Pelly River Aquatic Effects Assessment – 2006

Selkirk First Nation

Date:

March 2007

DRAFT

Prepared by:

Laberge ENVIRONMENTAL SERVICES

ACCESS CONSULTING GROUP

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1.0 INTRODUCTION

1.1 PURPOSE AND STUDY OBJECTIVE

The Faro Mine complex is located at the headwaters of the Rose/Anvil Creeks and Vangorda Creek. These creeks eventually flow into the Pelly River, an important resource for the Selkirk First Nation (SFN) as it flows through SFN traditional territory. As a downstream user of this water, the SFN has expressed concern for the water quality and possible effects to the aquatic ecosystem in the drainages affected by the Faro Mine complex. The SFN Final Agreement states that:

> *"...a Yukon First Nation has the right to have water which is on or flowing through or adjacent to its Settlement Land remain substantially unaltered as to quantity, quality, and rate of flow, including seasonal rate of flow."*

In 2000, the SFN Land and Resource Branch commenced aquatic environmental studies in their traditional territory. The first water quality investigation was undertaken in 2001 by Laberge Environmental Services (LES). Follow up water quality sampling has occurred on a yearly basis to 2006. The results of the 2001, 2002, and 2003 water quality investigations are reported in "Pelly River Water Quality Investigations 2001", "Pelly River Water Quality 2002 Surveillance Survey", and "Pelly River Water Quality Surveillance Survey 2003" (LES 2001, 2002, 2003). The results of the 2004 and 2005 investigations are provided in the Pelly River Aquatic Effects Assessment Reports for 2004 and 2005 prepared by Access Consulting Group in conjunction with the SFN, LES, and White Mountain Environmental Consulting.

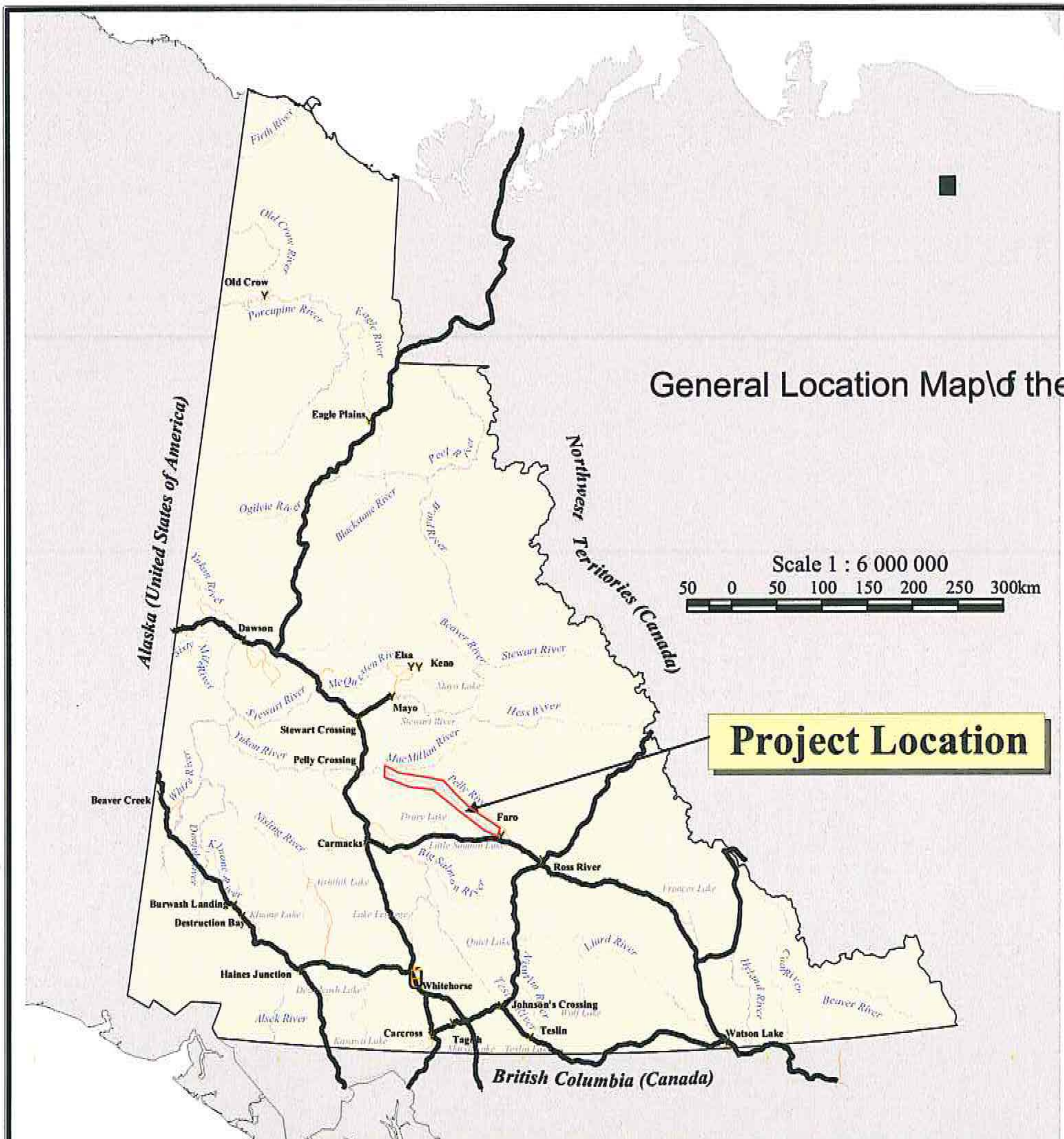
Specific fisheries investigations in the Pelly River drainages have also been undertaken by SFN. These studies include:

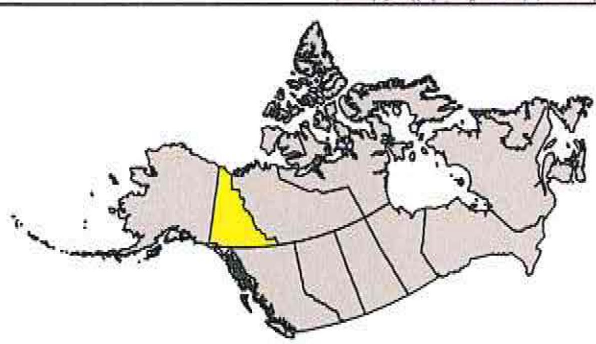
- the collection of baseline information on the Pelly River broad whitefish and their migration within the Tatlmain/Mica Creek and Pelly River drainages, prepared by Can-nic-a-nick Environmental (2001);
- fish habitat utilization assessments of tributaries to the Pelly River between Harvey Creek and the confluence with the Macmillan River in 2002 (Sparling 2003); and

- collection of Chinook salmon DNA from the Earn River was conducted by SFN in conjunction with DFO during 2003 and 2004.

As in previous years, the principle area of investigation for the aquatic assessment was Anvil Creek. Secondary sample locations were situated along the Pelly River both upstream and downstream of the confluence with Anvil Creek, and at Rose Creek both upstream and downstream of the confluence with Anvil Creek. The sample sites have been selected so as to dovetail with, but not duplicate, other monitoring efforts by the Faro Mine receiver or government agencies as part of Water Use Licence QZ03-059. Figure 1 shows the general location of the assessment area in the Yukon and Figure 2 provides an overview of the Pelly River drainage with sample station locations.

The goal of the 2006 Pelly River aquatic effects assessment was to sample specific sites to determine and track water quality, stream sediment quality, and to track the presence and relative abundance of benthos within Pelly River and Anvil Creek. Benthic invertebrates are also collected to determine the level of metals in their tissue. Sampling methods duplicate those used in 2004 and 2005 to the best level possible.





Selkirk First Nation

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Pelly River Aquatic Effects Assessment - 2006

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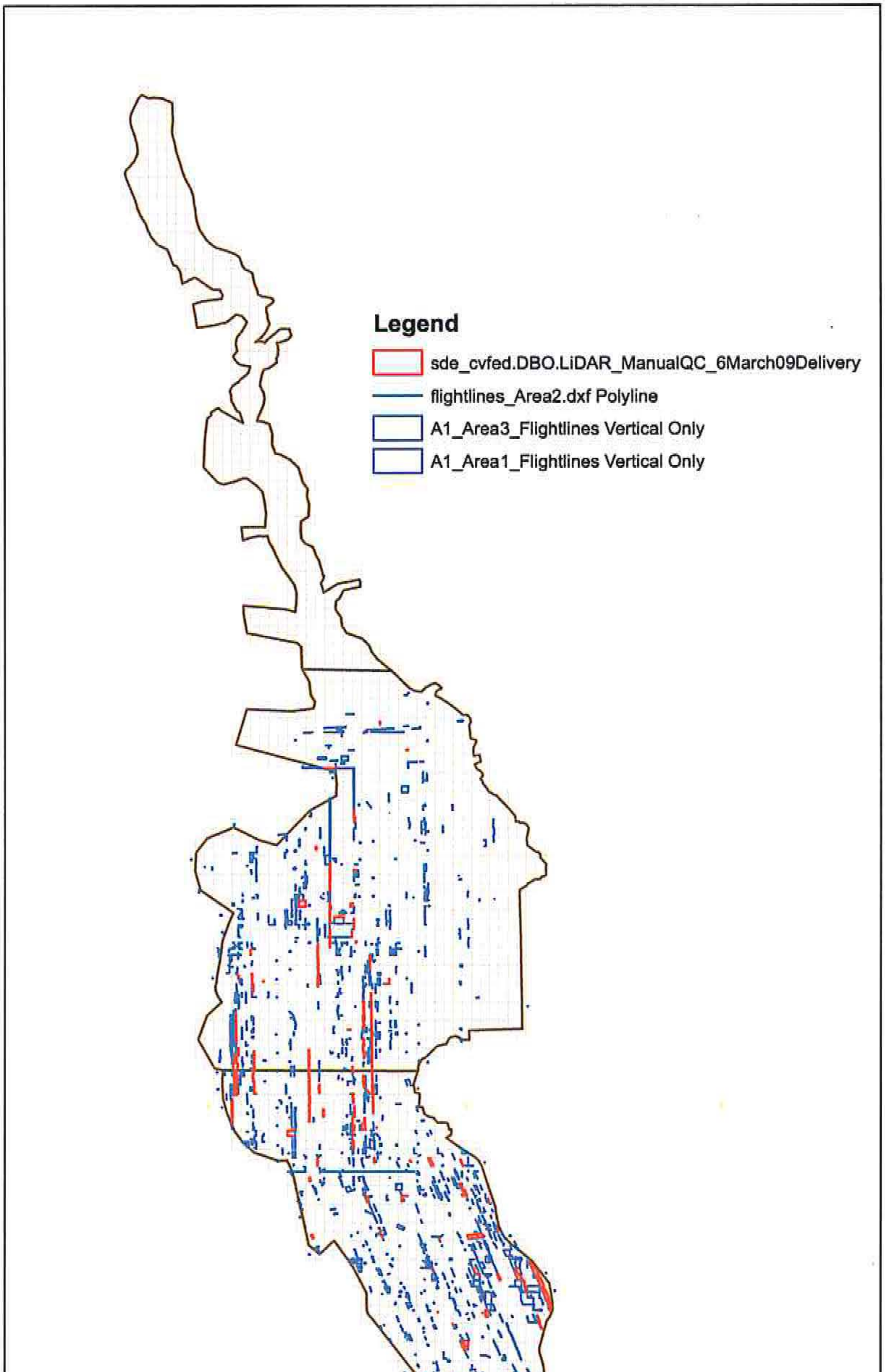
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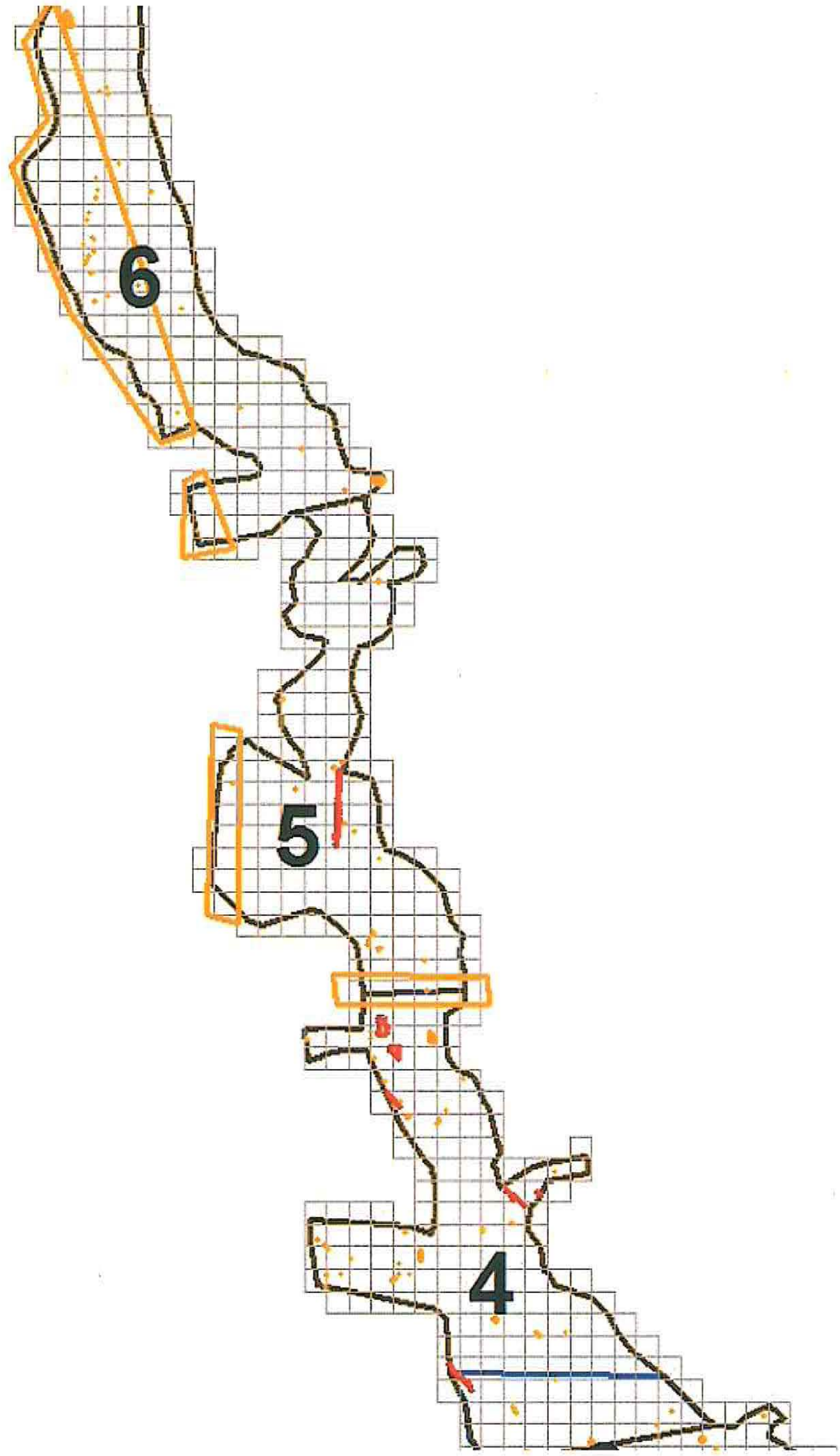
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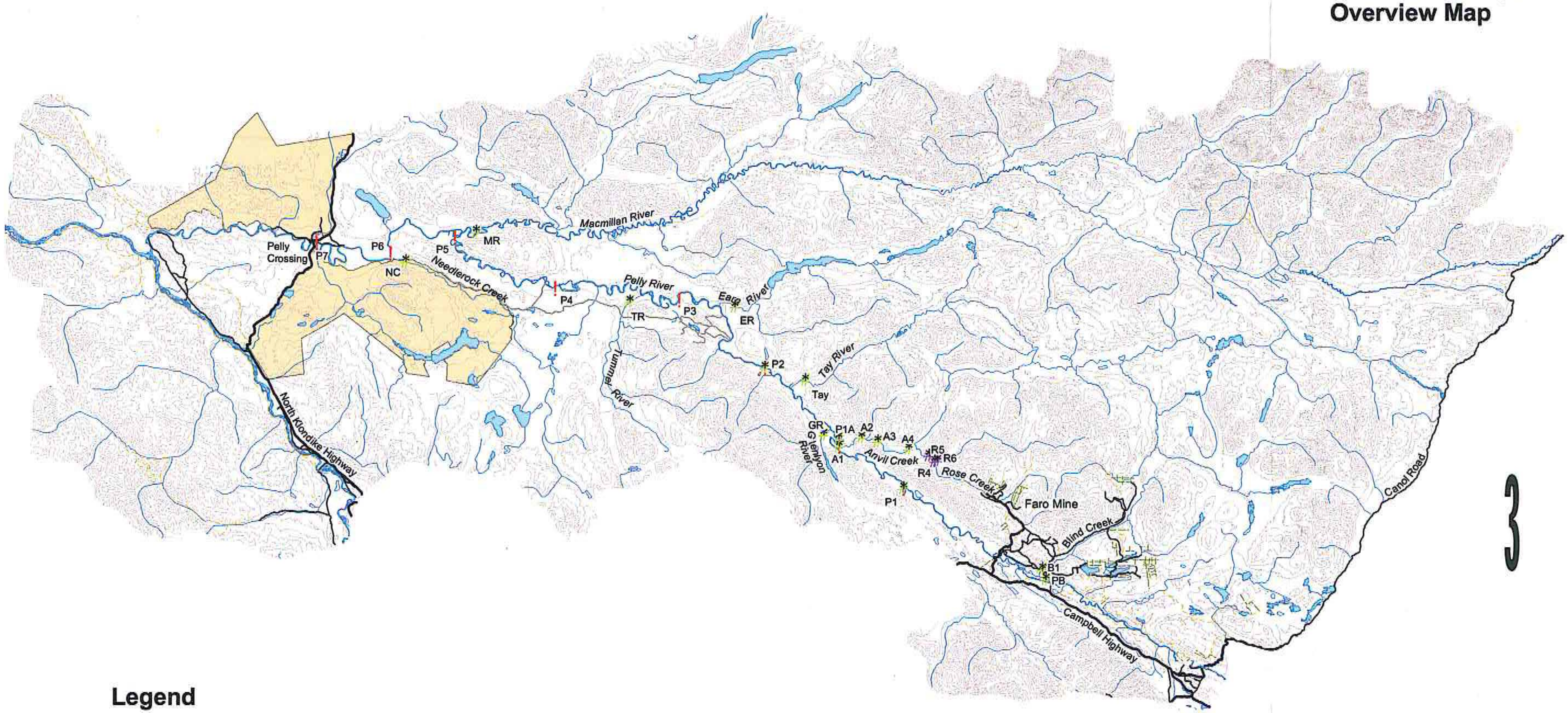
Selkirk First Nation

