Pelly River Aquatic Effects Assessment – 2005

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DRAFT

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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 Lands 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 occurred in 2002, 2003, 2004, and again in 2005. 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 investigations are reported in the Pelly River Aquatic Effects Assessment – 2004, 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 2004, the principle area for investigation for the aquatic assessment was Anvil Creek. Secondary sample locations were located along the Pelly River both upstream and downstream of the confluence with Anvil Creek, at Rose Creek both upstream and downstream of the confluence with Anvil Creek, and a single control site on Blind Creek just upstream of its confluence with the Pelly River. 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. A general location map and Pelly River Drainage overview map are shown on Figures 1 and 2 respectively.

The goal of the Pelly River aquatic effects assessment is to sample specific sites to determine and track water quality, sediment and soil quality, and to track the presence, relative abundance, and condition of benthos and fish within Pelly River and Anvil Creek. Slimy sculpin (*Cottus cognatus*), Arctic grayling (*Thymallus arcticus*) and benthic invertebrates were collected to determine the level of metals in their tissue. Fish utilization data was also collected to document long-term fisheries resource use and to establish an adequate level of reference data. Sampling methods duplicated those used in 2004 to the best level possible.

Specific objectives of the Pelly River aquatic effects assessment include:

- Gather water quality 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 the data collected with the existing SFN dataset, the Faro and Vangorda Mine Water Use License monitoring data, and with the data from the 2004 Pelly River aquatic effects assessment;
- Assess the Anvil Creek drainage for possible effects to aquatic resources resulting from historic operation of the Faro mine;

- Enable an assessment of the 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 the 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 between the towns of Faro and Pelly Crossing, Yukon, between August 5th and 12th 2005. Analytical results are presented for 2005 and compared with the 2004 assessment data. Figures 2 and 3 provide an overview of the project area with monitoring station locations and stations located closer to the Faro mine site, respectively.

Figure 1 General Location Map

Figure 2 Pelly River Drainage Overview Map

2.0 METHODS

The 2005 aquatic effects assessment was conducted between August 5 and 12th when water levels were low and fish distribution at its seasonal peak. The timing corresponds with previous investigation conducted between July 27 and August 4, 2004. Three sample stations were added at the Anvil and Rose Creek confluence during the 2005 assessment. Sampling occurred at Rose Creek, upstream of Anvil Creek (R4), and on Anvil Creek upstream (R5) and downstream (R6) of the Rose Creek confluence (Figure 3). These three sites comprise a portion of the monitoring program for the existing water licence. All sites on Anvil Creek were accessed with a helicopter.

Locations of the sample sites established within the Pelly River watershed for data collection are shown in Figure 2 and include 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 the Anvil Creek monitoring stations along with existing water licence monitoring stations on Rose Creek. Table 1 provides a listing of the monitoring stations, their location and assessment parameters.

Table 1 Monitoring Station Assessment Parameters for 2005

Station Code	Description	Assessment Parameters
GR	Glenlyon River	**WQ**
TR	Tummel River	**WQ**
Tay	Tay River	**WQ, B**
ER	Earn River	**WQ**
NC	Needlerock Creek	**WQ**
MR	Macmillan River	**WQ**
PB	Pelly River U/S Blind Creek	**WQ, FS**
B1	Blind Creek U/S Pelly River	**SS, WQ, B**
P1	Pelly River U/S Anvil	**SS, WQ, B**
P1A	Pelly River D/S Anvil Creek	**SS, WQ, B**
A4	Anvil Creek ~18 km U/S Pelly River	**SS, WQ, F, B, FS**
A3	Anvil Creek ~12 km U/S Pelly River	**SS, WQ, F, B, FS**
A2	Anvil Creek ~7 km U/S Pelly River	**SS, WQ, F, B, FS**
A1	Anvil Creek at mouth	**WQ, F, B, FS**
R4	Rose Creek	**WQ, SS**
R5	Anvil Creek D/S Rose Creek	**WQ, SS**
R6	Anvil Creek U/S Rose Creek	**WQ, SS**
P2	Pelly River	**-**
P3	Pelly River at SFN Sign	**WQ**
P4	Pelly River D/S Slide	**WQ**
P5	Pelly River at LJ slough	**WQ**
P6	Pelly River at Needlerock Creek	**WQ**

List of abbreviations:
WQ - water quality analysis, **SS** - stream sediment analysis, **B** - benthos tissue analysis, **F** - fish tissue analysis, **FS** – floodplain soil analysis.

