

## Appendix B

### Background Chemical Concentrations in Sediment

Metals occur naturally in environmental media, including sediment. Additionally, several anthropogenic chemicals, such as PCBs and dioxins/furans, have become widespread due to transport and deposition from global and regional sources. Therefore, anthropogenic hazardous substances may be detected in sediment samples far removed from point sources. It is important to be able to differentiate the natural or regional concentrations of hazardous substances from those that are associated with a source and pathway at a specific site.

Six sediment samples from two reference areas were collected as part of the 2001 investigation of the St. Regis Company site (Tetra Tech 2002). Three samples were collected from Ball Club Lake and three samples were collected from the creek connecting Big Lake and Andrusia Lake. Samples were analyzed for metals, VOCs, SVOCs, and dioxins/furans. The chemical concentrations in these two sets of samples were compared using the nonparametric Mann-Whitney (Wilcoxon) *W* test (one-tailed) to determine if their medians were significantly different from one another (the results of the Wilcoxon *W* test comparisons are summarized in Tables B-2 and B-3). Only detected concentrations were included in the *W* test evaluation, and a chemical had to have at least two detections from the lake and two detections from the creek reference areas to be included in the test. None of the 21 chemicals tested (5 dioxins, 1 PAH, 3 pesticides, 4 VOCs, and 8 metals) showed a significant difference between creek and lake reference areas at the  $p \leq 0.05$  level. Therefore, the reference data from the creek and lake areas were pooled to form a data set considered representative of site-specific reference conditions. In addition, a single sediment sample (SD-FCUFH) was collected from Fox Creek at a location west of its intersection with Highway 371 in 2003. This sample is also considered to be an upgradient background sample and was included in the site-specific sediment background data set.

In addition to the site-specific background data, the Minnesota Pollution Control Agency (MCPA) conducted a study of trace metal concentrations in lake sediments in northern Minnesota (MCPA 2000). A total of 30 composite surface sediment samples were collected from nine minimally-impacted reference lakes from the Northern Lakes and Forests Ecoregion, which encompasses the Cass Lake area. The goal of the study was to provide estimates of background metal concentrations typical of minimally-impacted lake sediments in the ecoregion. Sediment samples were analyzed using two methods: a field screening x-ray fluorescence (XRF) method and a standard laboratory method. Since most of the data were from the XRF screening method, and results of the XRF analysis may vary from results using standard laboratory methods, caution should be used in evaluating the MCPA data. Specifically, XRF analyses typically provide higher analytical

values and quantitation limits than standard analyses. A review of Table B-1 indicates that, except for manganese and selenium, the minimum and maximum concentrations of all metals are higher in the MPCA study than those based on site-specific reference samples.

MCPA recommended the use of the interquartile range (25<sup>th</sup> and 75<sup>th</sup> percentile) as an estimate of typical sediment metal background concentrations. However, a simple comparison of the maximum detected metal concentration in sediment from a potentially impacted site to the 75<sup>th</sup> percentile of the MCPA background concentrations could lead to erroneous conclusions. Therefore, the absolute range and 90<sup>th</sup> percentile of metal concentrations in sediment from the MCPA study was included to provide a more robust estimate of sediment background. These statistics were derived using the combined XRF and standard laboratory methods data. Table B-1 shows the minimum, maximum, and 90<sup>th</sup> percentile of detected chemical concentrations from the seven site-specific reference samples, as well as the minimum, maximum, 90<sup>th</sup> percentile, and interquartile range of detected metals concentrations from the MCPA study. These data will be used to compare concentrations of chemicals detected in sediment samples from the St. Regis Paper Company Site with background concentrations. It should be noted that additional background/reference samples will be collected in Fox Creek during Summer 2004 (Integral 2004a). Finally, analytical results from the St. Regis Paper Company Site will be compared to analytical results for background/reference locations using the following order of preference for identifying relevant background/reference locations (from most to least preferred): (1) site-specific (e.g. background/reference locations), (2) regional (e.g. state-specific locations), and (3) national or international locations.

## **REFERENCES**

Minnesota Pollution Control Agency (MCPA). 2000. Trace Metal Concentrations in Surface Sediments of Nine Minnesota Northern Lakes and Forests Ecoregion Reference Lakes. MCPA, St. Paul, MN. July 2000.