Pelly River Aquatic Effects Assessment -2006

Pelly River Drainage Overview Map



3

Legend

- Selkirk First Nation Monitoring Station
- Aquatic Effects Monitoring Station
- Faro Mine License Monitoring Station
- 100ft Topographical Contour
- Watercourses
- Cut line
- Limited-used road
- Road
- Selkirk First Nation Settlement Lands
- Waterbodies

1:1,000,000

0 10 20 40 60 80 km

Figure 2	
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Specific objectives of the Pelly River aquatic effects assessment include:

- Gather water, sediment, soil, and aquatic resources data to track metals levels and distribution and abundance of benthos and fisheries in local streams (Anvil Creek, Blind Creek, Rose Creek) within the Pelly River watershed, located down gradient of the Faro Mine site;
- Integrate data collected with the existing SFN dataset, the Faro and Vangorda Mine Water Use License monitoring data, and with data from the 2004 and 2005 Pelly River aquatic effects assessments;
- Assess the Anvil Creek drainage for possible effects to aquatic resources resulting from historic operation of the Faro mine;
- Enable an assessment of possible effects of the Faro mine complex on local aquatic resources to support the Faro Mine Complex Remediation Plan environmental assessment;
- Partner with the Faro mine office and local First Nations in collecting aquatic resources data; and
- Build local capacity within the SFN to undertake environmental monitoring programs.

The following report details results of field activities conducted on the Pelly River and its tributaries (Anvil and Rose Creeks) on July 25 & 27 and August 29 & 30, 2006. Analytical results are presented for 2006 and compared with the 2004 and 2005 assessment data.

2.0 METHODOLOGY

The 2006 aquatic effects assessment was conducted on July 25 & 27 and August 29 & 30 when water levels were low and fish distribution at its seasonal peak. The timing corresponds with previous years assessments conducted between July 27 and August 12. Water quality, sediment and benthos sampling was performed at nine stations on Rose Creek, Anvil Creek, and the Pelly River. All sites were accessed by helicopter.

Plate 1 Mobilizing for the Pelly River Aquatic Effects Assessment

Locations of the sample sites established within the Pelly River watershed for data collection are shown on Figure 2 (Pelly River Drainage Overview Map) and includes stations that SFN has sampled in the past. Sample sites located at the confluence of major tributaries to the Pelly River to document water quality within the SFN traditional territory are also shown in Figure 2. Figure 3 shows the location of Anvil Creek monitoring stations along with existing water licence monitoring stations on Rose Creek. Table 1 provides a listing of the monitoring stations sampled in 2006 and a description of their location.

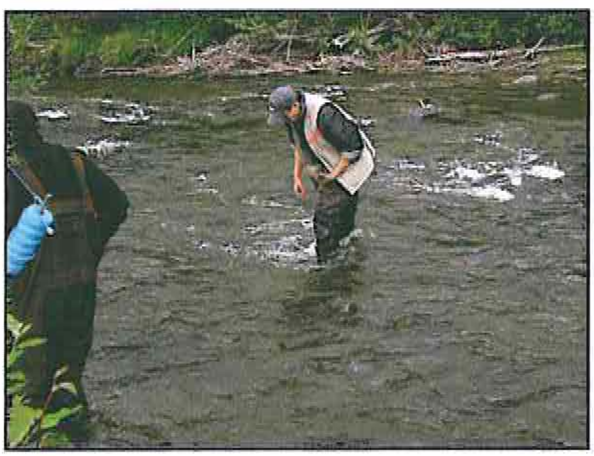


Plate 2 Sample Collection for the Pelly River Aquatic Effects Assessment

Table 1 Monitoring Station Locations and Assessment Parameters for 2006

Station Code	Description
P1	Pelly River U/S Anvil Creek
P1A	Pelly River D/S Anvil Creek
A1	Anvil Creek near mouth
A2	Anvil Creek ~7 km U/S Pelly River
A3	Anvil Creek ~12 km U/S Pelly River
A4	Anvil Creek ~18 km U/S Pelly River
R4	Rose Creek (just U/S of Anvil Creek)
R5	Anvil Creek 300 m D/S Rose Creek
R6	Anvil Creek U/S Rose Creek

On July 25 and 27, water and stream sediment samples were collected for analysis from all sites. Invertebrate biomass samples were collected from all sites for metals analysis. In situ measurements (temperature, pH, conductivity, total dissolved solids, and dissolved oxygen) were also recorded at all nine stations. Benthic invertebrate substrate samplers were set at each site to colonize over a five week period, to determine community abundance and distribution.

On August 29 and 30, the substrate samplers were retrieved and samples collected for identification and enumeration. In situ measurements were recorded from all nine sites and additional water samples were collected for analysis from sites P1, P1A, A1, A2, A3, and A4.

Plate 3 Benthos Sampling for the Pelly River Aquatic Effects Assessment

2.1 WATER QUALITY MONITORING PROGRAM

Water quality sampling occurred during the July sample program at all nine station locations. During the August sample program, water samples were again collected from sites P1, P1A, A1, A2, A3, and A4. Samples were sent to Deloitte & Touche Inc. (R4, R5, and R6) and Norwest Labs for analysis of dissolved and total metals, nutrients, and routine parameters.

Water samples were collected following standard protocols in clean new plastic bottles, kept cool, and shipped to the lab for analysis of a suite of parameters mirroring the 2004 and 2005 sample programs, which are comparable to the 2001, 2002 and 2003 LES sampling programs. Parameters were selected to enable both a "snapshot" of the water quality of the Pelly River, and Anvil and Rose Creeks, as well as a low detection limit background data set. In situ measurements were also recorded.

2.2 STREAM SEDIMENT SAMPLING

Three replicate stream sediment samples were collected at all nine stations and analyzed for metals and acidity at Deloitte & Touche Inc. (R4, R5, R6) and Norwest Labs (A1, A2, A3, A4, P1, P1A). Sediment samples were collected from the streambed using a hand trowel, labeled accordingly, kept cool and transported in polypropylene sediment sample bags supplied by Norwest Labs.

2.3 BENTHOS

2.3.1 Assemblage Assessments

On July 25th and 27th, triplicate artificial substrate samplers were set at A1, A2, A3, A4, R4, R5 and R6. The basket samplers were cylindrical in shape, measured 26 cm long with a diameter of 17 cm, and were constructed of galvanized wire with a one centimeter mesh. Each substrate sampler was filled with washed indigenous gravels collected from the stream bed or the bank at each sample site. The surface area provided by this 'artificial substrate' was approximately 6000 ± 1000 cm^2 (Baker 1979).

P

Plate 4 Benthos Sampling for the Pelly River Aquatic Effects Assessment

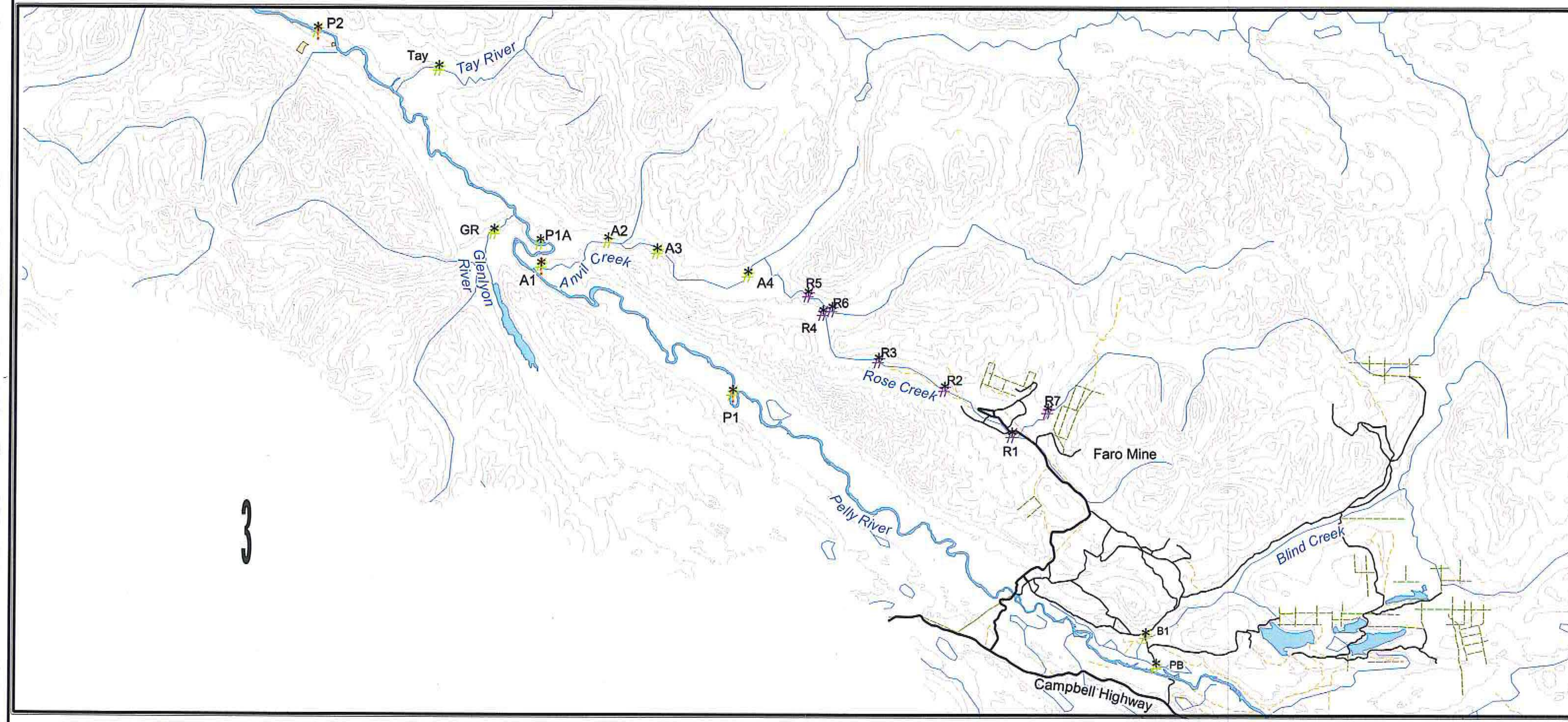
Three rock filled samplers were submerged in riffle areas of the stream at each site in July. These samplers were left to colonize for five weeks. On August 29th and 30th 2006, the artificial substrate samplers were retrieved by placing a screened bucket with a 300 micron mesh, downstream and under the basket. On shore the basket was opened in the bucket. Individual rocks were then carefully washed in the screened bucket to remove and collect all invertebrates from that sample. The detritus and benthic invertebrates remaining in the bucket were placed in a one litre nalgene bottle and preserved with 10% formalin. These samples were sent to Charles Low PhD, an entomologist in Victoria, B.C. for enumeration and identification.

The two sites on the Pelly River, P1 and P1A are not suitable locations for the use of artificial substrate samplers. Benthic invertebrates were collected at these two sites using a Surber sampler equipped with a 300 micron mesh net on August 30th when the basket samplers were retrieved from the Anvil and Rose Creek sites. Triplicate samples were collected at each site and preserved with formalin. These samples were sorted, identified and enumerated along with the basket samples.