Figure 3 Monitoring Station Locations

At each Anvil Creek station (A1 – A4), the following information was collected:

- Water samples for analysis, and in situ measurements;
- Stream sediment replicates for metals analysis (except A1);
- Soils within test pits for metals and sequential extraction analysis;
- Benthic invertebrates for community abundance, distribution and metals analysis;
- Fish sampling for abundance, utilization, distribution and specimen collections for metals levels in tissue was conducted; and
- Photographs representative of each site were taken and any observed changes to the sites that occurred between 2004 and 2005 were recorded.

Refer to Appendix 1 for general descriptions of the Anvil Creek sites including in situ measurements and and selected photographs taken during the effects assessment.

Pelly River sample locations were located between Faro and Pelly Crossing to measure downstream effects from the mine sites located near Faro. While these sites were not sampled for fish utilization, water samples were collected as well as benthic and sediment samples upstream and downstream of Anvil Creek.

2.1 WATER QUALITY MONITORING PROGRAM

Water quality sampling occurred between August 5th and 12th at all station locations. Water samples were collected at each site and analyzed for dissolved and total metals, nutrients, and routine parameters at Norwest Labs in Vancouver. Water samples were collected following standard protocols in clean new plastic bottles, kept cool, and shipped to Norwest Labs for analysis of a suite of parameters mirroring the 2004 sample program, which is 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 its major tributaries, as well as a low detection limit background data set. In situ measurements were also recorded.

2.2 STREAM SEDIMENT SAMPLING

Two replicate stream sediment samples were collected at Anvil Creek, Rose Creek, Blind Creek and Pelly River sample stations and analyzed for metals and acidity at Norwest Labs in Vancouver, B.C. Additional soil samples were collected at the Anvil Creek stations (A1 – A4) to document possible historic mine effects (see Section 2.3). The Blind Creek station served as a control station for the project.

2.3 FLOODPLAIN SOIL SAMPLING

Soil sampling was undertaken at the Anvil Creek stations to document soil metal and pH levels and to look for the remains of the 1975 tailings spill. During the 2004 sample program, hand dug test pits were sampled across the channel flood plain along a transect at each location on Anvil Creek. The test pit exhibiting the lowest pH in each transect was selected for further sampling in the 2005 effects assessment. In August 2005, a single composite sample was collected from the individual soil horizons within the test pit identified from the 2004 sampling program. The composite sample was collected using standardized protocol, placed in clean plastic bags, kept cold and shipped to Norwest Labs in Vancouver for metals analysis. In situ measurements of pH were recorded for each soil horizon within the test pit. An additional sample was collected from that soil horizon with the lowest pH for sequential chemical extraction analysis as well as lead isotope analysis. Sequential extraction testing was undertaken to document the metals leaching characteristics within the testpits with low pH soil horizons. Lead isotope samples were also collected from the low pH soil horizons to determine whether tailings from the historic spill could be identified in the floodplain soils of Anvil Creek and attributed to the Faro mine site.

2.4 BENTHOS

Between August 4thand 8th 2005, benthic invertebrates were collected from eight sites as a component of the Pelly River Aquatic Effects Study. At each site, triplicate samples were collected with a Surber sample equipped with a 300 micron mesh net, and placed together into a one-litre Nalgene bottle. The samples were preserved with formalin and later sorted, identified and enumerated by Charles Low, an entomologist in Victoria, BC, to determine the invertebrate assemblage at the sample sites.

An additional set of samples was collected concentrating on acquiring as much biomass as possible from each site, using the Surber sampler and a kick net. These samples were gut purged and frozen until they could be sorted, identified and sent refrozen to Norwest Labs in Surrey for analysis of metal content in the tissues.

2.5 FISHERIES

The four locations assessed in 2004 along Anvil Creek (A1 – A4) were investigated again in 2005. At each of the four established sample locations on Anvil Creek the same 100 meter reach of creek as sampled in 2004 was located. The reaches were selected as a component of the 2004 investigations and each reach has a representative variety of fish habitats that also provide opportunities for fish sampling. Sites A2, A3, and A4 on Anvil Creek were accessed with a helicopter, site A1 was accessed by boat from the Pelly River. UTM locations for the downstream end of each sample reach were recorded and compared with the sample information from 2004 to ensure re-sampling of the same location.

The general description of fish habitats recorded for each site included; the site location, flow parameters including velocities (floating object method), depth, wetted and channel widths, substrates, channel configuration, bank stability, water temperature, riparian vegetation and an assessment of available fish cover. Photographs representative of each site were taken. Any observed changes to the sites that occurred between 2004 and 2005 were recorded.

The principle fish collection technique used was electro-fishing. Secondary techniques included minnow trapping and angling. Crew members wore polarized glasses at all times to enhance fish viewing abilities. All visual observations of fish were recorded.

