eba.ca

North American Tungsten Corporation Ltd.

## ISSUED FOR USE

# MACTUNG PROJECT
# 2008 ENVIRONMENTAL BASELINE STUDIES
# FISHERIES AND
# AQUATIC RESOURCES PROGRAM

W23101021.015

December 2008

creating & delivering
better solutions

North American Tungsten Corporation Ltd.

ISSUED FOR USE

# MACTUNG PROJECT
# 2008 ENVIRONMENTAL BASELINE STUDIES
# FISHERIES AND AQUATIC RESOURCES

W23101021.015

December 2008

EBA Engineering Consultants Ltd.
p. 867.668.3068 • f. 867.668.4349
Calcite Business Centre • Unit 6, 151 Industrial Road • Whitehorse, Yukon Y1A 2V3 • CANADA

## EXECUTIVE SUMMARY

North American Tungsten Corporation Ltd. (NATC) is considering development of a world-class tungsten deposit located near Macmillan Pass, on the Yukon side of the border with the Northwest Territories. NATC retained EBA Engineering Consultants Ltd. (EBA) to update and supplement historic baseline fisheries and aquatic resources information at the Mactung Project Property (Mactung study area) within the Yukon. The 2008 baseline studies objective was to document fish, fish habitat, and aquatic habitat characteristics within the study area and with a particular focus on the proposed access road route for anticipated regulatory submissions.

Fisheries and aquatics sampling occurred between July and October of 2008 within the mine footprint area, the Hess River Tributary, and the watercourse crossings along the proposed access road. In July 2008, EBA sampled 3 different sites (Tributary C, Reach C6 and C8) in the footprint area which resulted in no fish captures or observations.

The Hess River Tributary (HRT) was sampled at four sites in the vicinity of the proposed pumphouse infrastructure. EBA conducted studies during two time periods: an early summer assessment (July) and a spawning and overwintering fish presence assessment (September and October). Sampling was conducted using backpack electrofishing, seine netting, gill netting as well as angling. Arctic grayling (*Thymallus arcticus*), round whitefish (*Prosopium cylindraceum*), and slimy sculpin (*Cottus cognatus)* were the species captured or observed predominantly in the upper HRT where the water quality is higher. Other than slimy sculpin, no fish were collected or observed during late September or October surveys, possibly indicating that the HRT in the study area does not provide suitable overwintering habitat.

EBA conducted sampling on 23 watercourse crossings along the proposed access road. Channel and fish habitat assessment were performed and water quality were also recorded. Fish presence was assessed through electrofishing which resulted in the capture of Dolly Varden (*Salvelinus malma*) on three fish bearing streams (D3, D9 and D13).

As part of the aquatics program, EBA collected sediment samples from seven sites across five streams within the study areas. Generally, the results of the grain size distribution were representative of high energy/high slope stream systems, consisting largely of fine to coarse sand with little silt deposition. Metal levels in sediment were generally elevated for copper, arsenic, cadmium, zinc and sometimes mercury.

Benthic macroinvertebrate abundance was described as low on Tributary D and dominated by Dipterans in all three samples. Species richness and diversity was high in comparison with results collected from other sites in the study area during 2006 and 2007.Periphyton analysis for Tributaries A, C, D, E and the HRT indicated a low level of primary productivity across the study area. At the time of the production of this baseline report and its deliver to NATC, the results of periphyton taxonomic analyses were not yet available.

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS

PAGE



## TABLES

TABLE OF CONTENTS



## FIGURES

TABLE OF CONTENTS

## PHOTOGRAPHS

TABLE OF CONTENTS



## APPENDICES

# 1.0 INTRODUCTION

North American Tungsten Corporation Ltd. (NATC) is considering development of a tungsten deposit located near Macmillan Pass, Yukon, on the Yukon side of the border with the Northwest Territories (Figure 1). The mine site is located in the Selwyn Mountains at an elevation of 1,725-1,800 m above sea level (a.s.l). The mine site is connected to the southern Yukon during summer months by the North Canol Road, and is 650 km (400 air km) northeast of Whitehorse. The mine site is currently linked to the North Canol Road just east of Macmillan Pass by a 10 km access road.

NATC retained EBA Engineering Consultants Ltd. (EBA) to conduct environmental baseline studies at the Mactung property. EBA's 2008 studies are a continuation of baseline studies that began in October of 2005.

This report outlines the results of EBA's 2008 fisheries and aquatics baseline study efforts. The primary objective of these studies was to further refine fish presence and habitat use and aquatic habitat characteristics in relation to several key proposed project infrastructure components within the proposed receiving environment, including a proposed access road route. The information was collected to support anticipated regulatory submissions for the proposed project.

# 2.0 ENVIRONMENTAL SETTING

## 2.1 STUDY AREA LOCATION

The Mactung Project study area is located approximately 175 km northwest of the town of Ross River, Yukon (Figure 1). The Mactung Project lies within two regional-level watershed drainages, and is drained via two major river systems, the Hess River and the South Macmillan River. The majority of the project area, however, falls within the drainage of the Hess River. The center of the project site is located in the Yukon near the continental divide in a high pass area that separates the Stewart watershed (Yukon River drainage) and the first Central Mackenzie Blackwater Lake watershed (Mackenzie River). A number of first order tributaries originate on the site and lead downstream to east and west slopes. The Hess River and the Tsichu/Peel rivers both feed from the corresponding primary watercourses.

## 2.2 GENERAL DESCRIPTION

The Mactung site is located in the Mackenzie Mountains and is characterized by rugged, mountainous terrain which forms part of the continental divide. The Mackenzie Mountains are considered a northern extension of the Rocky Mountains with some peaks exceeding 2900 m. Vegetation cover varies largely in response to climatic conditions that change with elevation. Alpine and subalpine open woodland zones dominate the study area, while barren talus slopes are also common in higher areas.

The project area lies within two watersheds: the Hess River and the South Macmillan River. The headwaters of the Hess River are located on the Yukon side of the territorial border, north of Keele Peak. All streams located in and around the proposed Mactung mine site drain into a tributary of the Hess River (HRT). The South Macmillan River is located to the southeast of the local study area, and is crossed by the proposed access road route. The majority of the Mactung project proposed mine infrastructure (the local footprint) is situated in alpine environment (dominated by grasses, lichen, moss and small shrubs) or in extensive stands of shrub communities (including the proposed areas for mine infrastructure and a reservoir).

## 2.3 HISTORICAL STUDIES

AMAX Northwest Mining Company Ltd. completed a comprehensive environmental baseline study of the Mactung Project study area in 1983 (AMAX 1983). This report compiled environmental data collected from 1977 to 1982 in an area extending into the Northwest Territories from the current camp locations. These results, including water quality, benthic invertebrates and fish collection results, were summarized in the 2006 Mactung Environmental Baseline Studies report on Fisheries and Aquatic Resources (EBA 2007a).