Selkirk First Nation

Pelly River Aquatic Effects Assessment -2006

Monitoring Station Locations



Legend

- Selkirk First Nation Monitoring Station
- Aquatic Effects Monitoring Station
- Faro Mine Licence Monitoring Station
- 100ft Topographical Contour
- Watercourses
- Cut line
- Limited-used road
- Road
- Waterbodies

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0 2.5 5 10 15 20 km

Figure 3	
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2.3.2 *Tissue Samples*

During the July site visit, benthic invertebrates were collected for tissue analysis. The objective was to acquire as much biomass as possible from each site. A Surber sampler, a kick net, and individually picking up and inspecting rocks, were the methods used to collect invertebrates. These samples were frozen until they could be sorted, identified and sent refrozen to Norwest Labs in Surrey for analysis of metal content in the tissues. It is difficult to obtain enough biomass for metal analysis from Yukon streams. Although more effort was spent in the 2006 season to obtain sufficient biomass, and more biomass was collected than in the summer of 2005, there was not enough to run any duplicate samples.

Plate 5 Benthos Sampling for the Pelly River Aquatic Effects Assessment

The creek configurations at R5 prohibited the use of the above methods. For the acquisition of biomass, three extra rock filled baskets were installed here on July 25th. Upon retrieval these three samples were frozen and sorted, identified, and sent out with the other previously prepared biomass samples to Norwest Labs.

3.0 DATA RESULTS

Information was recorded on field forms and field books during the field assessments, and then transferred to a computer format at the completion of the field session.

3.1 Water Quality Monitoring Program

The project team conducted sampling events in July and August with the assistance of SFN Land and Resources staff. In situ measurements (shown in Tables 2 and 3) were made of temperature, pH, conductivity, total dissolved solids, and dissolved oxygen using either LES or SFN Land and Resources scientific equipment.

Table 2 In situ Measurements, July 25 and 27, 2006

Site #	Site Description	Date & Time	Temp °C	pH	Conductivity (us/cm)	TDS (mg/L)	Dissolved Oxygen (mg/L)
R-4	Rose Creek just u/s of Anvil Creek	July 25 @ 12:00	9.8	8.21	521	246	13.3
R-6	Anvil Creek just u/s of Rose Creek	July 25 @ 09:30	8.1	8.34	268	125	14.5
R-5	Anvil Creek 300 m d/s Rose Creek	July 25 @ 10:30	8.5	8.35	285	133	14.4
A-4	Anvil Creek d/s R-5	July 27 @ 09:30	8.4	8.6	477	223	12.6
A-3	Anvil Creek d/s A-4	July 27 @ 10:30	8.6	8.67	321	150	12.4
A-2	Anvil Creek d/s A-3	July 27 @ 11:45	8.9	8.64	458	215	11.6
A-1	Anvil Creek near mouth	July 27 @ 12:45	9.8	8.68	441	207	11.2
P1	Pelly River u/s Anvil Creek	July 27 @ 14:30	15.9	8.77	458	219	8.75
P1-A	Pelly River d/s Anvil Creek	July 27 @ 13:30	14.9	8.7	455	217	8.68

Table 3 In situ Measurements, August 29 and 30, 2006

Site #	Site Description	Date & Time	Temp °C	pH	Conductivity (us/cm)	TDS (mg/L)	Dissolved Oxygen (mg/L)
R-4	Rose Creek just u/s of Anvil Creek	August 29 @ 12:30	5.3	7.45	312	143	11.8
R-6	Anvil Creek just u/s of Rose Creek	August 29 @ 10:00	4.1	7.59	264	---	12.6
R-5	Anvil Creek 300 m d/s Rose Creek	August 29 @ 11:00	4.5	7.62	268	122	12.7
A-4	Anvil Creek d/s R-5	August 30 @ 09:45	6.9	7.57	270	124	13.7
A-3	Anvil Creek d/s A-4	August 30 @ 11:00	7.4	7.33	258	121	13.7
A-2	Anvil Creek d/s A-3	August 30 @ 12:00	7.1	7.41	256	121	11.6
A-1	Anvil Creek near mouth	August 30 @ 13:15	7.5	7.57	254	118	11.4
P1	Pelly River u/s Anvil Creek	August 30 @ 15:15	12.8	7.58	269	126	8.8
P1-A	Pelly River d/s Anvil Creek	August 30 @ 14:15	12.4	7.55	268	125	9.0

Table 4 provides comprehensive results from the water quality analysis including parameters and their detection limits. Concentrations that exceed the CCME guidelines for the protection of freshwater aquatic life are displayed as red value entries. Appendices 1 and 2 contain Norwest Labs analytical data reports as well as original data received from Deloitte & Touche Inc.

Table 4 Comprehensive Results - Water Quality 2006

Location Description	Pelly River U/S Anvil Creek		Pelly River D/S Anvil Creek		Anvil Creek near Mouth		Anvil Creek		Anvil Creek		Anvil Creek		Rose Creek U/S Anvil	Anvil Creek D/S Rose	Anvil Creek U/S Rose	Detection Limit (Norwest)	CCME Guidelines Water: Freshwater Aquatic Life
Site ID	P1		P1A		A1		A-2		A-3		A-4		R4	R5	R6		
Lab	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Norwest	Deloitte	Deloitte	Deloitte		
Lab Lot ID	482049	489654	482049	489654	482049	489654	482049	489654	482049	489654	482049	489654	607280374	607280375	607280376		
Date Sampled	27-Jul-06	30-Aug-06	27-Jul-06	30-Aug-06	27-Jul-06	30-Aug-06	27-Jul-06	30-Aug-06	27-Jul-06	30-Aug-06	27-Jul-06	30-Aug-06	25-Jul-06	25-Jul-06	25-Jul-06		
Parameter[1]																	
Inorganic nonmetallic																	
Ammonia - N	0.003	0.006	0.007	0.008	0.006	<0.002	0.007	0.009	0.008	0.006	0.01	0.012	0.05	< 0.01	< 0.01	0.002	
Orthophosphate-P	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01	<0.02	<0.01	-	-	-	0.01	
Dissolved Metals																	
Silicon	2.86	2.78	2.94	2.85	4.04	4.03	3.99	3.91	3.95	4.01	3.86	3.92	4.19	4.15	4.48	0.05	
Sulfur	18.1	16.9	17.9	17.2	16	15.2	17.1	15.8	17.2	16.1	18.4	17.4	-	-	-	0.3	
Aluminum	0.018	0.038	0.017	0.044	0.005	0.008	<0.005	0.006	<0.005	0.008	<0.005	<0.005	0.004	0.004	0.005	0.005	
Antimony	0.0002	<0.0002	0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	< 0.0002	< 0.0002	< 0.0002	0.0002	
Arsenic	0.0005	0.0005	0.0006	0.0005	0.0005	0.0006	0.0006	0.0005	0.0004	0.0004	0.0003	0.0004	0.0003	0.0003	0.0004	0.0002	
Barium	0.073	0.063	0.072	0.063	0.062	0.056	0.06	0.057	0.06	0.059	0.059	0.058	0.047	0.053	0.061	0.001	
Beryllium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.0002	< 0.0002	< 0.0002	0.0001	
Bismuth	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	< 0.0002	< 0.0002	< 0.0002	0.0005	
Boron	0.003	0.005	0.003	0.004	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	< 0.01	< 0.01	< 0.01	0.002	
Cadmium	0.00004	0.00005	0.00004	0.00005	<0.00001	<0.00001	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	< 0.00004	< 0.00004	< 0.00004	0.00001	
Chromium	<0.0005	0.0008	<0.0005	0.0007	0.0012	0.0007	<0.0005	0.0005	<0.0005	0.0006	<0.0005	0.0006	< 0.0002	< 0.0002	< 0.0002	0.0005	
Cobalt	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0005	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0003	< 0.0002	< 0.0002	< 0.0002	0.0001	
Copper	<0.001	0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0006	0.0005	0.0005	0.001	
Lead	0.0007	0.001	0.0007	0.0008	0.0007	0.0009	0.0006	0.0009	0.0007	0.0007	0.001	0.001	< 0.0002	< 0.0002	< 0.0002	0.0001	
Lithium	0.003	0.003	0.003	0.003	0.003	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.0043	0.0016	0.0015	0.001	
Molybdenum	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0006	0.0009	0.0011	0.001	
Nickel	0.0009	0.0023	0.0008	0.0021	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001	0.0004	0.0004	0.0005	
Selenium	0.0009	0.001	0.0007	0.001	<0.0002	0.0003	<0.0002	0.0005	0.0002	0.0003	0.0002	0.0005	< 0.0002	0.0005	0.0006	0.0002	
Silver	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	< 0.00005	< 0.00005	< 0.00005	0.0001	
Strontium	0.155	0.158	0.152	0.162	0.125	0.136	0.12	0.138	0.121	0.138	0.124	0.143	0.175	0.106	0.112	0.001	
Thallium	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	< 0.00002	< 0.00002	< 0.00002	0.00005	
Tin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.0002	< 0.0002	< 0.0002	0.001	
Titanium	0.001	<0.0005	0.001	<0.0005	0.0009	<0.0005	0.0009	<0.0005	0.001	<0.0005	0.0011	<0.0005	< 0.0002	< 0.0002	< 0.0002	0.0005	
Uranium	0.0015	0.0014	0.0015	0.0014	0.0014	0.0016	0.0015	0.0016	0.0014	0.0017	0.0013	0.0016	0.0008	0.0012	0.0013	0.0005	
Vanadium	0.0008	0.0013	0.0008	0.0011	0.0007	0.0008	0.0006	0.0009	0.0006	0.001	0.0004	0.0008	< 0.0002	< 0.0002	< 0.0002	0.0001	
Zinc	0.004	0.004	0.003	0.004	0.003	0.004	0.003	0.006	0.004	0.007	0.005	0.009	0.008	0.003	0.001	0.001	
Total Metals																	
Calcium	40.2	41.4	40.3	37.7	54	42.2	43.8	45.1	43.8	48.6	45.4	45.1	53.4	38.9	38.9	0.2	
Iron	0.3	0.3	0.2	0.3	0.1	<0.2	0.2	<0.2	0.2	<0.2	0.1	<0.2	0.15	0.15	0.16	0.1	0.3
Magnesium	12.8	13	12.5	12	8.5	9.1	9	10	9	9.5	9.5	10	10.3	10.2	10.4	0.1	
Manganese	0.015	0.022	0.014	0.02	0.027	0.053	0.049	0.09	0.057	0.11	0.084	0.17	0.218	0.028	0.012	0.005	
Potassium	0.7	<0.8	0.7	<0.8	1.3	1.1	1.3	1.2	1.2	1.1	1.2	1.1	1.32	0.96	0.95	0.4	
Silicon	3.03	3.39	2.84	3.28	3.81	4.15	3.84	4.19	3.79	4.08	3.66	3.97	4.43	4.33	4.49	0.05	
Sodium	1.6	1	1.7	2	3.1	3	3.1	3.2	3.1	3.1	3.2	3.1	4.38	1.92	1.68	0.4	
Sulfur	17.8	18	17.4	17	15.6	15	16.8	17	16.9	16	18.1	18	-	-	-	0.3	
Aluminum	0.189	0.23	0.125	0.219	0.106	0.042	0.142	0.042	0.095	0.071	0.032	0.01	0.018	0.031	0.035	0.005	0.005 - 0.1
Antimony	0.0002	<0.0004	0.0002	<0.0004	<0.0002	<0.0004	<0.0002	<0.0004	<0.0002	<0.0004	<0.0002	<0.0004	< 0.0002	< 0.0002	< 0.0002	0.0002	
Arsenic	0.0008	0.0007	0.0008	0.0006	0.0007	0.0005	0.0007	0.0004	0.0007	0.0005	0.0005	<0.0004	0.0003	0.0004	0.0004	0.0002	0.005
Barium	0.082	0.082	0.081	0.078	0.062	0.062	0.066	0.067	0.065	0.065	0.062	0.063	0.052	0.063	0.066	0.001	
Beryllium	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	< 0.0002	< 0.0002	< 0.0002	0.0001	
Bismuth	<0.0005	<0.001	<0.0005	<0.001	<0.0005	<0.001	<0.0005	<0.001	<0.0005	<0.001	<0.0005	<0.001	< 0.0002	< 0.0002	< 0.0002	0.0005	
Boron	0.014	0.005	0.008	0.005	0.005	<0.004	0.004	0.004	0.003	0.004	0.003	<0.004	< 0.01	< 0.01	< 0.01	0.002	
Cadmium	0.00007	0.00008	0.00006	0.00007	<0.00001	<0.00002	0.00001	<0.00002	0.00003	<0.00002	<0.00001	<0.00002	< 0.00004	< 0.00004	< 0.00004	0.00001	0.000017
Chromium	0.0007	<0.001	<0.0005	<0.001	0.0006	<0.001	0.0006	<0.001	0.0008	<0.001	<0.0005	<0.001	< 0.0002	< 0.0002	0.0002	0.0005	
Cobalt	0.0002	<0.0002	0.0002	<0.0002	0.0001	<0.0002	0.0002	<0.0002	0.0002	<0.0002	0.0001	<0.0002	0.0002	< 0.0002	< 0.0002	0.0001	
Copper	0.002	<0.002	0.003	<0.002	0.008	0.003	0.002	<0.002	0.001	0.004	<0.001	<0.002	0.001	0.0007	0.0013	0.001	0.002 - 0.004
Lead	0.001	0.0008	0.001	0.0009	0.0009	0.001	0.0011	0.0009	0.0009	0.0007	0.0009	0.0008	0.0003	< 0.0002	0.0003	0.0001	0.001 - 0.007
Lithium	0.004	0.003	0.004	0.003	0.004	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.0047	0.0018	0.0016	0.001	
Molybdenum	0.001	<0.002	0.001	<0.002	0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	0.0006	0.001	0.0011	0.001	0.073
Nickel	0.0039	0.0049	0.0038	0.0044	0.0018	0.002	0.0019	0.0024	0.0016	0.0021	0.0012	0.002	0.0011	0.0004	0.0005	0.0005	0.025 - 0.15
Selenium	0.0011	0.001	0.0011	0.001	0.0006	<0.0004	0.0006	<0.0004	0.0004	<0.0004	0.0006	0.0005	< 0.0002	0.0006	0.0005	0.0002	0.001
Silver	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	<0.0001	<0.0002	< 0.00005	< 0.00005	< 0.00005	0.0001	0.0001
Strontium	0.189	0.17	0.192	0.16	0.162	0.13	0.158	0.14	0.154	0.14	0.163	0.14	0.192	0.123	0.119	0.001	
Thallium	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	<0.00005	<0.0001	0.00002	< 0.00002	< 0.00002	0.00005	
Tin	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	0.0002	0.005	0.0002	0.001	
Titanium	0.0057	0.0059	0.004	0.0056	0.0046	0.0024	0.0073	0.0024	0.005	0.0032	0.0025	0.001	0.0006	0.0011	0.0013	0.0005	
Uranium	0.0017	0.001	0.0017	0.001	0.0015	0.001	0.0016	0.002	0.0017	0.002	0.0015	0.001	0.0009	0.0014	0.0015	0.0005	
Vanadium	0.0013	0.001	0.001	0.001	0.0006	0.0002	0.0008	0.0002	0.0006	0.0003	0.0004	<0.0002	< 0.0002	0.0003	0.0003	0.0001	
Zinc	0.007	0.01	0.007	0.01	0.005	0.006	0.005	0.006	0.011	0.008	0.007	0.009	0.009	0.002	0.001	0.001	0.03
Zirconium	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	<0.001	<0.002	< 0.002	< 0.002	< 0.002	0.001	
Physical and Aggregate																	
Turbidity (NTU)	2.6	4	1.6	3.1	0.7	0.6	0.9	1	1	0.8	0.4	0.6	-	-	-	0.1	
Solids - Total Suspended	12	16	10	12	6	4	4	<2	8	<2	2	<2	< 1	1	2	1	
Solids - Fixed Suspended	9	7	10	6	6	<2	4	<2	8	<2	2	<2	-	-	-	1	
Solids - Volatile Suspended	3	9	0	6	0	4	0	<2	0	<2	0	<2	-	-	-	2	
Colour (Colour units)	12	15	10	15	10	12	10	12	12	14	10	10	-	-	-	5	
Routine Water																	
pH (pH units)	8.14	8.03	8.17	8.1	8.15	8.12	8.13	8.14	8.12	8.1	8.16	8.13	8.18	8.32	8.33	-	
Electrical Conductivity (uS/cm)	287	292	288	295	290	296	306	307	301	305	303	319	353	275	267	1	
Calcium	40.5	37.4	40.6	42	42	42.4	44.1	43.5	42.8	43.8	44.9	45.3	-	-	-	0.2	
Magnesium	14.4	12.4	14.2	12.4	9.6	9.1	10.3	9.5	10	9.6	10.6	10.2	-	-	-	0.1	
Sodium	1.6	1.3	1.7	1.5	2.6	2.9	3	3	2.8	3	2.8	3	-	-	-	0.4	
Potassium	0.8	0.5	0.8	0.5	1.4	1.1	1.2	1.1	1.2	1.1	1.2	1.1	-	-	-	0.4	
Iron	0.02	0.03	0.02	0.04	0.06	0.05	0.04	0.06	0.04	0.07	0.06	0.07	-	-	-	0.01	
Manganese	<0.005	<0.005	<0.005	<0.005	0.017	0.041	0.034	0.073	0.048	0.098	0.075	0.15	-	-	-	0.005	
Chloride	0.27	0.24	0.26	0.24	0.38	0.31	0.34	0.34	0.34	0.34	0.36	0.36	-	-	-	0.07	
Nitrate - N	<0.03	<0.03	<0.03	<0.03	0.03	0.03	0.04	0.04	0.06	0.05	0.06	0.05	-	-	-	0.03	
Nitrite - N	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	-	-	-	0.03	
Nitrate and Nitrite - N	<0.06	<0.06	<0.06	<0.06	0.03	0.03	0.04	0.04	0.06	0.05	0.06	0.05	-	-	-	0.1	
Sulfate (SO_4)	58	50	56	50	49	44	52	48	51	47	59	52	97.9	27.2	20.1	0.1	
Hardness (dissolved as $CaCO_3$)	161	144	160	156	145	143	152	148	148	149	156	155	156	123	135	-	