Electro-fishing was conducted with a Smith-Route POW type 12A battery powered, back pack electro-fisher. The electro-fisher operator was accompanied by 2 crew members with dip nets. Stop nets were not used and each site was sampled with a single pass technique moving in an upstream direction and sweeping from side to side through each reach; all shoreline areas were fished and attempts at covering all mid-stream habitats were made. Effort extended by electro-fishing was similar for each site.

Minnow trapping was conducted with “Gee type” minnow traps (¼” mesh), using a technique known to be effective for the capture of Yukon River juvenile chinook salmon (jcs). Traps were baited with salmon roe (Yukon River origin) suspended in the trap in a perforated plastic bag, and were set in a variety of habitat types. Traps were set for an overnight period with soak times varying from 16 to 24 hours.

Beach seining was conducted at site A1 as an extra tool to denote fish presence/absence and to collect metal analysis specimens. Catch per unit effort from seining was not calculated as the effectiveness of seine pulls varied due to such factors as shoreline configuration, water depth, and velocity. Area seined and seine catches were recorded in a field notebook.

Angling was conducted with light spin casting gear and a variety of small lures. Effort was recorded as minutes fished.

Fish samples for metal content analysis were collected during the course of general sampling. A maximum of 5 Arctic grayling and 5 slimy sculpin samples were collected from each site for analysis of metals in tissue. All other fish captured were handled delicately to allow for live release after sampling. Anaesthetics were not used. All fish captured or observed were identified as to species and general life stage (fry, juvenile, sub-adult, adult), a sub-sample was measured for fork length (±1 mm) and then released unharmed as near as possible to the location from which they were sampled. All fish captured or observed were recorded into a field notebook and the information was later entered into a computer.

Arctic grayling with a fork length >200 mm were selected for tissue sampling and sculpins 80 mm or longer were selected when possible. At sites where less than 5 sculpins over 80 mm in length were caught, composite samples of 2 or more individual sculpins were taken.

Specimens collected for metal samples were placed into labeled specimen bags immediately after capture. The collected specimens were sampled later in a controlled environment. For the Arctic grayling, fork length, round weight, stomach contents and sexual maturity were recorded. From each grayling a sample of approximately 50 grams of tissue was taken from the caudal area and placed in separate labeled bags. Specimens were stored frozen until shipped to the lab for metals analysis.

For the slimy sculpins, total length and weight for each sample was recorded, including the individual lengths from composite samples. Each sculpin sample was bagged separately; each composite sample was bagged separately as a single sample. The samples were then placed in separate bags for each site.

The tissue samples were submitted to Norwest Labs for metals analysis. Metal analysis included microwave acid digest for ICP metals in tissue. The metal results were expressed as ug/gram (wet). Laboratory techniques were enhanced for the 2005 sample analysis as detection limits for certain metals have been lowered from those analyzed in 2004 and others, specifically lead, have been raised. Lead detection limits in 2004 were 0.05 ug/g and in 2005 were 0.50 ug/g.

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 the sampling event in early August with the assistance of SFN Land and Resources staff. In situ measurements (shown in Table 2) were made of pH, conductivity, temperature, and total dissolved solids, using either LES or SFN Land and Resources scientific equipment.

Table 2 In situ Measurements, August 5 & 6, 2005

Station ID	Site Description	pH	Conductivity (uS/cm)	Total Dissolved Solids (mg/L)	Temperature (°C)
A4	Anvil Creek ~18 km U/S Pelly River	8.14	265	123	7.3
A3	Anvil Creek ~12 km U/S Pelly River	7.59	246	117	9.3
A2	Anvil Creek ~7 km U/S Pelly River	8.36	244	114	10.4
R6	Anvil Creek U/S Rose Creek	8.46	245	114	8.4
R4	Rose Creek	8.42	277	130	10.0
R5	Anvil Creek D/S Rose Creek	8.28	298	140	9.9
PB	Pelly River U/S Blind Creek	7.85	267	136	12.5
B1	Blind Creek U/S Pelly River	6.90	140.9	66	10.9

Table 3 provides a 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. Appendix 2 contains the Norwest Labs analytical water quality reports.

Table 3 Comprehensive Results– Water Quality 2005

All samples tested returned results that met the CCME guidelines for total arsenic, copper, lead, molybdenum, nickel, and silver. Total iron concentration levels exceeded the CCME guideline at six locations along the Pelly River as well as at the Macmillan River. Total aluminum concentration levels exceeded the CCME guideline at several locations along Anvil Creek and the Pelly River as well as at the Macmillan River, and Tummel River. Total cadmium concentration levels also exceeded the CCME guideline at several locations along Anvil Creek and the Pelly River as well as at the Macmillan River, Needlerock Creek, and Tay River samples stations. Total selenium concentration levels met the CCME guidelines at all sample stations except for the Macmillan River station. The Pelly River station upstream of Blind Creek was the only sampling location that exceeded the guidelines for total zinc.