Tetra Tech EM, Inc. 2002. Response Action Contract for Remedial Oversight and Non-time Critical Removal Activities in Region 6, Data Evaluation Report, St. Regis Company Site, Cass Lake, Minnesota. Prepared for U.S. EPA Region 5. August 23, 2003.

**Table B-1. Background Concentrations of Chemicals in Sediment**

Analyte	Units	Site-specific Background			MPCA Study (2000)			
		Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>	Interquartile Range	Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>
<b>Dioxins/Furans</b>								
1,2,3,4,6,7,8-HpCDD	ng/kg	0.429	9.23	8.54	--	--	--	--
1,2,3,4,6,7,8-HpCDF	ng/kg	0.221	2.28	2.035	--	--	--	--
1,2,3,4,7,8-HxCDF	ng/kg	0.149	0.39	0.384	--	--	--	--
1,2,3,6,7,8-HxCDD	ng/kg	0.302	0.302	--	--	--	--	--
1,2,3,6,7,8-HxCDF	ng/kg	0.149	0.296	0.282	--	--	--	--
1,2,3,7,8,9-HxCDD	ng/kg	0.617	0.617	--	--	--	--	--
1,2,3,7,8-PCDD	ng/kg	0.182	0.182	--	--	--	--	--
1,2,3,7,8-PCDF	ng/kg	0.245	0.245	--	--	--	--	--
2,3,4,6,7,8-HxCDF	ng/kg	0.182	0.334	0.319	--	--	--	--
2,3,4,7,8-PCDF	ng/kg	0.38	0.38	--	--	--	--	--
2,3,7,8-TCDD	ng/kg	0.314	0.314	--	--	--	--	--
2,3,7,8-TCDF	ng/kg	0.314	0.773	0.757	--	--	--	--
OCDD	ng/kg	2.3	68.1	56.04	--	--	--	--
OCDF	ng/kg	0.321	6.74	4.916	--	--	--	--
TEQDF-WHO98 (ND = 1/2 DL)	ng/kg	0.12	1.39	1.18	--	--	--	--
<b>Metals</b>								
Aluminum	mg/kg	573	2280	2016	--	--	--	--
Antimony	mg/kg	0.04	0.53	0.481	1.16-2.05	2.04	8.44	6.38
Arsenic	mg/kg	0.5	23.3	18.2	6.93-12.8	3.21	53	29.2
Barium	mg/kg	6.2	303	103.64	286-444	152	840	658
Beryllium	mg/kg	0.03	0.15	0.134	--	--	--	--
Bromine	mg/kg	--	--	--	37.9-66.4	9.45	141	103
Cadmium	mg/kg	0.1	0.4	0.37	1.53-1.82	2.07	3.79	3.43
Calcium	mg/kg	2040	76100	41300	1120-1900	5480	147000	49750
Chromium	mg/kg	1.5	21.1	11.82	37.4-45.4	9	102	75.56
Cobalt	mg/kg	0.68	19.8	16.124	--	--	--	--
Copper	mg/kg	0.42	11.7	7.06	21.1-29.9	5.2	156	88.84