Notes:

[1] All units are in mg/L unless otherwise indicated.

Values in red are in exceedence of CCME's guidelines for the protection of freshwater aquatic life

All samples tested returned results that met the CCME guidelines (freshwater aquatic life) for total arsenic, iron, lead, molybdenum, nickel, silver, and zinc. Total aluminum concentration levels exceeded the CCME guideline at both Pelly River stations, upstream and downstream of Anvil Creek. The CCME guideline for total aluminum (0.1 mg/L) was also exceeded in Anvil Creek at sites A1 and A2. Total cadmium concentration levels exceeded the CCME guideline at both Pelly River stations, and in Anvil Creek at site A3. The CCME guideline for total copper (0.004 mg/L) was exceeded in Anvil Creek at site A1. Total selenium concentration levels exceeded the CCME guidelines at both Pelly River stations in July.

Note that the foregoing discussion relates to total metals analysis. This method often returns values above CCME guidelines in Yukon streams when the dissolved value for the same sample is below the guideline concentration. Figures 4, 5 and 6 present water quality results for total zinc, cadmium and selenium by station for all stations sampled.

As shown in Figure 4, the highest concentration of total zinc in 2006 was recorded in Anvil Creek (A4 = 0.009 mg/L). Similar to the results of the 2004 and 2005 assessments, the Pelly River stations had higher concentrations of total cadmium and selenium than those recorded in either Anvil or Rose Creeks (Figures 5 and 6).

A comparison of zinc, cadmium, and selenium levels between the 2004, 2005, and 2006 water quality assessments are shown in Figures 7, 8, and 9 respectively. Figure 7 shows zinc levels in 2006 slightly lower than they were in 2005 in Rose Creek (R4) as well as in Anvil Creek upstream and downstream of Rose Creek (R6, R5, and A4). Zinc levels in 2006 further downstream in Anvil Creek (A1, A2, and A3) and in the Pelly River (P1 and P1A) are comparable with results observed in 2004 and 2005, with the exception of an elevated level (0.039 mg/L) at A3 in 2004.

As shown in Figure 8, cadmium levels in 2006 in Anvil Creek (A1, A2, A3, and A4) are generally lower than those observed in 2004 and 2005. For these sites, August 2006 levels are all below laboratory detection levels. Cadmium levels in the Pelly River (P1 and P1A) were marginally higher in August 2006 than in 2004 and 2005, with the exception of an elevated concentration of 0.00012 mg/L observed at P1 in 2005.

Figure 9 shows that selenium in Rose Creek (R4) is below laboratory detection levels in 2006. Selenium levels measured in Anvil Creek (A1, A2, A3, A4, R5, and R6) in July 2006 are generally comparable to those observed in 2004 and 2005. In August 2006 however, selenium levels are below laboratory detection levels at A1, A2, and A3. Selenium levels measured in the Pelly River (P1 and P1A) in 2006 are similar to those measured in 2004 and 2006. Both stations experienced marginally higher levels in July (above CCME) than in August (below CCME).

Figure 4 2006 Water Quality Results for Total Zinc

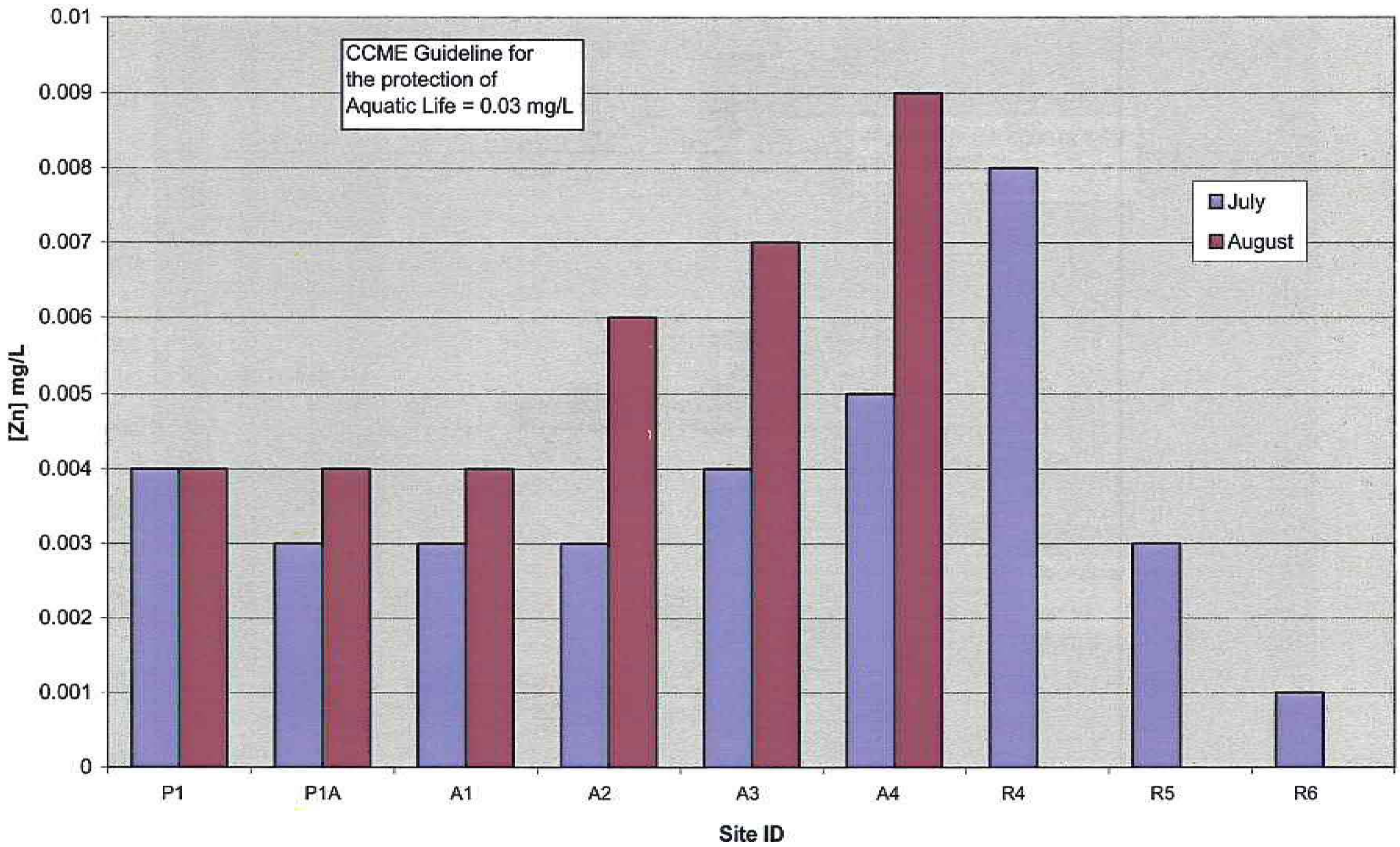
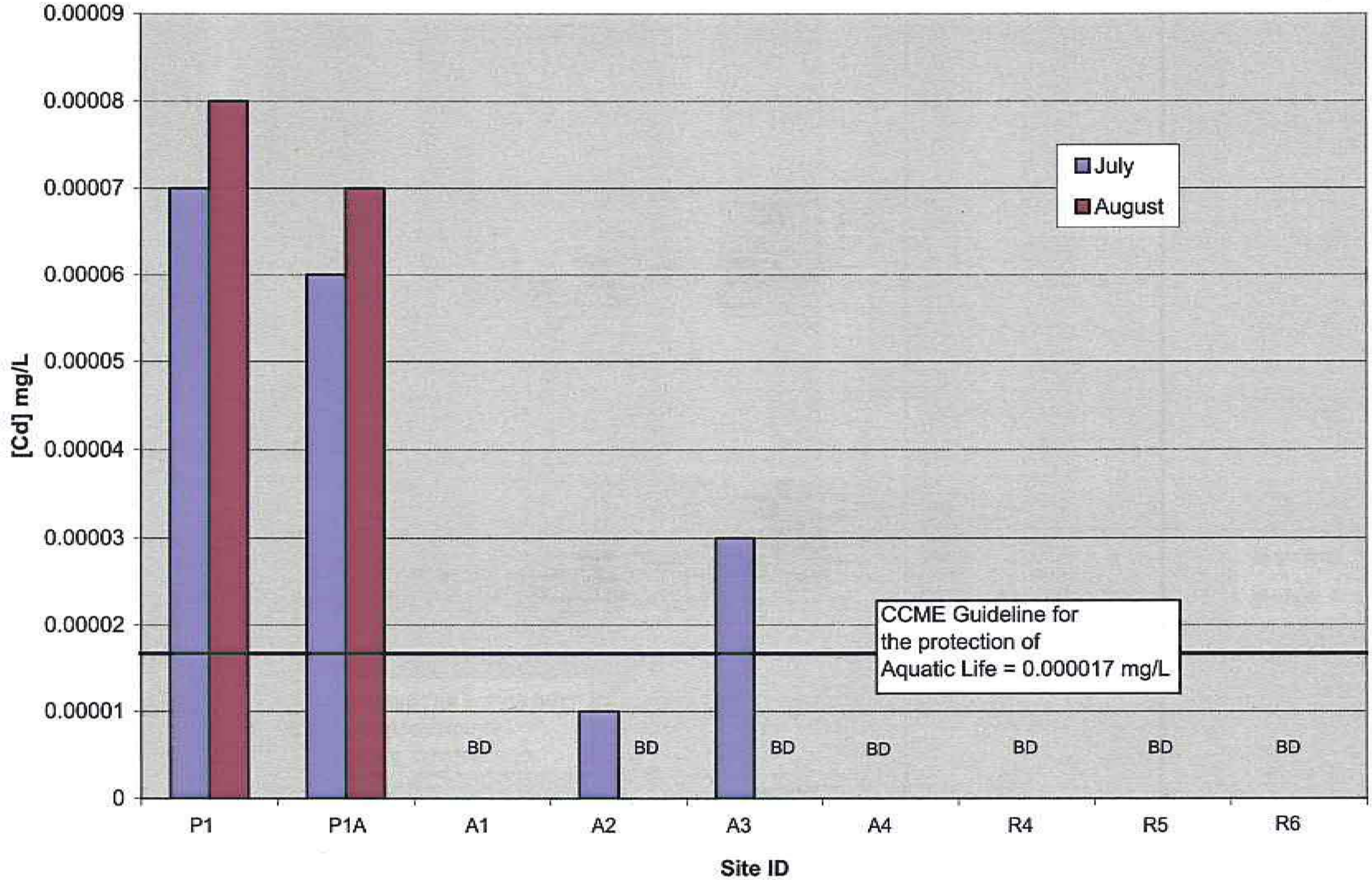
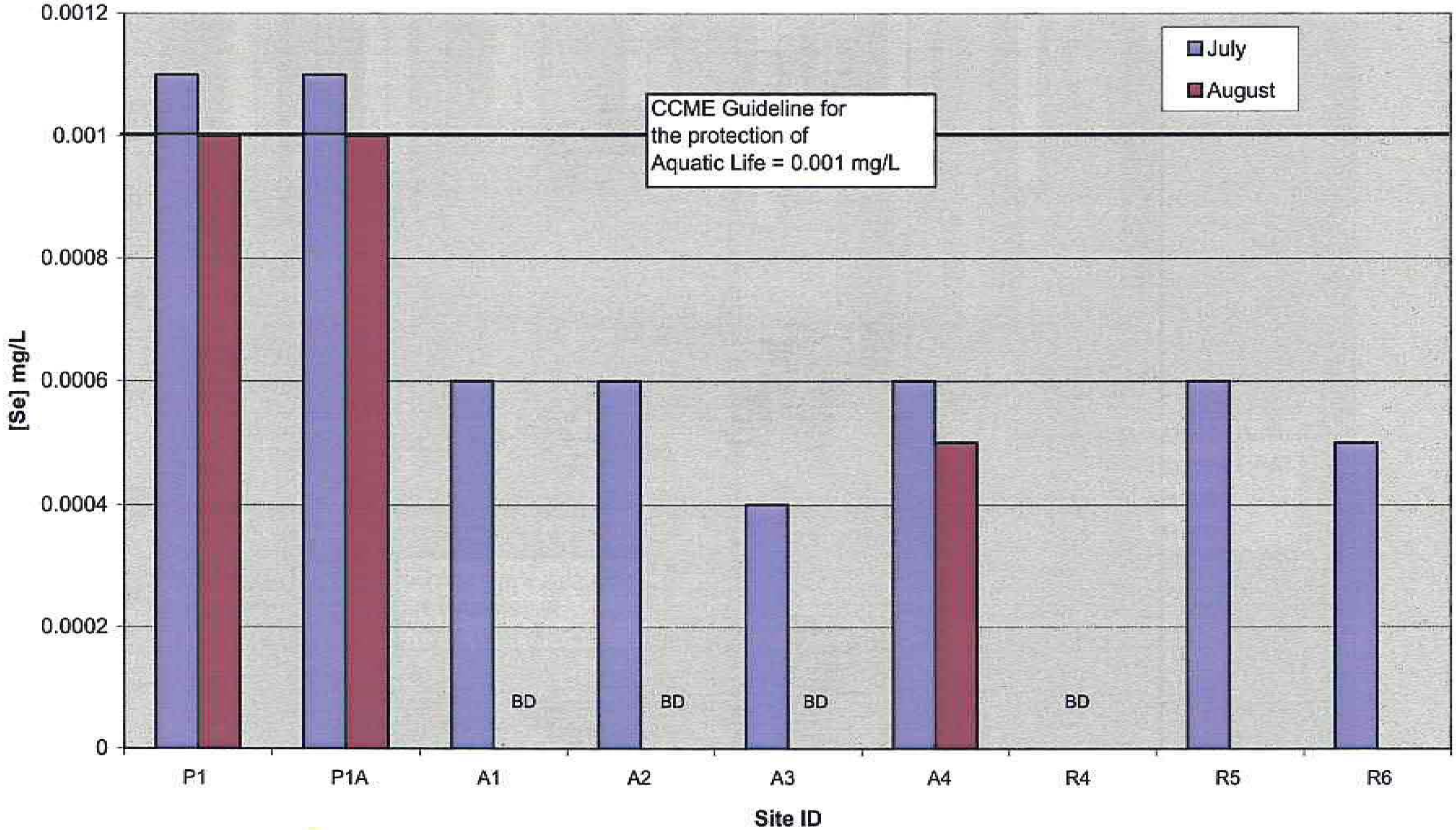