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 selected water quality results for total zinc, cadmium and selenium by station for all stations sampled. The Blind Creek metal values are quite low and representative of the control station. The highest concentration of total zinc was recorded in the Pelly River upstream of Blind Creek (Figure 4). Similar to the results of the 2004 assessment, the Pelly River stations had higher concentrations of total cadmium and selenium than those recorded in either Anvil or Blind Creeks (Figures 5 and 6).

A comparison of zinc, cadmium, and selenium levels between the 2004 and 2005 water quality assessments are shown in Figures 7, 8, and 9 respectively. Zinc levels between 2004 and 2005 are comparable, with slightly elevated levels at some stations, and depressed levels at others. Levels were slightly elevated in 2005 at PB, A4, A2, and P1, while zinc levels at B1, A3, A1, and P1A were slightly lower than 2004 (Figure 7). For cadmium, all stations compared except B1, had the same or a slightly elevated concentration between 2004 and 2005. At B1, cadmium levels were below detection (Figure 8). For selenium, 2005 levels were generally lower than levels recorded in 2004, with the exception of site A4, which had slightly higher levels in 2005 (Figure 9).

Figure 4 2005 Water Quality Results for Zinc Across Stations

Figure 5 2005 Water Quality Results for Cadmium Across Stations

Figure 6 2005 Water Quality Results for Selenium Across Stations

Figure 7 Water Quality Comparison of 2004 / 2005 Results for Zinc

Figure 8 Water Quality Comparison of 2004 / 2005 Results for Cadmium

Figure 9 Water Quality Comparison of 2004 / 2005 Results for Selenium

3.2 STREAM SEDIMENT SAMPLING

Results of the stream sediment sampling program are shown in Table 4. Sediment samples have been analyzed at –10 and –100 mesh size fraction. Concentrations that exceed the CCME Canadian Environmental Quality Guidelines, Interim Sediment Quality Guide, are displayed as red value entries in Table 4. Appendix 3 contains the Norwest Labs analytical soil/sediment reports.

All samples tested returned results that exceeded the CCME guideline for total arsenic, including the control station on Blind Creek. All samples tested for total cadmium, excluding the control station on Blind Creek, exceeded the CCME guideline. Total chromium was exceeded at all stations excluding the control station on Blind Creek and in 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 excluding R6, the control station on Blind Creek, and in the Pelly River upstream of Anvil Creek. The CCME guideline for total lead was exceeded at R6, the control station on Blind Creek and in the Pelly River upstream and downstream of the confluence with Anvil Creek. Total mercury was exceeded in the duplicate samples taken from R5 and R4 as well as in the Pelly River downstream of Anvil Creek. The CCME guideline for total zinc was exceeded at all stations excluding the control station at Blind Creek, and one of the replicates at R6.

The accompanying graphs, Figures 10 to 12, compare the 2005 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, and 2005 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 reveals a new trend as copper, lead, and zinc concentrations are elevated compared to the 2004 data.

Table 4 Comprehensive Results – Stream Sediment 2005

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

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

Figure 12 Zinc Concentrations in Sediments Trend by Site and Year

Metals concentrations seem to increase at first moving downstream from the Faro mine site starting at site R1 reaching maximum concentrations between sites R2 and R4 as metals are mobilized. Metals concentrations downstream from site R4 appear to decrease towards the Pelly River. However, metals concentrations at the individual sites have consistently increased from levels recorded in 2004. Figures 10, 11, and 12 show this notable trend of increased concentration of copper, 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 copper and zinc concentrations in sediments increase from A1 to P1A, which may indicate the presence of an unrelated influence to the Pelly River at that time.

3.3 FLOODPLAIN SOIL SAMPLING

The results of the floodplain soil sampling program are provided in Table 5 and in Figures 13 – 16, which illustrate the general trends in soil metals and pH from the Anvil Creek upstream sampling location A4, downstream to A1 before the Pelly River Confluence. Soil sample data from the Pelly River upstream of Blind Creek (PB) is also included.

The test pits from the 2004 transects at each station that exhibited the lowest pH were resampled in 2005. Samples were collected from each soil horizon within the test pit for stations A4, A3, A2, and A1. Only A4 had 3 soil horizons sampled, while A3, A2, and A1 had two horizons sampled. A single sample was collected from the test pit at sample station PB. In situ measurements of pH were recorded for each horizon within the test pit. An additional soil sample was collected from the soil horizon with the lowest in situ pH for sequential chemical extraction analysis as well as lead isotope analysis.