# 3.0 DEFINITION OF STUDY AREAS

The design of EBA's fisheries baseline study program was organized according to two primary study areas, based on two main types of proposed project infrastrucutre: the Project Aquatics Study Area ($ASA^P$) and the Road Aquatics Study Area ($ASA^R$).

**$ASA^P$** – The Project Aquatics Study Area includes all watercourses that may be influenced directly or indirectly by the project infrastructure, including but not limited to the receiving environment (including the mine development, pumping station and transfer infrastructure, and the airstrip expansion). This includes Tributaries A and C, the HRT, the South Macmillan River, as well as several first order tributaries to Tributary C that are found within the proposed mine footprint area (Figure 2).

**$ASA^R$** – The Road Aquatics Study Area includes all watercourses that are crossed by the proposed mine access road, as well as those included within a defined downstream zone of impact. This included Tributaries A through E (all tributaries to the Hess River), as well as the South Macmillan River (Figure 2).

# 4.0 PROJECT SCOPE

## 4.1 2008 MACTUNG FISHERIES AND AQUATIC PROGRAM SCOPE

The 2008 fisheries and aquatics baseline assessment for Mactung was comprised of multiple components. For ease of reading, the various assessments/surveys have been divided into

two main program components: Fish and Fish Habitat and Aquatics. The following components were included in the 2008 scope:

## 4.2 FISH AND FISH HABITAT PROGRAM

### 4.2.1 Project Footprint Fish Presence Assessment

Previous baseline studies by EBA (2007) identified significant barriers to fish passage separating the proposed development footprint area from lower reaches of Tributary C (that were found to be fish bearing). Furthermore, reconnaissance-level habitat surveys of the footprint area identified only limited habitat with no potential to support overwintering of fish in that area. In order to corroborate these results, EBA conducted a brief, high-intensity assessment of fish presence in the upper reaches of Tributary C.

### 4.2.2 Pumphouse Infrastructure Habitat Assessments

Based on updates to proposed development infrastructure determined by NATC, EBA performed directed fish and fish habitat studies to be able to better consider potential effects related to the addition of the following infrastructure components:

- NATC has proposed the withdrawal of water and the construction of associated pumping infrastructure on the Hess River Tributary, approximately 550 m upstream from its junction with Tributary A.
- NATC has also proposed an upgrading (widening and lengthening of the Macmillan Pass airstrip), which lies adjacent to the South Macmillan River.

In response to these proposed infrastructure additions, EBA conducted the following fish and fish habitat studies on the HRT:

- A peak flow/early summer assessment to determine the extent of habitat availability and habitat use in the HRT in the pumping location, with a specific focus on young-of-year (YOY) or juvenile fish.
- Fall and early winter assessments to determine whether the HRT in the project area may be used by Dolly Varden or other fall spawners for spawning, staging, or migration.
- An early winter assessment (to freeze-up) to better understand the degree to which fish may be using the HRT in the project area as over-wintering habitat.

### 4.2.3 Access Road Watercourse Crossing Fish and Fish Habitat Assessments

EBA performed a standardized assessment of watercourses along the proposed access road to provide information for use in regulatory and planning works. This included determining fish bearing status, basic physical attributes, and fish habitat features at all proposed watercourse crossing locations and other areas potentially influenced by the proposed road development.

## 4.3 AQUATICS PROGRAM

The baseline aquatics program for 2008 expanded on the program initiated by EBA in 2006. Since then, the program has included detailed aquatic habitat assessments, benthic sampling and water quality sampling. In 2008, EBA expanded the program footprint to incorporate a proposed access road and other potential impact areas. This included the addition of periphyton and stream sediment sampling, in both the $ASA^{P}$ and $ASA^{R.}$ The following components were included in the 2008 program:

- Stream sediment metals, loss on ignition (LOI), and grain size analyses for Tributaries A, C, D, E and the HRT;
- Periphyton productivity and taxonomic analysis for Tributaries A, C, D, E and the HRT;
- Macroinvertebrate sampling and taxonomic analysis for Tributary D; and,
- Basic physical water quality assessments for Tributaries A, B, C, D, E, the South Macmillan River and the HRT.

# 5.0 FISH AND FISH HABITAT PROGRAM

## 5.1 PROJECT FOOTPRINT FISH PRESENCE ASSESSMENT

EBA conducted a single day intensive assessment of fish presence/absence in the proposed mine footprint area (primarily the footprint of proposed dam infrastructure). This effort focused on corroborating previous evidence of non-fish bearing status in the upper reaches of Tributary C and one of its sub-tributaries (C9) that fall within the proposed footprint area.

### 5.1.1 Methods

EBA assessment was conducted on July 6, 2008 using a Smith-Root LR24 backpack electrofisher. A crew of two people assessed fish presence/absence by working long lengths of the watercourses using in a high intensity of survey (full channel sweep) in a continuous motion moving from downstream to upstream. The upper section of Tributary C was surveyed from its uppermost barrier to the south boundary of the tailings facility borrow area, with the exception of a large rock-cascade canyon (Figure 3). One small unmapped feeder channel to reach C6 was also fished, which included a beaver pond complex. Additionally, the lowest reaches of Tributary C8 were sampled in a similar fashion. Total effort (duration in seconds), distance, as well as general habitat characteristics (change in the slope, substrate, confinement and flow) were recorded.

### 5.1.2 Results

EBA surveyed a total of three stream reaches, as well as one pond/stream complex area (Figure 3). A total of 576 m of reach 6 (Tributary C) was surveyed in a total effort of 814

seconds, resulting in the capture of no fish (Table 1). In this reach, the stream was characterized mainly by step-pools with large boulders. Flatter portions of the stream contained riffles, dominated by cobble. This area is located near the upper tree line limit, in an area of tall shrub and herbaceous cover.

On reach 8 (Tributary C) (Figure 3) a length of 241 m was electrofished in 469 seconds, and no fish were caught or observed (Table 1). Habitat in reach 8 consisted of riffle run segments with substrate dominated by cobbles and gravels. Small to medium shrubs and herbs were the primary cover components.

A sub-tributary stream/pond complex was surveyed in 182 seconds over a total length of roughly 330 m, with no fish captured or observed (Table 1). The channel was composed of fines, supported no vegetation and extended into the alpine zone. An unused beaver lodge was present in the pond.

Finally, a 340 m length of tributary C8 was surveyed in 758 seconds, resulting in no fish captures or observations (Table 1).

### 5.1.3 Discussion

The absence of fish capture during the footprint electrofishing effort corroborates EBA's previous evidence that the upper areas of Tributary C (upstream of defined barriers) are not fish bearing. All areas of this watercourse upstream from local barriers are considered to be non-fish bearing.

## 5.2 PUMPHOUSE INFRASTRUCTURE HABITAT ASSESSMENT

Several baseline study components were undertaken to provide detailed information on fish species composition and seasonal habitat use in the Hess River Tributary (HRT), in the vicinity of proposed water intake infrastructure for the Mactung project. These study components focussed on gathering information related to potential impacts of water withdrawal from the HRT.