Figure 5 2006 Water Quality Results for Total Cadmium



BD = Below Detection

Figure 6 2006 Water Quality Results for Total Selenium



BD = Below Detection

Figure 7 Water Quality Comparison of 2004, 2005 & 2006 Results for Zinc

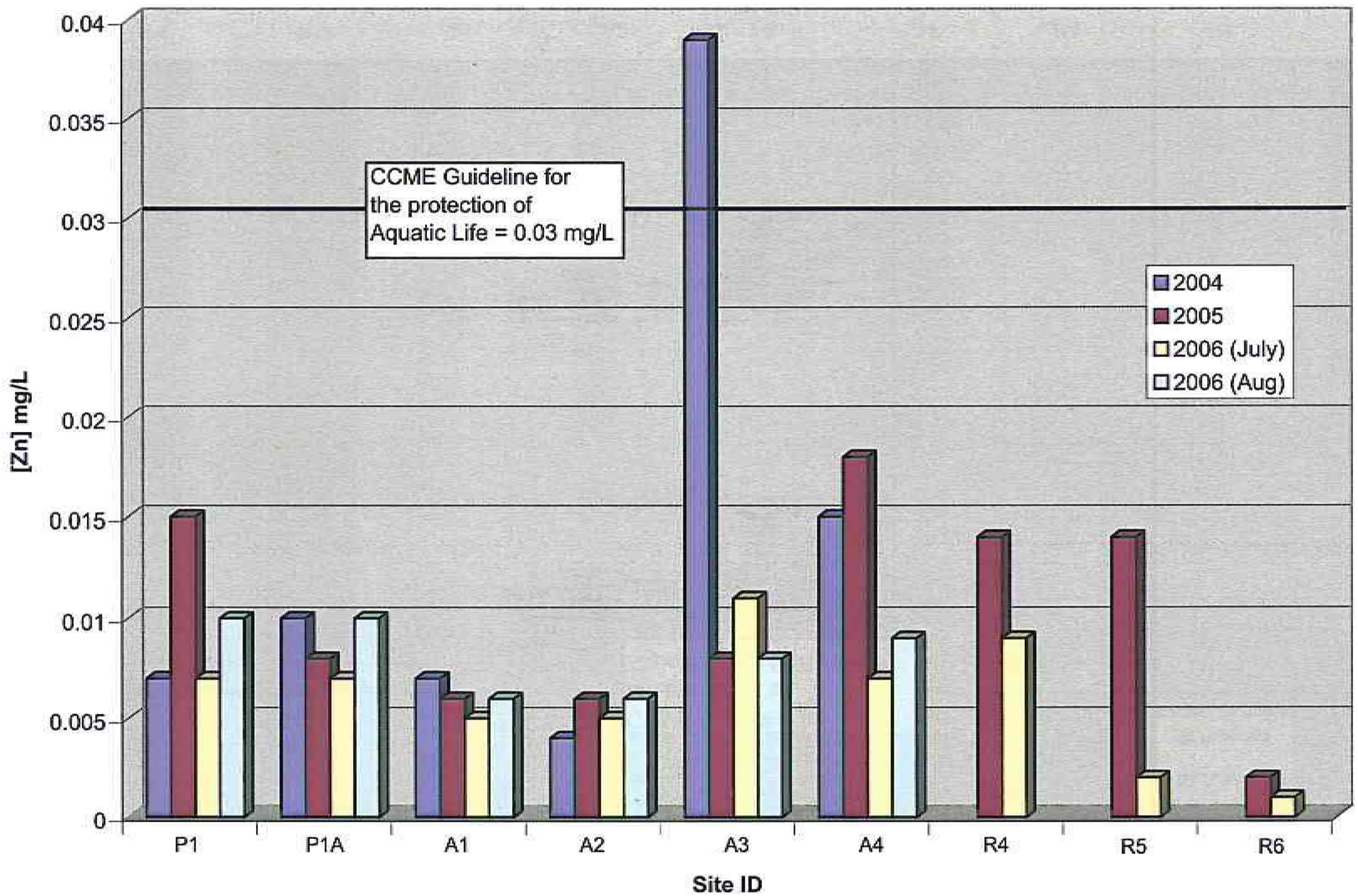
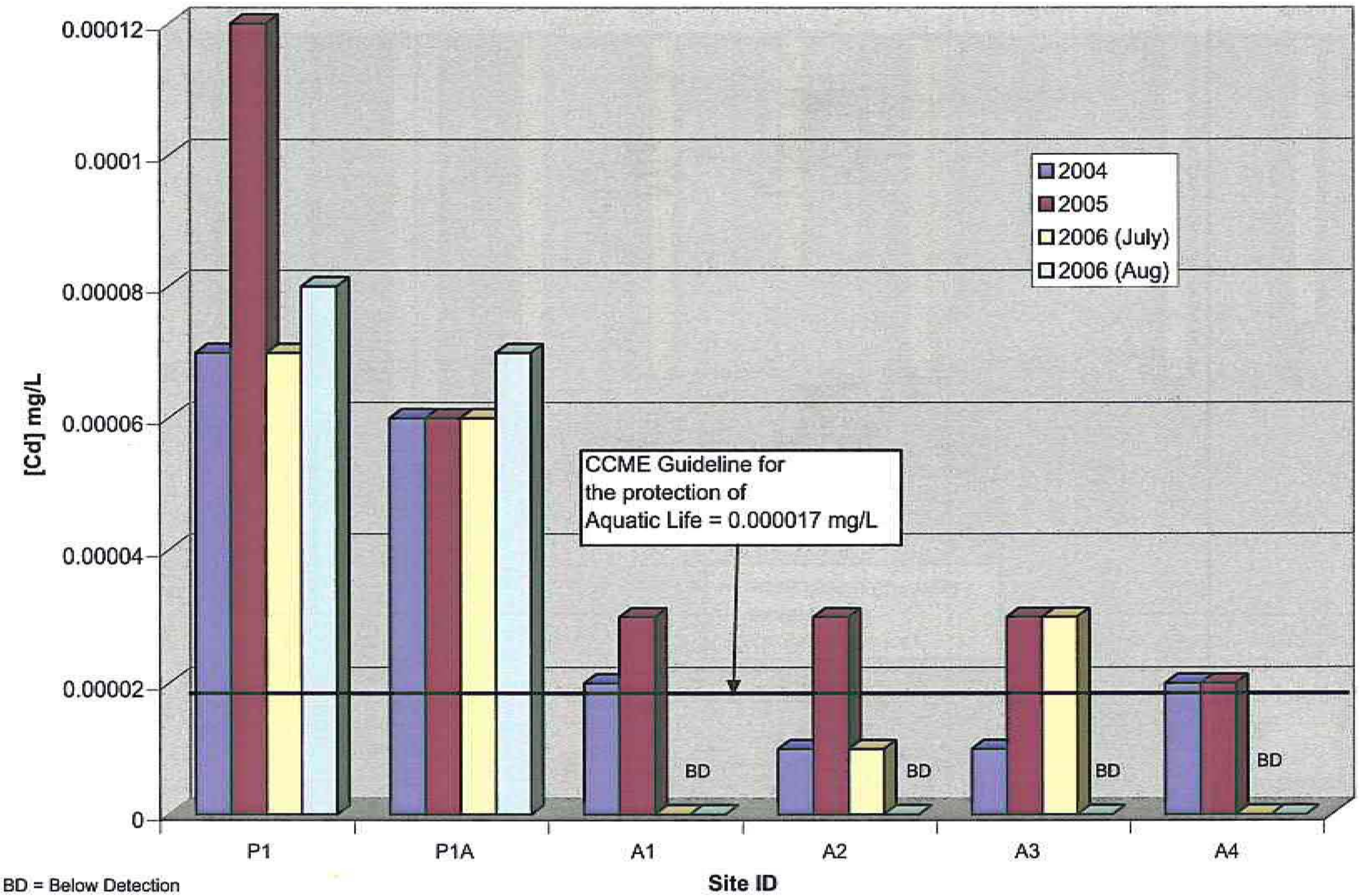
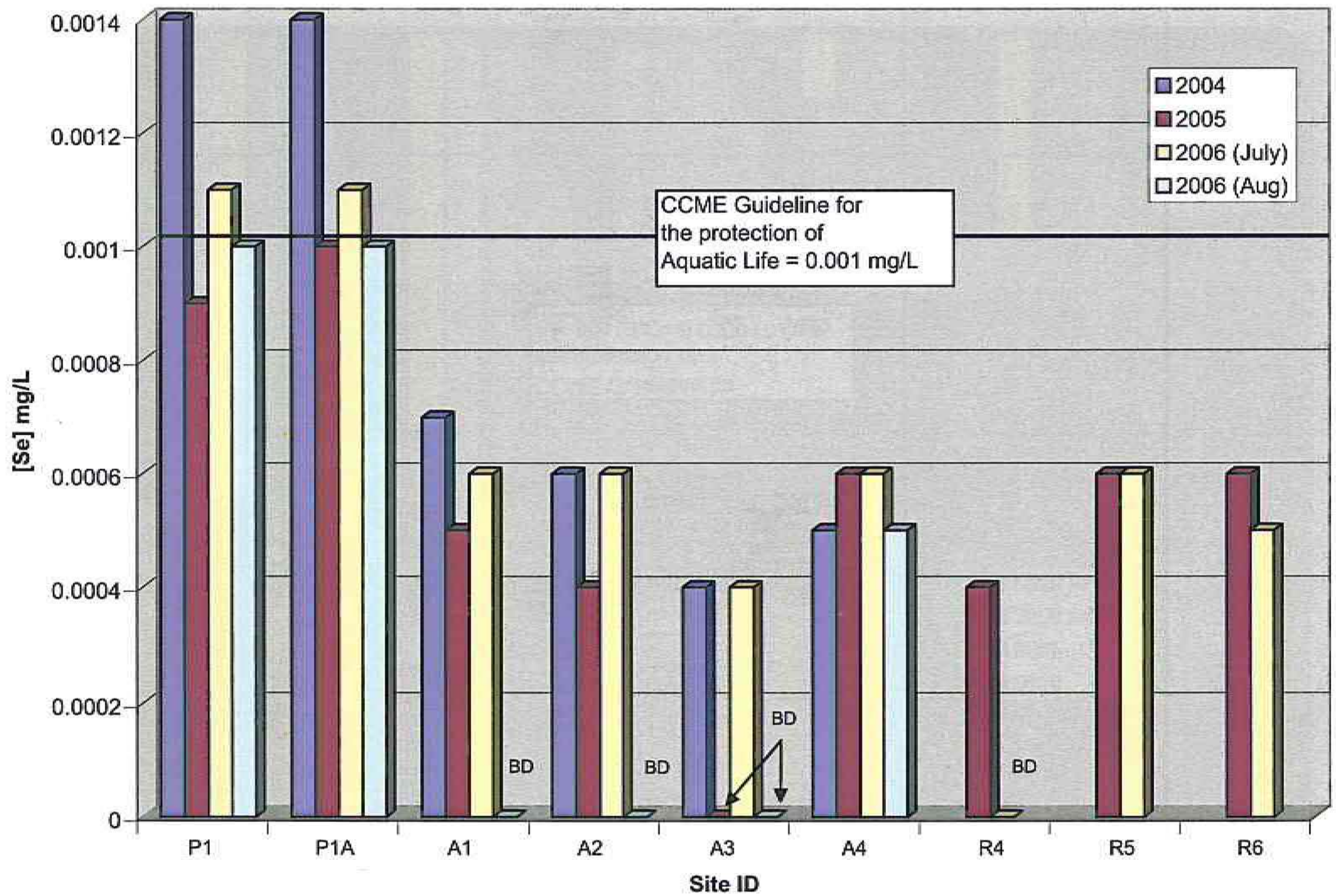


Figure 8 Water Quality Comparison of 2004, 2005 & 2006 Results for Cadmium



BD = Below Detection
Note: Cd levels at R4, R5 and R6 all BD

Figure 9 Water Quality Comparison of 2004, 2005 & 2006 Results for Selenium



BD = Below Detection

3.2 STREAM SEDIMENT SAMPLING

Results of the stream sediment sampling program are shown in Table 5. Sediment samples have been analyzed at –10 mesh size fraction. Concentrations that exceed the CCME Canadian Environmental Quality Guidelines, Interim Sediment Quality Guide, are displayed as red value entries in Table 5. Appendix 1 contains the analytical laboratory reports and sediment data.