Metals concentrations (shown in Figure 13 – 16) appear to peak at sample station A3, and decrease moving downstream towards A1. Metals levels observed at A4 are lower than those at A3, and are comparable to those observed at A2. For station PB, copper and lead levels are comparable to A1, while zinc levels are closer to those observed at

A2. Soil pH remains relatively consistent between the sample stations, ranging between 5.8 and 6.8 at stations A2, A3, and A4. At sample station A1, pH was slightly elevated at 7.7 and 7.5 for the two pits sampled. In the Pelly River upstream of Blind Creek, pH was measured at 8.1.

Sequential extraction data analysis to be completed; data included in Appendix 4.

Results of the lead isotope analysis determined that "Anvil Creek floodplain soils located 7 – 18 km upstream from the Pelly River were clearly contaminated in their surface layers" by lead derived from the Anvil Range mine site (Outridge, 2005). Sample stations that were determined to be contaminated include A4, A3, and A2. Lead originating from the Anvil Range mine site is estimated to comprise 65-90% of total lead at these locations (Outridge, 2005). The situation at sample station A1 is unclear and additional sampling and analysis is necessary to resolve the uncertainty (Outridge, 2005). Further information is located within Appendix 5, which includes the report entitled "Lead Isotope Analyses of the Anvil Range Mine Site, Faro, Yukon Territory" prepared by P.M. Outridge in December 2005.

Table 5 Comprehensive Results – Floodplain Soils 2005

Figure 13 Anvil Creek Floodplain Soil Results 2005 – Copper

Figure 14 Anvil Creek Floodplain Soil Results 2005 – Lead

Figure 15 Anvil Creek Floodplain Soil Results 2005 – Zinc

Figure 16 Anvil Creek Floodplain Soil Results 2005 – pH

3.4 BENTHOS

3.4.1 Community Analysis

A total of 11,911 invertebrates were collected in the study area, representing 69 different taxonomic groups. No invertebrates were found in the sample collected from P1, Pelly River upstream of Anvil Creek. The remaining seven communities had relatively robust populations ranging from 495 individuals at A1 on Anvil Creek to 3,453 individuals at A3 on Anvil Creek.

Diversity ranged from 5 different taxa at P1 to 42 different taxa at A3. The composition of the communities was fairly similar. All communities were dominated by the order Diptera (true flies) representing 55% to 80% of the population, with the exception of P1 which was dominated by Oligochaeta (aquatic earthworms) forming 99.4% of the population.

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. With the exception of A1 which only had an index of 1, all sites far exceeded eight with an EPT index of 13 to 19. 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 Anvil Creek excluding the site A1. This would indicate that these sites have greater habitat complexity providing a variety of niches for a wider array of taxa to colonize.

Benthos community data have been summarized by station location in Table 6 below. Refer to Appendix 6 for detailed community data.

Table 6 Summary of Benthic Invertebrate Data, 2005

	Anvil Creek				Pelly River			Blind Cr
	A1	A2	A3	A4	P1	P1A	P2	B1
Density (#/m²):	1,776	8,088	12,713	4,334	0	4,137	5,680	6,010
Diversity:	5	40	42	37	0	31	35	35
Dominant Group	Oligochaeta	Diptera	Diptera	Diptera		Diptera	Diptera	Diptera
EPT Index:	1	19	19	14	0	17	13	16
Richness Index:	0.6	5.1	5.0	5.1	0	4.3	4.6	4.6

These sites were also sampled in the summer of 2004. Population numbers and diversity were generally much greater in 2005. There was a general shift in dominance from a more sensitive group in 2004 to a more tolerate group in group in 2005. Table 7 compares the data for each year.

Table 7 Benthic Invertebrate Community Composition Data for 2004 and 2005

	Anvil Creek				Pelly River			Blind Cr
	A1	A2	A3	A4	P1	P1A	P2	B1
Density (#/m²):								
2004	488	657	513	215	133	104	39	427
2005	1,776	8,088	12,713	4,334	0	4,137	5,680	6,010
Diversity:								
2004	10	14	12	14	8	6	3	11
2005	5	40	42	37	0	31	35	35
Dominant Group:								
2004	Diptera	Ephemeroptera	Ephemeroptera	Ephemeroptera	Ephemeroptera	Ephemeroptera	Diptera	Ephemeroptera
2005	Oligochaeta	Diptera	Diptera	Diptera		Diptera	Diptera	Diptera

3.4.2 Metals in Benthic Invertebrate Tissues

In addition to Benthos community analysis, samples were collected at select stations for total metals analysis. A greater effort was made in 2005 to collect as much biomass as possible from each of the sites. Due to time constraints, this is not always possible.