### 5.2.1 Methods

EBA's pumphouse infrastructure baseline study program on the HRT focussed on a broad area centered on the proposed pumping location, across four sites. Three sample sites were established in the upper HRT (Figure 4): the location of the proposed pumping station (PS2), site FS8 (from EBA 2007a, 2007b) (denoted as PS3), and a reference area selected as having diverse pool, riffle, and off channel habitats located roughly 900 m upstream of the proposed pumping area (PS4). One site in the lower HRT (PS1) was also established as a reference for habitat use below the confluence of Tributary A with the HRT (Figure 4).

These four sites were the used for all sampling associated with the pumping infrastructure for the 2008 season.

#### 5.2.1.1 Early Summer Fish Presence Assessment

In early July of 2008, an intensive survey of fish habitat use was conducted in the Hess River Tributary to determine fish species usage during early summer high flow periods (Photo 1).

This program specifically targeted young-of-year or juvenile fish (primarily Arctic grayling and Dolly Varden), as well as adult fish of numerous species. This fish assessment employed backpack electrofishing, fine-mesh seine netting, as well as visual observations, and targeted all four sample sites as described above to provide a good stratification across riffle, run, pool, and off-channel habitats.

At each sampling site, EBA first sampled pool areas using a seine net. For this, sampling a 10 m by 1.2 m seine net of 3 mm mesh size was used to target both juvenile and adult fish that were beyond the range of the electrofisher (e.g. too deep in pools). In off-channel pool or channel area with calm currents, seine netting sweeps were performed by two people, in an orientation that maximized the efficiency of coverage (e.g. leading down a side channel systematically). In main channel pools, seine netting was performed by having one person lead the net along the pool/current boundary, after which both people drew the net across the pool and collected it on shore (Photo 2). For each effort, the area sampled, number of sets and catch were recorded (Photo 3). At each site, sets were conducted in the main channel and ranged in length from 200 to 400 meters.

Following seine netting, EBA electrofished side-, main- and off-channel habitats, working from downstream to upstream in accessible areas with an operator and netter. Electrofishing effort (number of seconds), voltage, duty cycle, frequency, and pulse were recorded for each session. GPS locations and track logs were recorded to document the areas fished.

For every fish captured, a record of fish species, location, fork length, weight, and notification of live release was recorded. A fin clip or scale sample was collected from a sub-sample of captured fish, for potential future needs (ageing/DNA analysis).

*Site Specific Effort Summaries*

At PS1 (located on the lower HRT) (Figure 4), two main side channels divert from the active, high-energy main channel. Sandbars and a vegetated shoreline lead to a large pool, relatively protected from the current by a small cliff. Pool edges on the periphery of current were seine netted first, then electrofishing was applied in small side channels, undercut banks and shelters, back eddies and riffle sections.

PS2 is located at the projected pumphouse station (Figure 4). Here, the HRT reaches an elbow turn, creating current breaks and several large, deep pools. Bedrock along the shoreline also forms numerous inlets from the current, forming deep pools and current breaks. Additional fish habitat is created by vegetated banks and boulders, slowing down current and presenting concealment. Seine netting was used in pool edges in periphery of

current as well as in current breaks. Electrofishing was applied along banks and boulders, back eddies and riffle sections.

PS4 is located upstream from the projected pumphouse location and was used as a reference site. The main channel in this area has a high current with riffle and run habitats. A long side channel exists at this site in which the upper section is shallow riffle with boulders, slowing down to a deep calm channel further down. A large pool is present just downstream as the river widens and the slope levels out. Seine netting was used in current edges, across pools, and in the deep side channel segments. Electrofishing was used to assess fish presence in sheltered areas around boulders and vegetated banks, as well as in slower current.

#### 5.2.1.2 Spawning and Overwintering Assessment

EBA performed a survey of fish presence and distribution in September and October of 2008, to determine the presence of fish in the HRT in the fall and early winter seasons. The purpose of these surveys was to assess staging/spawning, as well as over-wintering, as described above.

This survey was based on the same pumping station (PS) sites established for the early summer assessment and included PS3 (not assessed in early summer). Techniques used during these assessments closely paralleled those described above for the early summer assessment, with the exception that the fall/early winter assessments focussed more on deep pool areas. Electrofishing could not be used for the majority of these works due to cold water temperatures. Angling was used to a larger extent in deep pools, and a fine-mesh gill-net was used in pools when reduced current velocities allowed. This gill-netting effort was performed by leading a fine mesh gill net across several open pool areas, as close to the deepest portion of the pool as possible. The net used was an experimental gillnet (30 m long x 1.83 m tall) with mesh sizes (in cm) of 2.54, 3.81, 5.08, 6.35, 7.62 and 10.16. In the case where pools were inaccessible because of their depth and current, angling was used to assess fish presence and composition. The total effort (person hours) as well as fish captures were documented.

### 5.2.2 Results

#### 5.2.2.1 Early Summer Fish Presence Assessment

The early summer HRT assessment was conducted on July 6, 7 and 8, 2008 at sites PS1, PS2 and PS4 (Figure 4). During this time, numerous fish were captured in both in- and off-channel habitats using seine netting and electrofishing in the upper HRT (Tables 2 and 3). Between PS2 and PS4 EBA expended a total effort of 1800 seconds of electrofishing time, and seine netted roughly 455 $m^2$ of area among 8 sites (Tables 2 and 3).

*Upper Hess River Tributary*

At site PS2, five Arctic grayling and three slimy sculpins were caught in 1055 seconds of electrofishing effort. Seine netting 265 $m^2$ over five sites captured one round whitefish (158 mm), 11 Arctic grayling, (nine juveniles), as well as three slimy sculpins (Photo 4). Arctic grayling at PS2 ranged from 72 mm to 364 mm, and slimy sculpin ranged from 23 mm to 83 mm (Photo 5).

At site PS4, four Arctic grayling (three juveniles) and three slimy sculpin were caught in 745 seconds of effort (Table 3). Seine netting of 310$m^2$ across five different sites resulted in the capture of six Arctic grayling (which included one young-of-year (YOY), several yearlings, and subadults/adults) and one slimy sculpin (Table 2). Subadults were confirmed to be using small side pool habitats in the mainstem of the river, while the sole YOY was in an extensive off-channel network at site PS4 (Photo 6). Arctic grayling ranged in size from 29 mm to 294 mm, while slimy sculpin ranged from 26 mm to 59 mm (Figure 5).

*Lower Hess River Tributary*

EBA conducted a total electrofishing effort of 499 seconds at site PS1, and captured only one slimy sculpin (Table 3). One round whitefish (257 mm) four slimy sculpins (37 mm – 106 mm) were captured while seine netting a total of 72 $m^2$ between 2 sites (Table 2). No Arctic grayling or Dolly Varden were captured.