**Table B-1. Background Concentrations of Chemicals in Sediment (continued)**

Analyte	Units	Site-specific Background			MPCA Study (2000)			
		Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>	Interquartile Range	Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>
Iron	mg/kg	1340	23200	9824	24400-36100	8990	106000	66450
Lead	mg/kg	0.87	12.8	11.52	30.6-44.8	5.45	72	60.2
Magnesium	mg/kg	790	4330	2658	--	--	--	--
Manganese	mg/kg	51.3	14600	3379	421-745	181	2530	871
Mercury	mg/kg	0.016	0.097	0.089	0.06-0.09	0.02	5.11	0.19
Nickel	mg/kg	1.1	16.7	8.02	25.6-37.3	7.1	83.6	56.7
Potassium	mg/kg	70.9	1040	712.8	715-1230	3550	19400	17100
Selenium	mg/kg	0.7	6.5	5.92	--	0.2	5.89	1.79
Silver	mg/kg	0.33	0.33	--	0.833-1.11	2.06	3.7	3.64
Sodium	mg/kg	230	1710	--	--	--	--	--
Thallium	mg/kg	0.01	0.12	0.1	--	811	5760	--
Tin	mg/kg	--	--	--	1671-2103	--	--	--
Vanadium	mg/kg	1.9	23.4	10.92	--	--	--	--
Zinc	mg/kg	3.5	79.8	39.32	95.7-164	14.7	301	195
<b>Polycyclic Aromatic Hydrocarbons (PAHs)</b>								
Acenaphthene	µg/kg	1.2	1.6	1.56	--	--	--	--
Benzo(a)anthracene	µg/kg	2	34	22.6	--	--	--	--
Benzo(a)pyrene	µg/kg	2.5	38	25.28	--	--	--	--
Benzo(b)fluoranthene	µg/kg	2.9	77	42.55	--	--	--	--
Benzo(g,h,i)perylene	µg/kg	2.8	35	23.64	--	--	--	--
Benzo(k)fluoranthene	µg/kg	2.8	6.9	5.88	--	--	--	--
Chrysene	µg/kg	2.9	59	38.72	--	--	--	--
Fluoranthene	µg/kg	0.63	160	75.4	--	--	--	--
Fluorene	µg/kg	1.7	2.7	2.64	--	--	--	--
Indeno(1,2,3-cd)pyrene	µg/kg	2.2	32	19.7	--	--	--	--
Phenanthrene	µg/kg	2.9	71	38.95	--	--	--	--
Pyrene	µg/kg	5.8	110	62	--	--	--	--

**Table B-1. Background Concentrations of Chemicals in Sediment (continued)**

Analyte	Units	Site-specific Background			MPCA Study (2000)			
		Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>	Interquartile Range	Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>
<b>Pesticides</b>								
4,4'-DDE	µg/kg	0.55	4.4	3.6	--	--	--	--
4,4'-DDT	µg/kg	1.1	1.2	1.19	--	--	--	--
a-Chlordane	µg/kg	2.3	2.3	--	--	--	--	--
Aldrin	µg/kg	0.78	0.78	--	--	--	--	--
b-BHC	µg/kg	1.6	1.6	--	--	--	--	--
Chlordane	µg/kg	3	3	--	--	--	--	--
d-BHC	µg/kg	2.9	2.9	--	--	--	--	--
Dieldrin	µg/kg	1.1	1.1	--	--	--	--	--
Endosulfan I	µg/kg	0.56	5.5	4.26	--	--	--	--
Endrin	µg/kg	1	1.2	1.18	--	--	--	--
Endrin Aldehyde	µg/kg	1.7	1.7	--	--	--	--	--
g-BHC (Lindane)	µg/kg	1.1	1.1	--	--	--	--	--
Heptachlor	µg/kg	1.2	1.2	--	--	--	--	--
Heptachlor Epoxide	µg/kg	0.64	2.7	2.52	--	--	--	--
<b>Semi-volatile Organic Compounds</b>								
Acetophone	µg/kg	170	600	560	--	--	--	--
Bis(2-ethylhexyl)phthalate	µg/kg	280	280	--	--	--	--	--
Phenol	µg/kg	15	190	155.4	--	--	--	--
1,2-Dibromoethane	µg/kg	17	17	--	--	--	--	--
<b>Volatile Organic Compounds</b>								
Acetone	µg/kg	25	7700	4804	--	--	--	--
Bromoform	µg/kg	7	61	49.4	--	--	--	--
Carbon disulfide	µg/kg	2	150	96.8	--	--	--	--
Chlorobenzene	µg/kg	2	2	--	--	--	--	--
Methyl acetate	µg/kg	12	320	237.8	--	--	--	--
Methyl ethyl ketone	µg/kg	17	74	68	--	--	--	--

**Table B-1. Background Concentrations of Chemicals in Sediment (continued)**

Analyte	Units	Site-specific Background			MPCA Study (2000)			
		Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>	Interquartile Range	Minimum Detect	Maximum Detect	90 <sup>th</sup> percentile <sup>1</sup>
Toluene	µg/kg	10	230	151.2	--	--	--	--
<b>Conventionals</b>								
Inorganic carbon	%	0.08	0.12	--	--	--	--	--
Organic matter	%	0.4	7	--	--	--	--	--
Solids Total Volatile	%	52	52	--	--	--	--	--
Total carbon	%	1.2	8	--	--	--	--	--
Total Organic Carbon	%	1.1	28	--	--	--	--	--
Total Solids	%	6.31	6.31	--	--	--	--	--

<sup>1</sup> The 90<sup>th</sup> percentile values were calculated using detected concentrations only.