Trichopterans formed the majority of the biomass collected at each of the sites. This included A1, where Oligochaeta formed 99% of the population, and only one Trichopteran was present in the assemblage sample. Ephemeropterans and Plecopterans were also common in most samples. In addition, although there were no benthic invertebrates in the sample collected for identification at P1, there were many

Trichopterans collected for tissue analysis. Bonnie: *I have no explanation for this as I was not on site. Paul Sparling collected these samples so maybe he can remember something while he was there?? I hope the samples for both the metals analysis and the assemblage were collected from the same area and habitat type.* Chemical sensitive organisms, Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) formed the majority of the biomass analyzed for metals at each site.

A summary of metal concentrations in benthic invertebrate tissue is in Table 8. Refer to Appendix 7 for Norwest Labs metals in benthic invertebrates report. Of the 29 metals analyzed, bismuth was not detected in any of the tissues. The highest metal concentrations recorded for all sample sites is indicated in bold in Table 8. Sample station A1, at the mouth of Anvil Creek, exhibited the highest concentrations for 10 of the metals. Station P1, upstream of Anvil Creek on the Pelly River, showed the highest metal concentration in tissue for 6 metals. Station A2, located in Anvil Creek about 7 km upstream of the Pelly River, had the highest metal concentration for 5 metals.

Table 9 shows a comparison of metal concentrations recorded for the overlapping stations sampled for benthos in both 2004 and 2005. In general, metal concentrations observed in 2005 are dramatically higher compared to analysis results from 2004. The increase in metal concentrations in benthic invertebrate tissue between 2004 and 2005 is consistent with the increase in metal concentrations also observed in sediments in 2005.

Table 8 Metal Concentrations in Benthic Invertebrate Tissue, 2005

Table 9 Comparison of Metal Concentrations in Benthic Invertebrate Tissues for 2004 and 2005

3.5 FISH HABITAT AND UTILIZATION

Fish habitats remained stable at all of the sample stations on Anvil Creek between the 2004 and 2005 sampling periods. Water levels were slightly higher during 2005 sampling.

A complete sample consisting of 5 sculpin samples and 5 grayling samples was taken from each site with the exception of grayling from site A1, where only 2 grayling were sampled. The sculpin samples were comprised of 8 single fish samples and 12 composite samples consisting of 2 to 6 fish in each sample.

The grayling samples consisted of 4 mature females, 4 immature females, 7 immature males and 2 mature males. Analysis of combined diets indicated that 68% of the diet was Trichoptera; a combination of ants, bees, and wasps comprised 18% of the diet; 9% was Plecoptera; and the rest consisted of trace amounts of aphids, black flies, chironomids and assorted woody debri.

As in 2004, juvenile chinook salmon were common near the Anvil Creek outlet, however, they became increasingly less common further up the system. The general abundance of jcs throughout the study area was lower than in 2004, likely due to a lower escapement and recruitment from 2004 than in 2003. Adult salmon were observed spawning at site A4 at the time of investigation in the largest aggregation of salmon on Anvil Creek reported during the last several years. A total of 6 adult salmon were observed near the A4 sample site. Also recorded at A4 were significant numbers of residual juvenile chinook salmon, these are jcs older than 1 year (1+) and have not returned to sea yet. Two of the eighteen captured jcs 1+ were exuding milt at the time of capture.

3.5.1 Site A1

Electro-fishing was conducted through a 120-meter reach in a single pass consisting of 790 seconds (about 13 minutes) of effort. A total of 36 jcs and 74 slimy sculpin were recorded (Table 10). This represents a slight decrease in the number of adult sculpins and a substantial increase in the number of jcs compared to 2004 results (Table 11).

The increase in jcs is of particular interest as the general numbers of jcs recorded in 2005 were lower than in 2004 at all other stations throughout the study area.

Minnow trapping at site A1 consisted of 9 traps set for approximately 16 hours each. The total catches from the minnow trapping consisted of 52 jcs (Table 12), representing a substantial decrease in the numbers of jcs from 2004.

Seining effort was thwarted by deeper water than encountered during 2004 and numerous small sticks. No fish were captured by seining.

A total of 3 Arctic grayling were recorded during a total of 225 minutes angling effort (Table 13), one of the grayling escaped.

All sculpin sampled for metal analysis from site A1 consisted of composite samples of between 4 and 6 fish in each sample, with length ranging from 50 to 79 mm and weight ranging from 11.4 to 14 grams. Only two Arctic grayling were taken for metal sample analysis, both were immature males with fork lengths of 282 and 324 mm. Stomach analysis showed the recent diet to be composed entirely of Trichoptera.

3.5.2 Site A2

Electro-fishing was conducted through the 100-meter reach in a single pass consisting of 811 seconds (about 14 minutes) of effort. A total of 7 Arctic grayling adults, 24 jcs, 1 round whitefish adult, and 76 slimy sculpin adults were recorded (Table 10). This catch represents a significant decrease in the numbers of jcs and a significant increase in the numbers of adult Arctic grayling (Table 11).