#### 5.2.2.2 Spawning and Overwintering Assessment

Sampling was conducted at the various HRT sites on September 4-5, September 23-24, and October 10, 2008. Results are presented below in chronological order to provide a time sequence of changes in fish presence. Electrofishing was only conducted in the HRT on September 4-5, 2008, as low water temperatures restricted electrofishing during later site visits.

*Upper Hess River Tributary*

**Early September**

In early September (4th and 5th), electrofishing was possible, but was becoming difficult due to reduced water levels, as many off-channel habitat areas had dried or been reduced in size.

At site PS2, EBA caught no fish during an electrofishing effort of 121 seconds. Seine netting efforts in early September were also concentrated on PS2, where EBA captured two Arctic grayling (230 mm and 310 mm) and one slimy sculpin (16 mm) in a total effort of 108 $m^2$ among 4 sites (Table 2). Additionally, 7 adult Arctic grayling were caught (two sampled, 322 mm and 327 mm) in 2.80 person hours angling effort (catch per unit effort (CPUE) of 2.50 fish/hour/person) (Table 4).

At site PS3, seven slimy sculpin were caught in an effort of 799 seconds (34 mm – 104 mm), but no Dolly Varden or Arctic grayling were observed or captured in this effort

(Table 3). 11 adult Arctic grayling were captured in 1.36 person hours of angling effort (CPUE of 8.09 fish/hour/person; fish not sampled) (Table 4). No seine netting was performed at this site in early September.

At site PS4, EBA electrofished for a total effort of 572 seconds and did not capture or observe any fish (Table 3). Three adult Arctic grayling (285 mm – 321 mm) were captured in 3.10 person hours of angling effort (CPUE of 0.97 fish/hour/person) (Table 4).

**Late September**

In late September, electrofishing was not longer possible due to cold water temperatures, but gill netting of pools could be used as flows and water velocities were reduced significantly.

EBA did not capture any fish at PS2 in late September. The efforts expended at that time included 0.33 person hours of angling effort and three hours of gill netting effort (Tables 2, 4, and 5).

Site PS3 was not fished in late September due to time constraints.

At site PS4, EBA did not capture any fish in late September. The efforts at that time included 0.25 person hours of angling and 2.75 hours of gill netting effort (Tables 4 and 5).

**Early October**

On October 10th during the final sampling effort, much of the marginal areas of the HRT had frozen over, including many off-channel areas (Photo 7). Additionally, flows were substantially reduced and many side channel and other shallow habitats were dewatered. EBA attempted to use gill netting during this visit, however significant slush and ice floes on the river immediately built up behind the net, tearing nets and making unsafe conditions for working.

At PS2, EBA seine netted pools and shallow run areas in a total area of 110 $m^2$ among two sites, and angled for 0.75 person hours (Tables 2 and 4) (Photo 8). No fish were captured.

At PS3, no fish were captured. EBA seine netted pools in a total of 160 $m^2$ among two sites, and angled for a total of 0.33 person hours (Tables 2 and 4) (Photo 9).

At PS4, no fish were captured. EBA seine netted pools in a total of 120 $m^2$ among two sites, and angled for a total of 1.47 person hours (Tables 2 and 4).

*Lower Hess River Tributary*

**Early September**

At site PS1, EBA did not catch any fish after having seine netted roughly 38 $m^2$ of area in pools and marginal run habitats (two sites) and angled for 0.42 person hours (Tables 2 and 4).

**Late September**

In late September, EBA again did not capture any fish at site PS1, after employing the following efforts: seine netting roughly 38 $m^2$ of area (three sites), angling for a total of 0.50 person hours, and two separate gill netting efforts in deep pools of two hours each (Tables 2, 4, and 5).

**Early October**

The lower HRT was not sampled during the early October site visit.

### 5.2.3 Discussion

EBA's combined sampling efforts indicate overall that fish presence and habitat use in the HRT appears to be highly seasonal in nature and also suggests that usage differs between the upper and lower HRT. Although the collection methods did not provide a direct comparison, an indication of higher abundance of fish in the upper HRT versus the lower suggests that the poorer water quality and resulting lower productivity (e.g. benthic macroinvertebrates, periphyton, etc.) limits the capacity of fish to use the lower HRT. This habitat quality reduction is predicted to be minimized further downstream as other tributary influences mitigate the poor water quality effects, although that distance or concept has not been studied.

In the upper HRT, early season habitat usage appears to be moderate. While baseline studies suggest that Arctic grayling use the study area for feeding, the low abundance of juvenile Arctic grayling suggests that spawning is rare, or is occurring only in reaches far upstream to the project area. Later in the season, however, these early life stages were completely absent from the study area, as individuals had likely retreated to downstream main stem areas with lower velocity/energy or better water quality. The late season occurrence of many large adult Arctic grayling suggests the availability of a late season food resource, but no overwintering by Arctic grayling is expected as suggested by fall capture data.

During the 2008 sampling season, no Dolly Varden were captured in the HRT despite large sampling efforts across four sites. One juvenile Dolly Varden may have been observed while electrofishing at PS4 in early September, however this observation was not confirmed.

The lack of Dolly Varden presence through the September-October sampling period suggests that the HRT on the vicinity of the project is not used by this species for spawning, or staging during the fall season. EBA had predicted that at least pre- or post-spawn individuals would have been captured during sampling if the HRT in the project area or upstream were used at that time of year. Similarly, no other fall spawning species (i.e. whitefish species) were observed during sampling.

EBA did capture several juvenile Dolly Varden in the HRT during the 2007 baseline studies program (EBA 2007b), which had suggested that spawning could be occurring in the watershed. However, the extremely low number captured in 2007 compared to areas like

Tributary C suggested that primary habitat for this species is restricted to small upper tributaries. This was also observed in Tributaries D, D9, and D13 (Figure 6). Based on baseline study data, EBA does not believe the HRT to provide significant spawning or over-wintering habitats, except for slimy sculpin which are expected to occur in the study area in all seasons.

## 5.3 ACCESS ROAD WATERCOURSE CROSSING FISH AND FISH HABITAT ASSESSMENTS

EBA conducted assessments of watercourses in relation to the a proposed access road route (approximately 45 km) that extends from the North Canol Road to the current exploration site (Figure 6). These studies had the primary objective of providing information regarding the fish bearing status, basic physical attributes, as well as fish habitat features in those watercourses and watercourses systems influenced by the access road development (Table 6).

### 5.3.1 Methods

Habitat assessments for the access road assessments were conducted according to the Reconnaissance (1:20,000) Fish and Fish Habitat Assessment Inventory: Standards and Procedures (RIC 2001). The proposed road route was first surveyed by helicopter using two fisheries biologist observers referencing 1:50,000 topographical map information via GPS. Watercourses were referenced and categorized, and those watercourses mapped but not present, or mapped but without defined channels were noted. Following this reconnaissance, each channelized watercourse was visited to perform an on-site assessment.