All samples tested returned results that exceeded the CCME guideline for total arsenic. All samples tested for total cadmium, excluding site A-1 (Anvil Creek near Mouth), exceeded the CCME guideline. Total chromium was exceeded at all stations excluding the control station on the Pelly River upstream and downstream of the confluence with Anvil Creek. Not all of the duplicates tested for chromium exceeded the CCME guideline. Total copper was exceeded at all stations. Not all replicates tested for copper exceeded the CCME guideline. Only 1 of 3 duplicates exceeded the CCME guideline for copper for the Pelly River downstream of the confluence with Anvil Creek. The CCME guideline for total lead was exceeded at R4 on Rose Creek and in the sample taken from the A-4 station on Anvil Creek. One of three replicates tested exceeded CCME the guideline for A-2 and A-3 on Anvil Creek. Total mercury was not exceeded in any of the samples collected. The CCME guideline for total zinc was exceeded at all stations excluding one replicate at A-1 on Anvil Creek and one replicate at R6 on Anvil Creek upstream of the confluence with Rose Creek.

The accompanying graphs, Figures 10 to 12, compare the 2006 monitoring results with results from previous and water licence monitoring studies conducted on Rose Creek. Figures 10 to 12 present copper, lead and zinc concentrations by site and year to demonstrate the overall trends of these selected metals concentrations in sediments over time and with distance from the Faro site influence. The metals total copper, lead and zinc were selected for further analysis as indicator metals from the Faro mine complex. Metal concentrations in sediments were recorded in 1973, 1983, 1996, 2004, 2005 and 2006 in Anvil Creek. Sediment samples were analyzed at <0.15 mm in 1983 and 1996. In 1973 it appears that an unsieved sample was analyzed for metals.

Metals analysis results recorded in 1973 are limited to Rose Creek sites R1, R2, R3, Anvil Creek Site A1, and Pelly River Site P1A, as these were the only locations sampled. Results recorded in 1973 compared with results from the same sites in later years generally reveal higher total metals concentrations in stream sediments at R1, A1 and P1A, and lower metals concentration at sites R2 and R3. Metals concentrations in sediments at Rose Creek sites downstream of R1 seem to reach peak levels in 1983 for copper, lead and zinc with concentration levels decreasing each subsequent sediment analysis, until 2005. The 1983 spike in metals concentrations in sediments may be a reflection of the 1975 tailings spill, as it is the first known analysis conducted after the spill. It should be noted however, that the 1983 data lacks quality control and therefore confidence in the anomaly is low.

The 2005 data revealed a new trend as copper, lead, and zinc concentrations were elevated compared to the 2004 data. Trends in the 2006 continue to show metal concentrations increasing. The Anvil Creek sites in particular show more than a doubling in copper concentrations.

Table 5 Comprehensive Results - Stream Sediment 2006

Sample Description	A-1			Anvil A-2			Anvil A-3			Anvil A-4			Pelly River P-1 U/S Anvil			Pelly River P-1A D/S Anvil			Rose Creek R4			R-5 - Anvil Cr d/s Rose Creek			R-6 - Anvil Cr u/s Rose Creek			Detection Limit (ug/L)	CCME Guidelines	
																													Interim Sediment Quality Guidelines (ug/g)	Probable Effect Levels (ug/g)
Replicate	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
Mesh Fraction	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			
Lab Lot ID (Norwest Labs)	482049-13	482049-14	482049-15	482049-16	482049-17	482049-18	482049-19	482049-20	482049-21	482049-22	482049-23	482049-24	482049-7	482049-8	482049-9	482049-10	482049-11	482049-12	*	*	*	*	*	*	*	*	*			
CANTEST ID (Deloitte & Touche Inc.)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	607280407	607280413	607280414	607280415	607280417	607280419	607280420	607280421	607280424			
Date Sampled	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	27-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06	25-Jul-06			
Parameter[1]																														
Metals Strong Acid Digestion (ug/L)																														
Aluminum	15800	12400	14100	17600	13500	13600	16500	13800	17700	17600	16100	15400	8910	8380	8310	9200	8900	8660	9380	18000	17700	17500	19700	20400	10100	20300	20700	1		
Antimony	<0.5	<0.5	<0.5	0.5	<0.5	0.9	0.9	0.9	0.6	1.5	1.4	1.3	1.3	1.5	1.3	1.7	1.3	1.9	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	0.5		
Arsenic	12.1	11.8	13.1	18.2	14.2	12.1	15.4	12.3	19.4	19.2	15.4	14.6	12.4	10.5	11.4	10.8	13	10.6	< 10	16	16	< 10	13	13	10	12	12	0.2	5.9	17
Barium	436	486	523	585	633	435	475	488	515	503	561	472	589	619	576	636	638	631	226	498	533	238	289	247	114	211	204	0.03		
Beryllium	0.58	0.48	0.58	0.77	0.58	0.57	0.73	0.57	0.74	0.73	0.66	0.62	0.46	0.43	0.42	0.48	0.46	0.44	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0.01		
Bismuth	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	< 1	< 1	1	< 1	1	1	< 1	1	1	0.5		
Cadmium	0.57	0.59	0.68	1	0.67	0.69	0.78	0.62	0.9	0.98	0.79	0.72	1.7	1.7	1.4	2	1.8	1.7	0.7	1.1	1.1	0.8	0.9	1.2	< 0.5	1	1	0.05	0.6	3.5
Calcium	12300	11700	9980	9580	8990	8100	8290	7850	8910	6640	6000	5490	26900	28200	26300	26100	26500	26500	4020	6880	6760	6170	6470	6450	4320	7130	6760	2		
Chromium	42.6	45.1	39.3	49.5	43.5	38.9	46.3	42.3	58.8	41.2	38.5	35.2	22.7	21.1	21.1	23.2	22.8	22.1	26	64	48	40	41	43	27	57	41	0.04	37.3	90
Cobalt	10.1	8.8	9.62	12.6	9.63	9.58	12.1	10.2	14.3	14.8	12.9	13.1	8.29	7.71	7.49	8.48	8.11	7.91	17	25	26	14	16	17	11	17	16	0.05		
Copper	108	97	43.1	203	30.4	43.7	77.6	42.3	248	52.7	40.1	34.9	41.8	27.6	41.7	30.3	38.9	27	39	51	51	32	38	45	16	41	42	0.05	35.7	197
Iron	26200	22800	23700	29500	24400	23300	27900	23600	28500	31300	30300	28600	22100	20600	20400	22100	22300	21300	18300	23500	22400	20400	21700	22900	18600	22500	21800	1		
Lead	20.9	15.1	24.4	42	31.9	30.4	35	33.6	64.4	64.4	62.8	69.5	12.2	15.6	10.9	12.5	11.8	11.2	97	135	128	24	28	22	10	17	17	0.3	35	91.3
Lithium	25.5	19.8	24.1	31.5	23.1	24.5	30.9	24.4	33	31.7	28.5	27.7	14.8	16.8	14	17.6	14.8	16.9										0.1		
Magnesium	9190	7460	7670	9040	7140	7410	8710	7510	10300	8100	7650	7270	11200	11600	10900	11200	11300	11300	4820	6770	6790	6890	7360	7710	5260	7850	7690	1		
Manganese	851	625	1140	2160	1260	945	1960	1300	3160	2450	1310	2050	564	485	504	496	514	481	3560	6670	7550	731	1340	970	632	690	580	0.3		
Mercury	0.044	0.037	0.06	0.084	0.061	0.062	0.078	0.056	0.076	0.084	0.081	0.088	0.092	0.079	0.074	0.104	0.099	0.088	0.05	0.11	0.11	0.03	0.04	0.04	0.01	0.03	0.03	0.003	0.17	0.486
Molybdenum	1.1	0.87	1.2	1.6	1.2	1.1	1.5	1.2	1.9	2.5	1.8	1.5	2.2	1.9	2	2.1	2.2	1.9	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	0.05		
Nickel	40.4	35.6	39.3	53.6	39.4	40.8	52.2	42.9	71.5	46.3	41	38.8	41.1	37.1	37	41.8	41.4	38.9	41	56	56	40	43	47	30	48	45	0.1		
Phosphorus	1080	1230	1020	1070	1170	982	929	980	938	1150	1160	1000	1260	1480	1310	1280	1320	1300	828	781	782	1250	1140	1130	1330	1160	1100	0.5		
Potassium	2290	1720	2030	2590	1840	1880	2260	1800	2680	1830	1570	1510	1390	1320	1300	1460	1340	1340	787	1340	1340	1100	1330	1310	663	1450	1380	5		
Selenium	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.5	0.8	0.8	0.6	0.8	0.8	0.4	0.8	0.7	0.3		
Silicon	368	196	365	394	424	353	385	417	383	277	166	149	684	505	184	424	224	406										1		
Silver	<0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.3	0.4	0.3	0.3	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	0.2		
Sodium	434	324	319	329	287	284	301	282	349	343	312	326	121	131	107	124	117	120	135	278	266	220	260	229	91	232	233	1		
Strontium	59.6	54	51.4	56.2	45.4	44.2	47.6	42.3	60.4	44.6	39.9	39.3	83.8	88.9	81.8	83.9	83.4	84.4	27	49	49	35	38	37	24	37	37	0.02		
Thallium	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3	<0.3	<0.3	<0.3	<0.3										0.3		
Tin	1.5	1.4	1.3	6.8	2.4	1	1.3	1.6	24.6	1.9	0.9	0.7	0.4	3.2	0.6	0.4	0.4	0.4	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	0.2		
Titanium	534	431	432	458	418	386	435	419	488	476	454	418	126	114	108	122	125	122	184	434	416	449	495	527	148	532	496	0.05		
Vanadium	51.1	46.7	49.5	61.8	52.7	47.5	54.8	47.7	55.3	66.2	61	54.6	47.8	46.2	44.4	51.2	48.1	47.9	26	34	32	52	52	61	35	61	58	0.1		
Zinc	138	112.0	150	248	162	175	226	178	260	341	292	306	200	178	183	211	209	196	280	546	584	134	153	160	69.0	133	126	0.1	123	315
Zirconium	4.6	4	4.5	5.4	4.5	4.3	4.8	4.4	5.7	4.3	4.2	3.9	4.98	5.42	4.5	5.23	4.5	5.11	1	1	1	2	2	2	2	2	2	0.05		
Soil Acidity																														
pH	8	7.9	7.5	7.5	7.8	7.8	7.9	8.1	7.7	7.6	7.5	7.6	8.1	8.3	8.1	8.2	7.8	8.1	7.5	7.7	7.7	7.9	7.7	7.5	7.8	7.7	7.9			

Note: Values in red are in exceedence of the CCME Interim Sediment Quality Guidelines