Minnow trapping at the site consisted of 9 traps set for approximately 17 hours each. The total catch from the minnow trapping consisted of 7 jcs and 2 slimy sculpin (Table 12). This represents a dramatic decrease in the number of jcs captured from 2004.

Angling effort of 30 minutes captured no fish (Table 13).

Samples taken for metal content analysis consisted of three whole fish sculpin samples and 2 composites of 2 and 3 sculpins. Five Arctic grayling adults ranging in length from 220 to 339 mm and in weight from 111 to 436 grams were also taken. The grayling consisted of 2 immature males, 2 mature males and a mature female. Stomach content evaluation indicated a diet comprised of 40% Trichoptera, 33% ants and bees and trace amounts of Plecoptera and beetles.

3.5.3 Site A3

Electro-fishing was conducted through the 100-meter reach in a single pass consisting of 954 seconds (about 16 minutes) of effort. A total of 73 slimy sculpin adults and 1 Arctic grayling juvenile and 3 sub-adults were recorded (Table 10). Of the three Arctic grayling sub-adults recorded during electro-fishing, 2 were actually dead and drifting downstream at the time of fishing. Electro-fishing results from 2005 showed an absence of sculpin fry and jcs that were both in abundance during 2004 and an increase in Arctic grayling from an absence in 2004 (Table 11).

Minnow trapping at site A3 consisted of 9 traps set for approximately 20 hours each. The total catch from the minnow trapping consisted of 1 jcs (0+), 1 jcs (1+), 1 Arctic grayling juvenile and 6 slimy sculpin adults (Table 12). The most significant difference between the 2005 and 2004 catches was the substantial decrease in the numbers of jcs captured in 2005.

Angling effort of 10 minutes captured 7 Arctic grayling adults (Table 13); angling was conducted in the large corner pool immediately downstream of the sample reach.

Samples taken for metal content analysis consisted of 2 whole fish sculpin samples and three composite samples consisting of 5, 5, and 6 sculpins each. The five Arctic grayling taken ranged in length from 257 to 323 mm, in weight from 152 to 336 grams and consisted of 2 mature females, 2 immature females, and one immature male. Stomach content analysis indicated a diet comprised of 88% Trichoptera with the remainder comprised mostly of wasps and some aphids.

3.5.4 Site A4

Electro-fishing was conducted through the 100-meter reach in a single pass consisting of 615 seconds (about 10 minutes) of effort. A total of 13 adults, 31 juvenile, and 1 slimy sculpin fry; 3 juvenile Arctic grayling; and 1 jcs (0+) were recorded (Table 10). Electro-fishing effort was stopped short of the top of the reach due to the presence of adult chinook salmon. The salmon were observed just prior to shocking the area and were observed again the following day to have moved into the top of the sample reach and appeared to be actively spawning at that location. A total of 6 Chinook salmon adults were observed near the site, representing the largest aggregation of adult salmon observed on Anvil Creek during the past several years. Electro-fishing results from 2005 were similar to 2004 results with the exception of the decrease in the number of jcs (Table 11).

Minnow trapping at the site consisted of 9 traps set for approximately 23 hours each. The total catch from the minnow trapping consisted of 1 jcs (0+), 18 jcs (1+) and 5 adult slimy sculpin (Table 12). The jcs 0+ was 58 mm; the average length of the jcs 1+ was 114 mm with a range of 101 to 128 mm. At least two of the jcs 1+ were exuding milt at the time of capture. Comparatively few jcs (1+) were captured at this site during 2004 and substantially more jcs 0+ were captured during 2004.

Angling effort of 50 minutes on August 5 captured 1 Arctic grayling (Table 13). Angling on August 6 for 50 minutes captured 12 Arctic grayling. All of the grayling captured were taken at the top of the reach near the site of the active salmon redd.

Samples taken for metals analysis consisted of 3 whole fish slimy sculpins and two composite samples of 4 and 5 sculpins each. The five Arctic grayling taken ranged in length from 230 to 323 mm and in weight from 112 to 295 grams and consisted of 1 mature female, 2 immature females and 2 immature males. Stomach content analysis indicated a diet comprised of 91% Trichoptera, the remainder of the diet consisted of black fly larvae.