At each watercourse assessed from the ground, a length of channel ranging from 100 to 400 m was assessed (according to channel width), and the following habitat data were recorded:

- Local stream channel characteristics (wetted width and bankfull width, residual pool depth, depth at bankfull, and channel gradient).
- Channel substrate composition and characteristics (dominant and subdominant substrates, substrate size classes).
- Distribution of major habitat groups (e.g. riffle, run, and pool).
- Bank stability, height, and vegetation cover.
- Riparian vegetation composition, instream cover abundance and composition.
- Large scale channel reach characteristics (disturbances, confinement, stream pattern, etc.)
- Basic water quality attributes (e.g. dissolved oxygen, conductivity, temperature, turbidity, pH).

Where the presence of fish was deemed possible (e.g. no downstream barriers, suitable water quality), fish presence and species diversity was assessed through backpack electrofishing. Methodologies used were consistent with the BC MOE Fish and Fish

Habitat Inventory and Information Program (1989), and by the BC Fish and Fish Habitat Inventory Standards and Procedures published by the Resource Inventory Committee (RIC 2001).

Additionally, EBA assessed sample points on main stems or other tributaries along the road route (habitat, fish presence/absence, or water quality) to allow further determination of potential impacts from indirect (downstream) effects, or to refine the fish bearing status of a particular tributary.

### 5.3.2 Results

In August and September 2008, EBA assessed a total of 23 watercourses to provide baseline information for a proposed access road route within the ASA$^{R}$ (Table 6, Figure 6). The results of the access road fisheries baseline studies are outlined below, organized according to tributary group starting from the North Canol Road and leading to the proposed mine site.

#### 5.3.2.1 South Macmillan River

The proposed access road crosses only the mainstem of the South Macmillan River (no tributaries) adjacent to the existing but deteriorated crossing (Figure 6) (Photos 10 and 11). At this location, the river consists of a wide and deep channel carved through gravels and fines, with minimal larger substrate composition. The channel in the greater crossing area is moderately mobile, showing signs of ongoing migration (eroding backs, depositional areas), and forms numerous point bars and deep pools/channel segments. Despite the presence of deep run and pool habitats, the upper reaches of this river are heavily impacted by local geological features and prior mining projects (e.g. Sekie Creek #2 from the Jason Project, pH = 2.9; MPERG 2007). Consequently, the area local to the crossing lacks suitable water quality to support fish, and shows visible signs of negatively impacted physical and water quality (e.g. visible siderite precipitate, local pH of 4.99, and turbidity of 30.2 NTU). Consequently, local areas of the South Macmillan River do not provide suitable fish habitat. Detailed information regarding this crossing is available in Tables 7 and 8. Based on the water quality, EBA did not conduct fishing effort and the watercourse is considered non fish bearing in this area (Table 9, Figure 7).

#### 5.3.2.2 Tributary Group D

Tributary D (which feeds the Hess River) flows adjacent to the proposed access road from roughly km 3.5 through km 17, and six tributaries to this watercourse are crossed within this span (three of which are channelized). All three channelized tributary crossings were assessed, as well as a total of seven additional sites on the mainstem or tributaries opposite to the access road that were used to determine the overall fish habitat value of the system (Table 6, Figure 6).

In addition to the tributaries crossed by the proposed road route and individually assessed, EBA electrofished the mainstem of Tributary D for a total of 400 seconds, capturing 2

Dolly Varden (ranging in size from 126 to 143 mm fork length)(Table 10). No Arctic grayling or slimy sculpin were captured or observed in Tributary D.

Individual tributary summaries are presented below, with summary information available in Tables 7 through 9. Stream locations can be observed in Figure 6.

*Tributary D3*

EBA assessed Tributary D3 on August 7, 2008. In the vicinity of the proposed crossing location, the watercourse is composed of multiple small drainages joining the mainstream at various locations. Tributary D3 is characterized by a cascade pool pattern with substrate dominated by gravel and boulder. EBA measured the channel gradient in the proposed crossing area at 12.5%. The channel and banks were primarily stable, and the channel width and wetted widths across six sites were 1.67 m and 1.19 m, respectively. Mean bankfull depth was 38 cm and residual pool depth was 20 cm. Within the area sampled, the channel consisted of riffle, pool habitat units and cascade/rapids, in order of abundance. Suitable fish habitat cover features were abundant (70% total), and dominated by overstream vegetation and light woody debris. Riparian vegetation consisted primarily of herbaceous, shrubs and conifers of a mature stage (Photos 13 and 14). A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at Tributary D3 for a total of 193 seconds, during which time 2 Dolly Varden were captured (ranging in size from 166 to 186 mm fork length) (Table 10).

*Tributary D9*

EBA assessed Tributary D9 on August 5, 2008. In the vicinity of the proposed crossing location, the watercourse was of moderate size and high discharge, and consisted of a cascade pool pattern with substrate dominated by boulder and gravel (Photos 15 and 16). EBA measured the channel gradient in the crossing area at 7%. The channel and banks were primarily stable, and the channel and wetted widths across six sites were 3.95 m and 3.53 m, respectively. Mean bankfull depth was 97 cm and residual pool depth was 27 cm. Within the area sampled, the channel consisted of cascade /rapid, riffle, pool habitat units and run, in order of abundance. Suitable fish habitat cover features were moderate (33% total), and dominated by surface turbulence and undercut banks. Riparian vegetation consisted primarily of shrubs, herbaceous vegetation and mixed forest. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at Tributary D9 for a total of 406 seconds, during which time 5 Dolly Varden were captured (ranging in size from 83 to 176 mm fork length)(Table 10).

*Tributary D13*

EBA assessed Tributary D13 on August 6, 2008. In the vicinity of the proposed crossing location, the watercourse was of moderate size and high energy, and consisted of a cascade pool pattern with substrate dominated by boulder and cobbles (Photos 17, 18 and 19) . EBA measured the channel gradient in the crossing area at 9%. The channel and banks

were primarily stable, and the channel and wetted widths across six sites were 3.73 m and 2.44 m, respectively. Mean bankfull depth was 61 cm and residual pool depth was 12 cm. Within the area sampled, the channel consisted of cascade, riffle, and pool habitat units, in order of abundance. Suitable fish habitat cover features were abundant (70% total), and dominated by surface turbulence, large woody debris, and overhanging vegetation. Riparian vegetation consisted primarily of tall shrubs (primarily willow) and herbaceous vegetation. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at Tributary D13 for a total of 924 seconds, during which time six Dolly Varden were captured (ranging in size from 152 to 215 fork length) (Table 10) (Photo 20).

Tributaries D1, D4 and D6 were visited by EBA in August of 2008. While these watercourses were mapped, no distinct channel was found on site and no stream channel habitat assessment or fish assessment was completed (Figure 6).