Figure 10 Copper Concentrations in Sediments, Trend by Site and Year

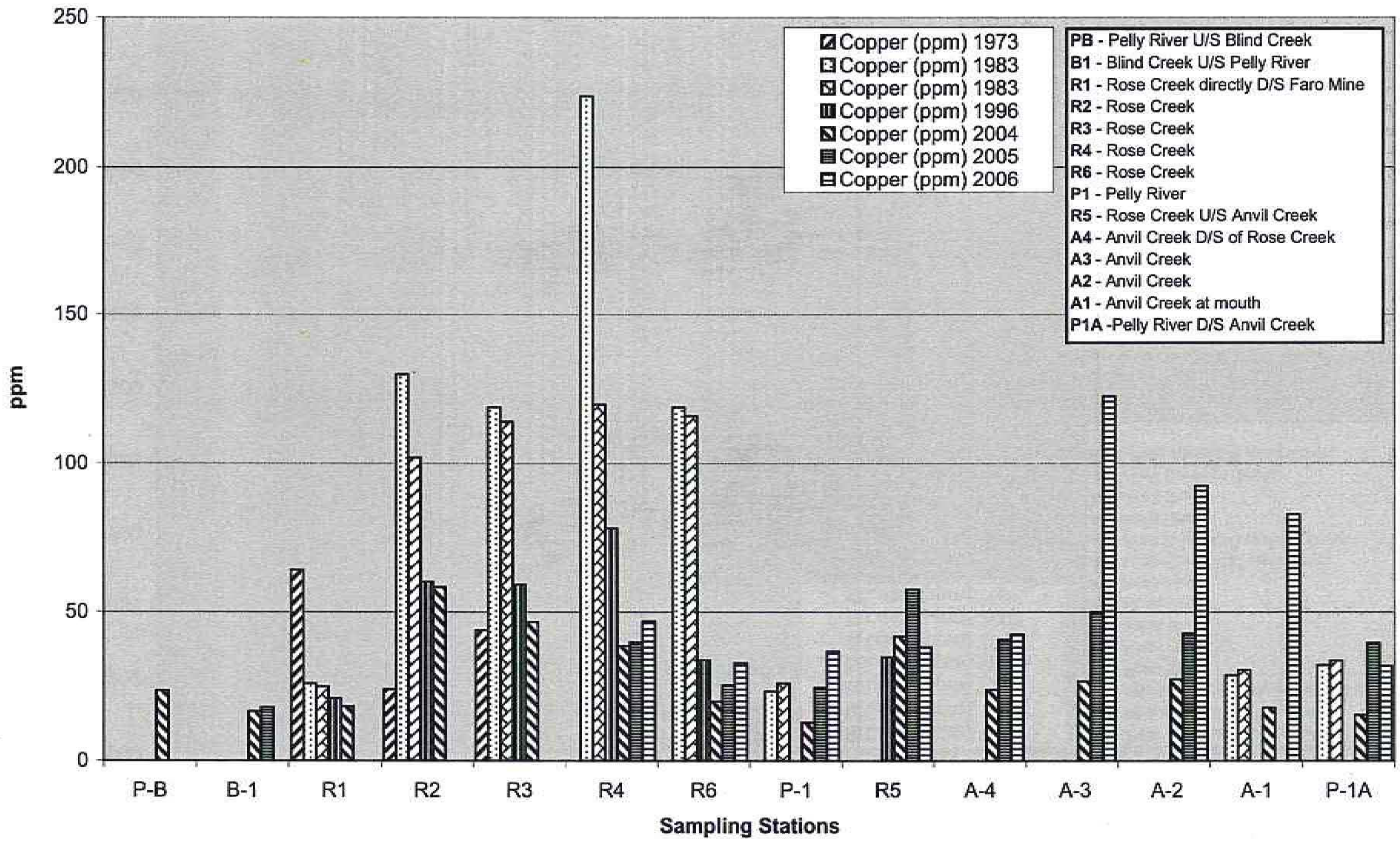


Figure 11 Lead Concentration in Sediments, Trend by Site and Year

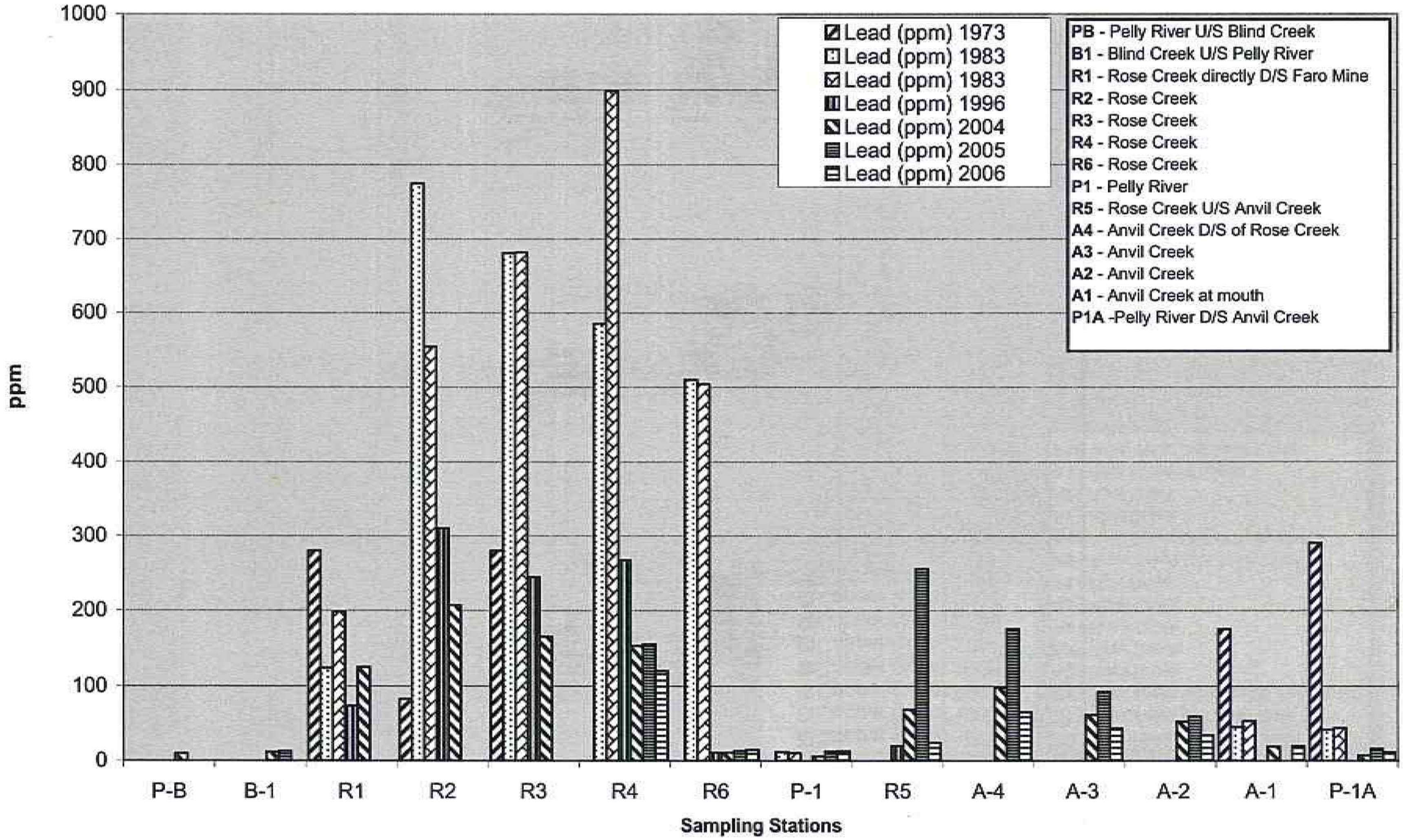
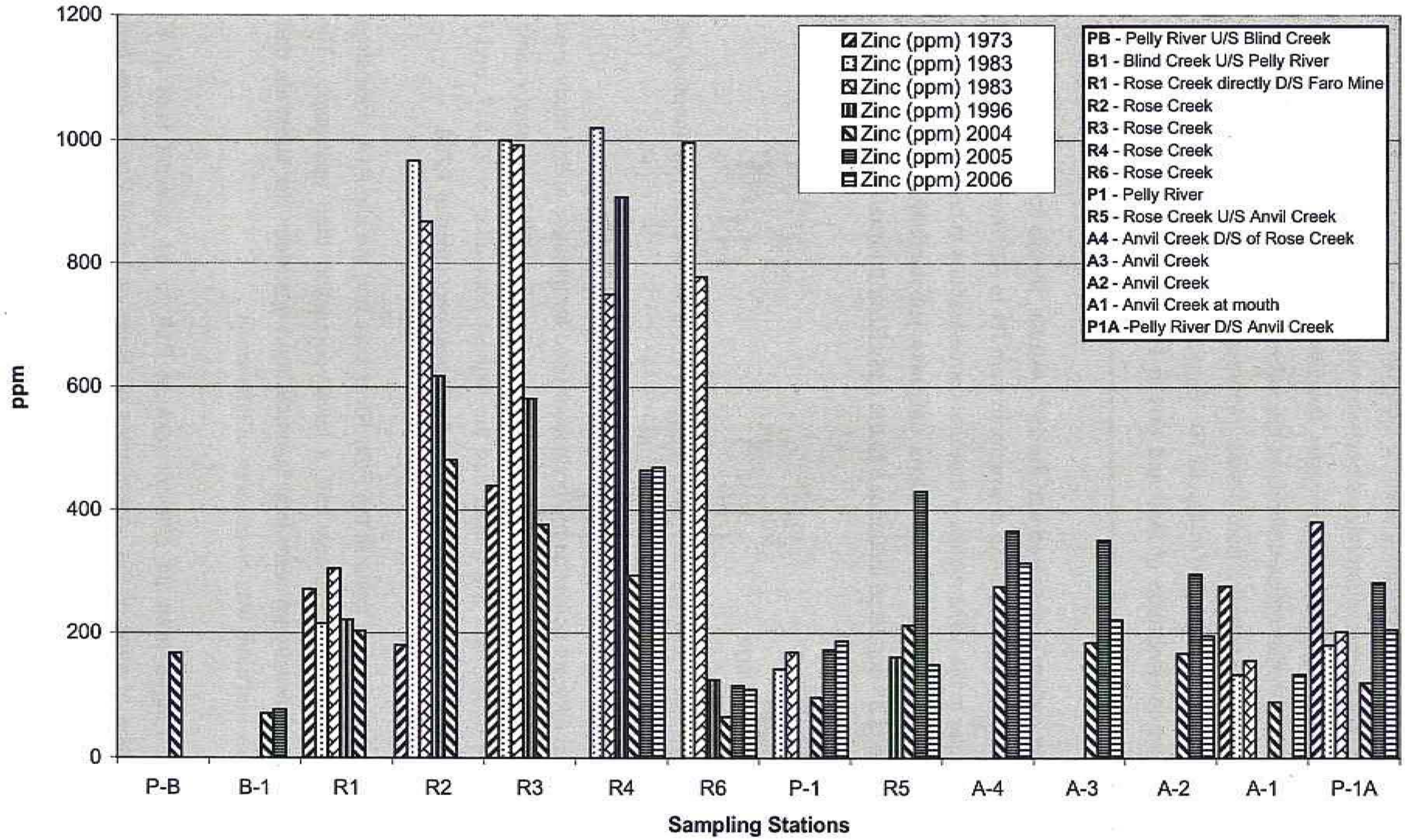


Figure 12 Zinc Concentrations in Sediments, Trend by Site and Year



In 2006, metal concentrations seem to increase at first moving downstream from site R4 reaching maximum concentrations between sites R4 and A3 as metals were mobilized. Metal concentrations, excluding copper, downstream from site R4 decrease towards the Pelly River. Metals concentrations at the individual sites have consistently decreased, again excluding copper, from levels recorded in 2005. The increase in copper concentrations is displayed in Figure 10. Figures 11 and 12 show this notable trend of decreased concentration of lead and zinc in sediments at the Rose and Anvil Creek sample stations.

A different pattern is observed with the 1973 results. Metals concentrations in sediments consistently decrease moving downstream from R1 to R2, then increase from R2 to R3. Also unique to the 1973 results is that zinc concentrations in sediments increase from A1 to P1A, while copper concentrations decrease substantially. This may indicate the presence of an unrelated influence into the Pelly River between A-1 and P1A.

3.3 BENTHOS

3.3.1 Assemblage

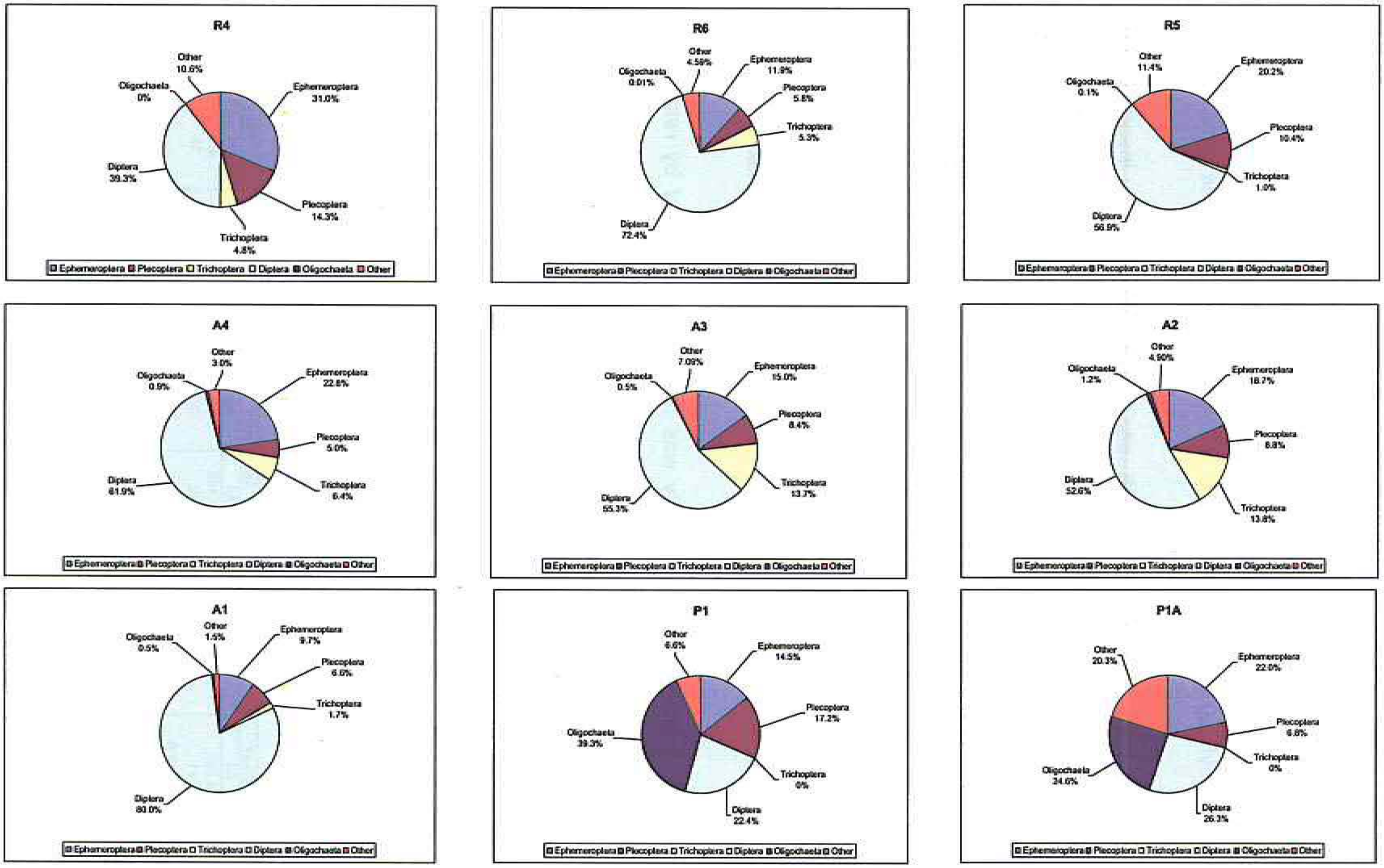
A total of 79,525 invertebrates were collected in the study area, representing 96 different taxonomic groups (Appendix 4).

Since two different collection methods were used for the sites in this study area, it is not appropriate to compare the abundance values. For the artificial substrate sampler sites, A1, Anvil Creek near the mouth had the highest population of 23,517, and R5, Anvil Creek downstream of Rose Creek, had the lowest population of 1,768.

Numbers were much lower at the Pelly River sites and the site P1A, downstream of the confluence with Anvil Creek had a lower population than upstream. The habitat conditions downstream were less favorable than upstream; the substrate consisted of more fines and there was an absence of riffle areas.

Diversity ranged from 24 different taxa at P1A to 51 different taxa at R4. The composition of most of the communities on Rose and Anvil Creek were fairly similar (Figure 13).

Figure 13 Composition of the Benthic Invertebrate Community at Each Site, 2006



The composition of the Pelly River sites was different from the other sites but relatively similar to each other. Any group of taxa that forms 25% or more of the community is considered dominant. All communities were dominated by the order Diptera (true flies) representing 26% to 80% of the population, with the exception of P1, which was dominated by Oligochaeta (aquatic earthworms) forming 39% of the population. Ephemoptera (mayflies) shared dominance at R4 representing 31% of the community.

The EPT index was calculated for each site. Members of the insect groups Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) require clean well aerated water, and the total number of these taxa give an indication of the quality of the habitat conditions. The Pacific Streamkeepers Federation has rated an EPT index of greater than eight as good. The Pelly River sites had an index of 8 and 9 (Table 6).

The Rose and Anvil Creek sites considerably exceeded eight with an EPT index ranging from 19 at R5 to 27 at R4. Although Diptera dominated these sites, the EPT index indicates there was good representation from the pollution sensitive organisms.

The taxonomic wealth of each community was further characterized by relating the diversity (total number of taxa in the sample) to the population size. The richest communities were located on Rose Creek and at the upper Anvil Creek sites (R6 and R5). This would indicate that these sites have greater habitat complexity providing a variety of niches for a wider array of taxa to colonize.

All of these data have been summarized in the table below.

Table 6 Summary of Benthic Invertebrate Data, 2006

	Rose Creek	Anvil Creek						Pelly River	
	R4	R6	R5	A4	A3	A2	A1	P1	P1A
Abundance	4,252	8,934	1,768	10,465	20,798	9,294	23,517	379	118
Diversity:	51	45	38	42	50	45	45	35	24
Dominant Group	Diptera & Ephemeroptera	Diptera	Diptera	Diptera	Diptera	Diptera	Diptera	Oligochaeta	Diptera
EPT Index:	27	20	19	21	23	21	20	8	9
Richness Index:	6.0	4.8	4.8	2.2	2.2	2.2	1.9	1.2	1.7

Most of these sites were sampled in previous years as a component of the annual Pelly Aquatics Effects Study. Since 2006 was the regular monitoring year for the Faro Rose Creek Benthic Monitoring Program under water license number QZ03-059, the sampling protocols for the Anvil River sites, A1 to A4, were modified from the past (Surber) to become consistent with the Rose Creek sites (substrate samplers) for comparison purposes. Therefore, the 2006 Anvil Creek data cannot be compared to the data collected from previous years (2004 and 2005). The sites on the Pelly River have continuously used Surber Samplers as the collection method and Table 7 provides a yearly comparison for 2004 to 2006.

