L	47.5	99.2	**334**	125	**208**	125
Cadmium	µg/L	<0.2	<0.2	<0.2	1.4	<0.2	1.4
Calcium	mg/L	24.8	19.6	8.84		11.6	
Chromium	µg/L	<1.0	<1.0	<1.0	49	<1.0	49
Cobalt	µg/L	<0.2	<0.2	0.32	5	0.24	2.8
Copper	µg/L	<0.7	1.0	1.9	5.2	2.4	5.2
Lead	µg/L	<0.5	<0.5	2.4	3.2	<0.5	1.3
Magnesium	mg/L	10.7	8.73	4.93		6.3	
Manganese	µg/L	43.1	60.3	51.9		44	(50)
Mercury	µg/L	**0.0017**	**0.0037**	**0.0063**	0.0013	**0.00536**	0.0013
Molybdenum	µg/L	2.3	1.4	0.39		0.35	
Nickel	µg/L	1.1	1.3	2.2	29	2.5	29
Zinc	µg/L	<6.0	<6.0	<6.0	67	<6.0	67

Bold indicates exceeds the Minnesota surface water quality standard.
Numbers in parentheses indicated Secondary Maximum Containment Levels (sMCL).
Hardness based standards for cadmium, chromium, copper, lead, nickel, silver and zinc are based on a hardness of 50 mg/L.
[1] Partridge River samples were collected on November 18, 2008.
[2] Colby Lake samples were collected on November 19, 2008.

Figure 1. 2008 Colby Lake Water Sampling Locations (Proposed and Actual)



Barr Footer: Date: 2/2/2009 4:30:07 PM File: I:\Client\Polymet\Maps\SamplingLocations\Baseline Monitoring\Figure 1 Colby Lake Monitoring 2008.mxd User: kow

Partridge River Monitoring Locations

Colby Lake Monitoring Locations

- Actual Sampled
- Proposed Continuation (Cu-Ni Site) Not Sampled
- Proposed New (Not Sampled)
- River / Stream

0 1000 2000 3000 4000 5000 6000
Feet

Figure 1

2008 Colby Lake
Water Monitoring Locations
NorthMet Project
PolyMet Mining Inc.
Hoyt Lakes, Minnesota