#### 5.3.2.3 Tributary Group E

Tributary E (which feeds Tributary D) is crossed by the proposed access road twice (kilometres 17.5 and 27), between which it flows adjacent to the proposed road route, crossing 5 mapped tributaries to that watercourse along its route (Figure 6). Of these five tributaries, two were found to have no distinct channel, or a channel that did not connect with the mainstem (E4 and E6). The three channelized tributaries (E1, E4, and E7), as well as two mainstem sites (upper and lower Tributary E) were fully assessed for habitat, fish presence, and water quality (Table 6).

From a physical habitat perspective, Tributary E was found to be a high energy/high discharge watercourse with channel characteristics dominated by a boulder substrate (riffle-pool with some cascade). Cover in Tributary E was also not abundant or of high quality (little canopy closure or vegetation/wood), but characteristic of other area main tributaries in the form of pools and turbulent water (Table 8).

Despite poor overall habitat quality, EBA assessed fish presence through a total of 905 seconds of electrofishing effort (across three sites, E, E1 and E7), which resulted in no fish captures or observations (Table 10).

Tributaries E6 and E9 were visited by EBA in August 2008. Despite the presence of the watercourse on maps, no distinct channel was found on the site and no stream channel habitat assessment or fishing was completed (Tables 6 and 7).

*Lower Tributary E*

EBA assessed lower Tributary E on August 6, 2008. In the vicinity of the proposed crossing location, the watercourse was fast with riffle/pool dominated by boulder and gravel (Photos 21, 22 and 23). EBA measured the channel gradient in the crossing area at 1%. The channel and banks were primarily stable, and the channel and wetted widths across six sites were 3.92 m and 3.80 m, respectively. Mean bankfull depth was 99 cm and residual pool depth

was 13 cm. Within the area sampled, the channel consisted of cascade, rapid, and riffle as well as pool habitat units, in order of abundance. Suitable fish habitat cover features were intermediate (40% total), and dominated by surface turbulence, and small woody debris. Riparian vegetation consisted primarily of herbaceous vegetation, shrubs and conifers. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at lower Tributary E for a total of 261 seconds, during which time no fish were captured. Based on the poor water quality of this tributary and the electrofishing results, lower Tributary E is considered non fish bearing (Table 10).

*Tributary E1*

EBA assessed lower Tributary E on August 7, 2008. In the vicinity of the proposed crossing location, the watercourse was constituted of cascade and pools dominated by fines and boulder. EBA measured the channel gradient in the crossing area at 18%. The channel and banks were primarily stable, and the channel and wetted widths across six sites were 1.43 m and 0.83 m, respectively. Mean bankfull depth was 42 cm and residual pool depth was 12 cm. Within the area sampled, the channel consisted of cascade, rapid, and riffle as well as pool habitat units, in order of abundance. Suitable fish habitat cover features were intermediate (40% total), and dominated by surface turbulence, and overstream vegetation. Riparian vegetation consisted primarily of shrubs, conifers and mixed forest. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at Tributary E1 for a total of 403 seconds, during which time no fish were captured. Despite the presence of good summer fish habitat, the fish access to the site is limited by low quality water of tributary E. Based on these criteria Tributary E1 is considered non fish bearing (Table 10).

*Tributary E7*

EBA assessed Tributary E7 on August 5, 2008. In the vicinity of the proposed crossing location, the slope is low and the watercourse of low energy riffle pools dominated by gravel and cobble. EBA measured the channel gradient in the crossing area at 3.5% (Photos 24, 25 and 26). While the left channel bank was primarily stable, the left bank was moderately stable. Channel and wetted widths across six sites were 1.7 m and 1.21 m, respectively. Mean bankfull depth was 39 cm and residual pool depth was 12 cm. Within the area sampled, the channel consisted of riffle, cascade and rapid, in order of abundance. Suitable fish habitat cover features were relatively high (45% total), and dominated by overstream vegetation and surface turbulence. Riparian vegetation consisted primarily of herbaceous and shrubs. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at lower Tributary E7 for a total of 241 seconds, during which time no fish were captured and no proper overwintering habitat was observed. Even thought the

water quality and fish habitat are suitable, Tributary E7 is considered non fish bearing (Table 10).

*Upper Tributary E*

EBA assessed upper Tributary E on August 8, 2008. In the vicinity of the proposed crossing location, the watercourse was of steep slope and high energy with very little valuable fish habitat. The channel is consisted of cascades and pools dominated by boulders and cobbles (Photos 27-29). EBA measured the channel gradient in the crossing area at 13.5%. The channel and banks were primarily stable, and the channel and wetted widths across six sites were 3.03 m and 2.1 m, respectively. Mean bankfull depth was 42 cm and residual pool depth was 21 cm. Within the area sampled, the channel consisted of cascade, pool habitat units and riffles, in order of abundance. Suitable fish habitat cover features were rather low (20% total), and dominated by surface turbulence and overstream vegetation (Tables 7 through 9).

EBA considered Upper Tributary E to be non- fish bearing due to poor water quality, and was not sampled for fish.

#### 5.3.2.4 Tributary Group B

Tributary B (which feeds Tributary A) flows adjacent to the proposed access road from roughly km 28 to km 32.5, and one tributary to this watercourse is crossed at tributary B1 (Table 6, Figure 6). This single crossing site was assessed, along with two additional sites on the mainstem or tributaries opposite to the access road that were used to determine the overall fish habitat value of the system (Figure 6).

*Tributary B1*

EBA assessed Tributary B1 on August 4, 2008. In the vicinity of the proposed crossing location, the watercourse was of high energy and steep slope, and consisted of a cascade pool pattern dominated by cobbles and boulder (Photos 30 - 32). The channel gradient in the crossing area is not available for this tributary. The channel and banks were moderately stable, and the channel and wetted widths across six sites were 14.9 m and 2.06 m, respectively. Mean bankfull depth was 77 cm and residual pool depth was 18 cm. Within the area sampled, the channel consisted of cascade, rapids, pool habitat units, and riffle, in order of abundance. Suitable fish habitat cover features were moderate (35% total), dominated by surface turbulence and overstream vegetation. Riparian vegetation consisted primarily of shrubs. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

The crossing site B1 was not found to support fish, nor did it provide suitable fish habitat. Despite being a steep, disturbance channel dominated by cobble and boulder cascades (with little cover), the pH of this watercourse was measured at only 3.75 (Table 9). Because of the low fish habitat value and the unsuitable water quality, EBA assume that Tributary B1 is non fish bearing.

#### 5.3.2.5 Tributary Group A

Tributary A (which feeds the Hess River Tributary) flows adjacent to the proposed access road from roughly km 32.5 through km 35.5, as well as along a proposed access road spur to the pumping station (2 km) (Figure 6). The proposed access road crosses two small non-channelized tributaries to Tributary A, and crosses the mainstem of Tributary A just downstream from its junction with Tributary C (Figure 6). Only this crossing location was assessed as part of the baseline program.