Table 10 Summary of Electro-fishing Results

Sample Site	Date Sampled	Effort (seconds)	Sampled area (meters)	Slimy Sculpin	jcs	RWF	Ag
A-1	Aug 7/05	790	120	74	36	0	0
A-2	Aug 5/05	811`	100	76	24	1 ad	7 ad
A-3	Aug 5/05	954	100	73	0	0	1 juv 3 sub ad
A-4	Aug 5/05	615	100	13 ad, 1 fry, 31 juv	1	0	3 juv

Abbreviations used: jcs= juvenile chinook salmon, juv = juvenile, sub. ad= sub adult, RWF= round whitefish

Table 11 Comparison of Electro-fishing Results from 2004 and 2005

Sample Reach	Year	S. sculpin Ad	S. sculpin fry	A. grayling	L. chubb	jcs	other species
1	2004	12.12	0	0	0.08	1.73	0
	2005	9.36	0	0	0	4.56	0
2	2004	15.96	3.19	0	0	15.13	0
	2005	8.63	0	0.49	0	2.96	0.12 RWF ad
3	2004	12.84	abundant	0	0	1.05	0
	2005	7.65	0	0.10 juv. 0.31 sub ad	0	0	0
4	2004	6.74	0	0	0	0.42	0
	2005	7.15	0.16	0.49	0	0.16	0

Note: Catches have been expressed as the number of fish captured for every 100 seconds of shocking time.

Table 12 Comparative Summary of Minnow Trap Results from 2004 and 2005

Sample Site	Date Set	Number Set	Avg. Hours set	Slimy Sculpin	jcs	jcs 1+	Arctic gray.
A-1	2004	6	14.5	2 adult	141	0	0
	2005	9	16	0	52	0	0
A-2	2004	6	18.6	1 (adult)	148	0	0
	2005	9	17	2 (adult)	7	0	0
A-3	2004	6	18.8	4 adult	41	5	0
	2005	9	20	6 adult	1	1	1
A-4	2004	8	19.6	4 adult	43		0
	2005	9	23	5 adult	1	18	0

Table 13 Angling Effort for Sites on Anvil Creek, August 2005.

Site	Date	Effort	Catch
A1	Aug. 7	225 min.	3 Arctic gray
A2	Aug. 5	30 min.	0
A3	Aug. 5	10 min.	7 Arctic gray
A4	Aug. 5	50 min.	1 Arctic gray
A4	Aug. 6	50 min.	9 Arctic gray

3.6 FISH TISSUE

Results from the metal content analysis showed levels of most metals to be lower in concentration than from 2004 samples. Lead was below the detection limits of 0.5 ug/g in all samples from both species. Variations in metal concentrations in fish flesh between sites were minimal. In Arctic grayling, zinc levels were the highest at site A1 and decreased moving upstream; however the second highest levels were from site A4. Zinc levels in sculpin increased further upstream from the Pelly River. Table 14 shows average zinc and copper concentrations in Arctic grayling and slimy sculpin tissue collected from each of the four sites. Table 15 provides complete results from the fish tissue analysis. Refer to Appendix 8 for Norwest Labs metals in fish tissue report.

Table 14 Average Zinc and Copper Concentrations from Fish Tissue, August 2005

Site	AG zinc (ug/g)	AG copper (ug/g)	SS zinc (ug/g)	SS copper (ug/g)
A1	18.5	0.52	27.2	1.3
A2	12.8	0.57	40.2	0.98
A3	10.5	0.45	33.4	0.79
A4	14.8	0.58	50.8	0.89

Table 15 Metal Concentrations in Fish Tissue, 2005

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 increased over levels reported in 2004.

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

As per the recommendations developed as a result of the 2004 assessment, further sampling and study was conducted to document the source of metals in floodplain soils. Results of the lead isotope analysis determined that Anvil Creek floodplain soils (A2, A3, and A4) were contaminated by lead derived from the Anvil Range mine site.

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

The general abundance of juvenile Chinook salmon throughout the study area was lower than in 2004, likely due to a lower escapement and recruitment from 2004 than in 2003. Adult salmon were observed spawning at sample station A4 in the largest aggregation of salmon on Anvil Creek reported during the last several years. Metal content analysis of fish tissue showed levels of most metals to be lower in concentration than from 2004 samples.

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 the Pelly River aquatic effects assessment be integrated with the water licence monitoring program in 2006 to document trends and refine study results.

The investigation of the March 1975 dam failure and tailings spill component to this study was worthwhile and results document the presence of Faro mine tailing deposition in Anvil Creek floodplain soils. The spill was certainly a spectacular, if not historic event in the site record. The extent to which these historic tailings are influencing the aquatic community in Anvil Creek is not fully understood. It is recommended that at the very minimum, water quality and sediment sampling be repeated in 2006 in conjunction with water licence monitoring to document metals burden in the local aquatic ecosystem.

5.0 CLOSURE

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

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→ Nichole Speiss, Access Consulting Group
→ Frank Patch, FCRP Office

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

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

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