Table 7 Benthic Invertebrate Data for the Pelly River Sites 2004, 2005 and 2006

	Pelly River	
	P1	**P1A**
Density (#/m²):		
2004	133	104
2005	0	4,137
2006	1,360	423
Diversity:		
2004	8	6
2005	0	31
2006	35	24
Dominant Group:		
2004	Ephemeroptera	Ephemeroptera
2005	N/A	Diptera
2006	Oligochaeta	Diptera

Numbers have fluctuated considerably at both sites over the past three years. Although samples were collected at P1 in 2005, no invertebrates were found in the detritus. Diversity has also varied over time. Dominance has shifted from the chemical sensitive order, Ephemeroptera to the more tolerant taxa of Oligochaeta and Diptera. Large rivers such as the Pelly are difficult to sample for benthos, espically using a Surber Sampler. Only the shoreline can be sampled due to the height restriction of the sampler, and the wetted perimeter of the accessable littoral zone changes throughout the summer, thereby providing a shorter time frame for colonization. No reliable trends can be deduced from the above data set.

3.3.2 *Metals in Benthic Invertebrate Tissues*

A greater effort was made in 2006 to collect as much biomass as possible from each of the sites. Two members of the crew devoted their time to this activity at each of the sites. Ephemeroptera formed the majority of the biomass collected at most of the sites and formed a large portion of the community at each site. Large larvae of the family Perlodidae of the order Plecoptera also formed a significant component of the biomass from the sites. As these two chemical sensitive orders were the bulk of the biomass analyzed for metal content at each of the sites, metal uptake comparisons between sites can be attempted. Table 8 describes the metals concentrations in biomass tissues collected for each site. Values indicated with red and bold are the highest concentrations over the three testing years. Refer to Appendix 3 for the Norwest Labs metals in benthic invertebrates report.

Station P1A, 5 kilometers downstream of Anvil Creek, had highest values in 12 metals. Values for station P1, upstream of Anvil Creek were highest in 7 metals. Sample station A4, less than 2.5 km downstream of the mouth of Rose Creek, exhibited the highest concentration in 1 metal. R6, upstream of Rose Creek, exhibited no maximum values.

Table 9 shows a comparison of metal concentrations recorded for the overlapping stations sampled for benthos from 2004 through 2006. The maximum values for all sample stations for 2004 through 2006 is indicated in bold. Analysis of station P-1A showed the highest concentrations in 15 of the metals. New maximums were found in 22 of the 29 metals tested. Moving upstream on the Pelly River and into Anvil Creek, station A-1 samples indicated the highest concentrations in silver only. Increases from 2005 were found in 10 of the 20 metals tested. Sample results moving further up Anvil Creek to sample station A-2 were highest only in 1 metal, Nickel. Increased levels from 2005 were found in 14 metals. Station A-3 displayed no new maximums for 2006. Values at this location increased for 12 of 29 the metals tested. Station A-4, the closest to the Rose/Anvil Creek confluence, had the highest values in manganese only, and increased values from 2005 in 22 of 29 metals tested.

The results of benthic invertebrate tissue analysis for 2004 through 2006 are supported by sediment analysis for 2004 and 2005. Results from 2006 benthic tissue metals testing are inconsistent with concentrations present in sediments. Benthic tissue samples taken from station P-1A show in increase in copper, lead and zinc concentrations, while sediment samples from this location indicate a decrease in the above metals. Sample station A-1 indicate a decrease in copper concentrations, an increase in lead and a decrease zinc. Sediment samples taken from this location do not match the above behavior when 2006 data is compared against 2004 levels. No data sediment sample data for 2005 was recorded. Station A-2 tissue samples indicate a continued rise in copper and lead levels, and a drop in zinc concentrations. Copper and zinc levels in sediment samples display similar behavior to benthic tissue levels. Benthic tissue metals concentrations trends for A-3 show a continued increase in copper and lead, with zinc falling slightly from 2005 levels. Sediment samples taken from this location show a rising trend for copper, while lead and zinc levels appear to be falling to levels similar to those seen in 2004. Metals in tissue samples from station A-4, when compared to sediment samples, show similar trends for both copper and zinc levels. Tissue lead levels have increased at this location while the lead concentrations in sediment have fallen below 2004 levels.

Table 8 Metal Concentrations in Benthic Invertebrate Tissue, 2006

Sample Station	A-1	A-2	A-3	A-4	P-1	P-1A	R-5 - Anvil Cr d/s Rose Creek	R-6 - Anvil Cr u/s Rose Creek	Detection Limit (ug/g)
Lab Lot ID	493044-7	493044-6	493044-5	2012516-4	2012516-8	2012516-9	2012516-3	2012516-2	
Date Sampled	7/27/2006	7/27/2006	7/27/2006	7/27/2006	7/27/2006	7/27/2006	7/25/2006	8/30/2006	
Parameter									
Total Metals (ug/g)									
Aluminum	918	972	1210	1060	2180	2550	**2620**	697	1
Antimony	<2	<0.8	<1	<3	<3	<3	**<4**	<1	3
Arsenic	2	2.5	1.9	2	2	4.2	**4.8**	1.3	0.7
Barium	46.2	72.6	58.3	146	204	**314**	175	48	0.4
Beryllium	<0.06	0.05	0.07	<0.09	**0.1**	**0.1**	**0.1**	0.05	0.01
Bismuth	<2	<0.8	<1	<3	<3	<3	**<4**	<1	3
Cadmium	6	3.2	2.7	2	15	**16**	1	8.9	0.1
Calcium	4770	3220	4470	4910	7560	**8020**	3260	2270	1
Chromium	2.54	2.9	3.81	2.8	4.9	6.22	**6.87**	1.89	0.2
Cobalt	2	2.4	2.1	2	**4.4**	3.6	3	3.1	0.2
Copper	56	47.1	64.5	51.6	**68.3**	42.1	57.5	48.3	0.2
Iron	1700	1740	2190	2090	5300	**6550**	5440	1770	0.4
Lead	6.1	4	7.3	7.7	10	11	**12**	3.4	1
Lithium	2.2	1.9	2.4	2	4.5	**4.7**	4.6	1.4	0.3
Magnesium	1640	1830	1860	1740	3170	**3870**	2370	1630	2
Manganese	327	1130	626	**1570**	252	322	1240	909	0.1
Mercury	0.5	0.4	0.4	0.8	0.9	**1**	0.9	0.6	0.005
Molybdenum	4.7	14.7	6.8	5.3	12	**16**	11	3.9	0.2
Nickel	8280	**8870**	7970	7930	7320	5990	4250	7580	0.5
Phosphorus	3360	**4650**	2040	2300	1600	2000	2800	2950	2
Potassium	**3.7**	1.6	2.5	<1	3	3.6	<2	3.1	4
Selenium	<0.6	<0.2	<0.4	<0.9	**<1**	<0.9	**<1**	<0.3	1
Silver	**4830**	3230	1200	996	1340	1580	998	1780	0.7
Sodium	13.2	9.48	12	15.8	28.6	**29.4**	14.4	6.19	0.2
Strontium	<1	<0.4	<0.7	<1	**3**	2	<2	<0.5	0.01
Titanium	35.1	32.3	43.3	42	44.8	55.1	**117**	22.2	0.2
Vanadium	3.3	3	3.8	4	10	**12**	9.6	2.6	0.4
Zinc	614	509	552	671	**1250**	1020	374	299	0.1
Zirconium	0.4	0.4	0.4	0.8	**1**	**1**	**1**	0.5	0.2

Note: Values bolded in red are highest total metal concentration observed for each parameter.

Table 9 Comparison of Metal Concentrations in Benthic Invertebrate Tissues for 2004 to 2006

Sample Station	A-1			A-2			A-3			A-4			P-1A			Detection Limit
Date Sampled	7/31/2004	8/9/2005	7/27/2006	7/29/2004	8/9/2005	7/27/2006	7/29/2004	8/9/2005	7/27/2006	7/29/2004	8/9/2005	7/27/2006	7/29/2004	8/9/2005	7/27/2006	(ug/g)
Parameter																
Total Metals (ug/g)																
Aluminum	60.8	2000	918	86.1	1170	972	92.1	1300	1210	33.9	434	1060	25.2	1280	**2550**	1
Antimony	0.02	<1	<2	0.02	<0.5	<0.8	0.02	<0.5	<1	0.03	<0.5	<3	<0.02	**0.5**	<3	3
Arsenic	0.11	1.3	2	0.18	1.5	2.5	0.17	1.9	1.9	0.1	<0.5	2	0.07	1.2	**4.2**	0.7
Barium	10.7	181	46.2	7.14	71.2	72.6	8.5	74.8	58.3	8.45	30	146	3.34	188	**314**	0.4
Beryllium	<0.009	0.07	<0.06	<0.007	0.08	0.05	0.006	0.08	0.07	<0.004	<0.07	<0.09	<0.008	0.08	**0.1**	0.01
Bismuth	<0.04	<10	<2	<0.03	<6	<0.8	<0.02	<7	<1	<0.02	**<20**	<3	<0.04	<10	<3	3
Cadmium	0.0842	1.6	6	0.214	1.9	3.2	0.121	1.7	2.7	0.15	0.5	2	0.574	3.9	**16**	0.1
Calcium	424	5010	4770	558	**9040**	3220	642	6470	4470	616	2500	4910	261	5760	8020	1
Chromium	0.24	**6.9**	2.54	0.27	4.8	2.9	0.29	5	3.81	0.15	4.7	2.8	0.14	5.2	6.22	0.2
Cobalt	0.054	1.9	2	0.102	1.9	2.4	0.104	2.3	2.1	0.104	1.1	2	0.041	1.6	**3.6**	0.2
Copper	1.67	**108**	56	2.36	43.2	47.1	2.36	38.8	64.5	2.17	38	51.6	6.97	35	42.1	0.2
Iron	99.5	3460	1700	169	1980	1740	185	2130	2190	114	860	2090	58.9	2580	**6550**	0.4
Lead	0.491	4.1	6.1	6.39	2.4	4	0.578	2.5	7.3	0.491	<0.5	7.7	0.085	2.3	**11**	1
Lithium	0.1	4.1	2.2	0.13	2.7	1.9	0.14	2.9	2.4	0.06	<2	2	<0.08	3	**4.7**	0.3
Magnesium	47	1460	1640	62	1260	1830	106	1240	1860	70	946	1740	68	1630	**3870**	2
Manganese	43.8	631	327	28	589	1130	47.2	630	626	65.1	343	**1570**	5.9	234	322	0.1
Mercury	<0.009	0.047	0.5	<0.007	0.042	0.4	<0.004	0.038	0.4	<0.004	<0.04	0.8	0.008	0.064	**1**	0.005
Molybdenum	<0.09	1	4.7	<0.07	0.8	14.7	0.08	1	6.8	0.06	0.6	5.3	<0.08	1	**16**	0.2
Nickel	0.22	19	8280	0.37	10	**8870**	0.42	13	7970	0.27	3.2	7930	0.25	9.8	5990	0.5
Phosphorus	174	4300	3360	182	**8540**	4650	372	7230	2040	326	5890	2300	318	5030	2000	2
Potassium	<40	635	3.7	<30	1460	1.6	26	1450	2.5	<20	**1780**	<1	<30	934	3.6	4
Selenium	0.12	2.3	<0.6	0.11	**3.2**	<0.2	0.18	2.7	<0.4	0.16	<0.7	<0.9	0.67	2.9	<0.9	1
Silver	0.011	<0.5	**4830**	0.019	0.2	3230	0.012	<0.2	1200	0.011	<0.2	996	0.048	<0.2	1580	0.7
Sodium	<40	100	13.2	<30	**1000**	9.48	<20	100	12	<20	900	15.8	<30	490	29.4	0.2
Strontium	1.21	17.2	<1	1.53	**28.7**	<0.4	1.58	20.8	<0.7	1.62	10.5	<1	0.94	22.5	2	0.01
Titanium	2.61	**65**	35.1	3.28	30.5	32.3	2.96	34.6	43.3	1.26	13	42	0.68	25	55.1	0.2
Vanadium	0.309	7.7	3.3	0.421	4.4	3	0.422	3.5	3.8	0.168	<0.5	4	0.222	6.6	**12**	0.4
Zinc	35.1	694	614	48.9	739	509	44.8	748	552	63.6	497	671	45.7	623	**1020**	0.1
Zirconium	<0.09	**1**	0.4	<0.07	**1**	0.4	0.05	0.8	0.4	<0.04	<1	0.8	<0.08	**1**	**1**	0.2

Note: Values bolded in red are highest total metal concentration observed for each parameter for 2004, 2005 and 2006.

4.0 CONCLUSIONS/RECOMMENDATIONS

Based on the results of this study, most water samples met the CCME guidelines for the protection of freshwater aquatic life. CCME guidelines were mainly exceeded for the parameters aluminum and cadmium. Cadmium levels recorded in 2005 showed an increase over levels reported in 2004. The 2006 data shows cadmium levels similar or lower than those reported in 2005.

Most sediment samples exceeded the CCME guidelines for arsenic, cadmium, chromium, copper, lead, and zinc. Results from the 2004 and 2005 Pelly River Aquatic Effects Assessments alluded to a trend in increasing levels of metals in Anvil Creek sediments. Data collected in 2006 continues to support this observation.

Further sampling and study of flood plain soils was not conducted in 2006.

Benthic population numbers and diversity were generally much greater in 2006 than in 2005, with a continued shift in dominance from more sensitive groups in 2004 and 2005, to more tolerant groups in 2006. In general, metal concentrations observed in 2006 are higher compared to analysis results from 2005.

Metal content analysis of fish tissue was not conducted during 2006 studies.

The extent to which the historic tailings are influencing the aquatic community in Anvil Creek is not fully understood. The results of this investigation provide valuable insight into downstream effects of the Faro mine site on lower Rose and Anvil Creeks. It is recommended that water quality and sediment sampling be repeated in 2007 to document metals burden in the local aquatic ecosystem.

Fisheries studies in Anvil Creel should coincide with the Water Use Licence studies conducted in Rose Creek.

5.0 CLOSURE

Access Consulting Group[1] of Whitehorse has prepared this Pelly River Aquatic Effects Assessment Report in conjunction with Selkirk First Nation, and Laberge Environmental Services.

The assistance of the following people is gratefully acknowledged:

- → Ellie Marcotte, Selkirk First Nation, Faro Mine Community Coordinator
- → Selkirk Renewable Resources Council
- → Bonnie Burns, Laberge Environmental Services
- → Nichole Speiss and Ryan Gould, Access Consulting Group

We trust the above report fulfils your present requirements. If you have any questions or require additional details, please contact the undersigned.

Dan Cornett, B.Sc., P.Biol, CCEP
Access Consulting Group

[1] Access Consulting Group is a registered trade name for Access Mining Consultants Ltd.

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