EBA assessed lower Tributary A during both the 2006 and 2007 baseline study programs, and this data was applied to this crossing site. The crossing site was visited again on August 7th, 2008 to collect further required data. The following information is summarized both from 2008 studies and from data collected in 2006 and 2007 (EBA 2007a, EBA 2007b). In the vicinity of the proposed crossing locations, the watercourse was fast flowing with riffle/pool dominated by cobbles and fines. EBA measured the channel and wetted widths across six sites at 14.8 m and 7.2 m, respectively. Mean bankfull depth was 35 cm and residual pool depth was 75 cm. Suitable fish habitat cover features were relatively low (25% total), and dominated by surface turbulence and deep water. Despite decent migration and feeding habitat, no fish were captured or observed which may indicate that they are restricted by water quality. A detailed summary of stream channel and fish habitat characteristics is available in Table 7. In total, a combined electrofishing effort of 1916 seconds in 2006 and 2007 resulted in the no fish captures or observations (EBA 2007, 2008).

Tributaries A3 and A4 were visited by EBA in August of 2008. Despite the presence of the watercourse on maps, no distinct channel was found on site and no stream channel habitat assessment or fishing was completed (Figure 6).

#### 5.3.2.6 Tributary Group C

Tributary C (which feeds Tributary A) flows adjacent to the proposed access road from roughly km 35.5 to the mine site (km 45), and five mapped tributaries to this watercourse are crossed within this span (only two of which are channelized) (Figure 6). EBA assessed the two channelized tributary crossings (C6 and C7) (Table 6), in addition to information on Tributary C collected as part of the receiving environment baseline studies.

*Tributary C6*

EBA assessed Tributary C6 on August 8, 2008. In the vicinity of the proposed crossing location, the watercourse consisted of cascade and pool with substrate dominated by boulder and gravel (Photos 33-35). EBA measured the channel gradient in the crossing area at 8%. The channel and banks were primarily stable, and the mean bankfull and wetted widths across six sites were 3.99 m and 2.72 m, respectively. Mean bankfull depth was 56 cm and residual pool depth was 19 cm. Within the area sampled, the channel consisted of cascade/rapid, pool habitat units, and riffle, in order of abundance. Suitable fish habitat cover features were high (46% total), and dominated by surface turbulence, overstream

vegetation and small woody debris. Riparian vegetation consisted primarily of herbaceous and shrubs. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at Tributary C6 for a total of 403 seconds, during which time no fish were caught or observed (Table 10). Water quality and habitat were found to be suitable for fish. Several large potential barriers to fish passage were observed within 300 m downstream of the proposed crossing site, and EBA considered the areas upstream of those to be non-fish bearing (Photo 36). Areas below the barriers or closer to Tributary C may be fish bearing, although it has not been confirmed.

*Tributary C7*

EBA assessed Tributary C7 on August 8, 2008. In the vicinity of the proposed crossing location, the watercourse consisted of a small meandering channel confined by vegetated banks. The channel is characterized by riffle pool with substrate dominated cobbles (Photos 37-39). EBA measured the channel gradient in the crossing area at 10.5%. The channel and banks were primarily stable, and the mean bankfull and wetted widths across six sites were 1.18 m and 0.84 m, respectively. Mean bankfull depth was 41 cm and residual pool depth was 8 cm. Within the area sampled, the channel consisted of riffle, pool habitat units, and cascade/rapids, in order of abundance. Suitable fish habitat cover features were low (15% total), and dominated by undercut banks, surface turbulence and overstream vegetation. Riparian vegetation consisted primarily of herbaceous and shrubs. A detailed summary of stream channel and fish habitat characteristics is available in Tables 7 through 9.

EBA electrofished at Tributary C7 for a total of 470 seconds, during which time no fish were caught (Table 10). Due to the small size of this stream and low cover, EBA considers it to be non-fish bearing.

*Other Tributaries*

Tributaries C1, C2 and C4 were visited by EBA in August 2008. Despite the presence of the watercourse on maps, no distinct channel was found on site and no stream channel habitat assessment or fishing was completed (Figure 6, Table 6).

### 5.3.3 Discussion

*South Macmillan River*

The proposed access road crosses only the mainstem of the South Macmillan River (no tributaries) adjacent to the existing but deteriorated crossing. As noted above, current water quality data and prior aquatic habitat results suggest that this river only supports minimal aquatic life, and that is does not support fish in the proposed crossing area (MPERG 2007).

*Tributary D*

Overall, this system was found to provide moderate quality fish habitat and to support populations of Dolly Varden. Total electrofishing effort in the system (1923 seconds in

Tributaries D, D3, D9 and D13) allowed EBA to capture 15 Dolly Varden. Complete habitat assessment at each of the three individual tributaries crossed (D3, D9, and D13) revealed energy cascade-pool watercourses with predominantly boulder based substrates, and high gradients. Basic water quality attributes of all three tributaries were suitable to support fish, and cover/habitat distributions were favourable to support feeding, potential spawning, and potential over-wintering habitat for Dolly Varden (areas studied were below the treeline). However, EBA did not assess D1, D4 and D6 since no distinct channel was found on site or the channel was not connected to the mainstem. These three watercourses are therefore considered non fish bearing.

*Tributary E*

Overall, this watercourse system was found to provide low fish habitat value, and was not found to support any fish. The uppermost reach of Tributary E, as well as site E1 that crossed the road route, were high energy streams with cobble or boulder dominated substrates and high gradients. E1 was the only site found to have suitable water quality and habitat distribution. In contrast, the suitability of Site E7 and Upper Tributary E (both of which cross the road route) were limited by acidic characteristics (pH of 3.36 and 4.5, respectively). This trend was also observed in other tributaries that feed the system from the south, which were found to have very poor water quality attributes (pH ranging from 5.94 to 7.93, and precipitate in E3 resulting in turbidity of 97 NTU), and overall habitat characteristics that did not appear to be suitable to support fish (Table 9).

Consequently, the lower mainstem of Tributary E was considered to provide generally low quality habitat, primarily as a result of poor water quality conditions (pH of 6.3 and a heavy precipitate load resulting in turbidity of 36 NTU at the lowest sample site and crossing). These attributes were considered to be one potential factor limiting the presence of fish in this watercourse system. Similar to characteristics in Tributary A, it is believed that the water quality of Tributary E may also be greatly reduced through the winter season, as the relative proportion of groundwater in the system increases (as described in EBA 2007).

EBA did not assess E4, E6 and E9 since no distinct channel was found on site or the channel was not connected to the mainstem. These three watercourses are therefore considered non fish bearing.

*Tributary B*

Despite the poor quality of Tributary B1, the mainstem of Tributary B was found to have suitable water quality characteristics. This watercourse has a steep slope, high energy and poor quality fish habitat. Both instream and overstream cover appeared to be suitable as fish habitat. Tributaries B and B2, however, were noted to be shallow with no observed overwintering habitat, and as earlier noted the Tributary A system (into which B flows) does not support fish, suggesting that seasonal fish presence in Tributary B is not likely to occur. No fish were captured or observed in 450 seconds of electrofishing effort in Tributary B, further supporting its classification as non-fish bearing.

*Tributary A*

Overall, this system has been found to provide only low quality fish habitat, and has not been found to support any fish. Tributary A near the proposed crossing is representative of the greater watercourse, consisting of a mid-energy riffle-pool channel dominated by cobbles and gravels, with isolated boulder cascades. Deep pools were the primary habitat cover available, and water quality appeared generally suitable to support fish (Table 7). However, both the suspended precipitate and benthic deposits/staining are suggestive of upstream ARD and elevated metals levels (confirmed at a pH of 5.25 in upstream areas). EBA's baseline water quality data for this tributary has shown a trend of increasing metals concentrations with progression of the season (EBA 2007, 2008). While this is believed to restrict fish presence in Tributary A throughout much of the open water season, the presence of fish in Tributary C confirms that fish are able to at least migrate through the lower area, likely during spring freshet. Based on the channel size and habitat quality, EBA did not conduct any fisheries work in A3 and A4, which are considered non fish bearing.

*Tributary C*

EBA previously found the mainstem of Tributary C provided good quality fish habitat, with the potential to support populations of Dolly Varden year-round (EBA 2007a and EBA 2007b). While both C6 and C7 were found to have moderate to good quality fish habitat value, neither was found to support fish during the 2008 fishing effort.

Tributary C6 was a steep, high energy stream and the study area was moderately confined by bedrock and boulder. As a result, numerous large cascades presented possible to likely barriers to fish passage. Consequently, areas upstream from the sampling location are considered to be non-fish bearing. However, it is possible that areas closer to the mainstem of Tributary C support fish populations. Water quality characteristics, cover, and general habitat distributions were found to be suitable to support fish (with the exception of barriers).

Tributary C7 was a much shallower watercourse with a predominantly cobble substrate channelized by tall vegetated banks. Despite being shallow and having little overhead cover, the water quality and availability of undercut bank cover in this tributary were conducive to supporting fish. However, as noted above, no fish were captured.

EBA did not assess C1, C2 and C4 since no distinct channel was found on site or the channel was not connected to the mainstem. These three watercourses are therefore considered non fish bearing.

# 6.0 AQUATIC ENVIRONMENT

## 6.1 STREAM SEDIMENT METALS AND PARTICLE SIZE

Stream sediment samples were collected as part of EBA's 2008 baseline studies in order to provide baseline reference data regarding stream habitat composition and energy, and the chemical makeup of sediments affecting the aquatic environment.

### 6.1.1 Methods

*Field Sampling*

Sampling for stream sediment particle size and metals was conducted as part of EBA's 2008 aquatics baseline study program. EBA collected sediment samples from seven sites across five streams within the $ASA^P$ and $ASA^R$, representing the both the potential receiving environment and the proposed access road areas (Figure 4). At each station, samples were collected from three separate depositional areas within the active channel. Each sample was collected using an aluminium scoop, by a collector wearing latex gloves. Samples were directly placed into labelled 125 mL glass jars and kept refrigerated until being placed on ice in coolers for transport under chain of custody to Maxxam Analytics Ltd. in Burnaby (BC) for analysis. All samples were collected on September 6, 2008. All sites were located at previous fisheries sites with the exception of two new sties, AQ-D and AQ-E that are associated with the access road (Photos 21, 22, 40, 41).

*Laboratory and Data Analysis*

At the laboratory, samples were dried and screened using sieves at ASTM mesh numbers 16, 30, 50, 100, 140, 200, 270 and 400. The percentage of total sample retained by sieve was recorded. Results of the particle size distribution were assessed for consistency between replicate samples at a given site by calculating the coefficient of variation (CV) between sample replicates for each sieve class.

Following physical particle size separation, a sub-sample of sediments from the #100 sieve was analysed by Maxxam Analytics for metals concentrations using ICPMS analysis, as well loss on ignition (LOI) at 550°C.

Results of the ICPMS analysis were compared to Canadian Council of Ministers of the Environment (CCME) Interim Sediment Quality Guidelines (ISQG) for the Protection of Freshwater Aquatic Life (CCME 2003). To provide a reference for those metals where no CCME standard exist, samples were also compared to the British Columbia Water Quality Guidelines (BCWQG 2001) for the protection of freshwater aquatic life

### 6.1.2 Results

*Grain Size Distribution*

Generally, the results of the grain size distribution[1] were representative of high energy/high slope stream systems. Samples from all sites consisted largely of fine to coarse sand with little silt deposition (Table 12). Low order streams (sites FS10, FS6) contained the highest composition of very coarse sand. Sediment samples taken from the Hess River Tributary (sites FS8 and FS9), a fifth order stream, were comprised largely of medium to coarse sand. Overall, sediment samples contained only minute amounts of silt. However, silt and fine sand levels were substantially elevated in the sediment samples collected at site FS10. This site is located on the upper portion of Tributary C, approximately 2 km downstream of the mine site (Figure 4). High silt content and fine sand deposits are not typical for low order, fast flowing, high gradient streams. EBA did note that crews were operating exploration roads and drilling test pits in the mine footprint area which may have resulted in fines entering the watercourse.

A moderate degree of grain size variability occurred in the replicate samples taken from the same location, as indicated by the coefficient of variation (CV) (Table 13). High variability (CV > 1.00) occurred in seven of the sample replicates (or 10% of replicates), six of which were at site FS8. Moderate variability (CV between 0.75 and 1.00) occurred in eleven sample replicates (16% of replicates), seven of which were taken from sites on the Hess River Tributary (sites FS8 and FS9).

Sediment Metals

Table 14 presents the detailed results of the metals concentrations from the sediment samples taken at each site during the 2008 study. Samples were compared against various standards as mentioned above, however these standards only exist for arsenic, cadmium, chromium, copper, lead, mercury, selenium, strontium and zinc. All metal parameters were below comparable standards except for those listed below:

*FS6 (Lower Tributary C)*

- Concentrations for arsenic, cadmium, copper, nickel, silver and zinc were above the comparable standards in all three samples that were collected at FS6.
- Concentrations for arsenic, cadmium and zinc also exceeded the Probable Effects Level (PEL) in all three samples.

*FS10 (Upper Tributary C)*

- Concentrations of arsenic, cadmium, copper, silver and zinc were above the comparable standards in all three samples that were collected at FS10.

[1] Substrate size was categorized using the Wentworth Scale for classification of mineral substrates by particle size (Cummins 1962 and Minshall 1984 as cited in Allan 1995).

- Nickel concentrations in Samples 2 and 3 were higher that the comparable standards.
- The PEL was exceeded for arsenic in all three samples for arsenic and in two samples for both cadmium and zinc.

*FS7 (Lower Tributary A)*

- Concentrations for arsenic, cadmium, copper, nickel, silver and zinc were above the comparable standards in all three samples that were collected at FS7.
- The mercury concentration in one of the samples collected at FS7 exceeded the acceptable guidelines.
- Concentrations for arsenic, cadmium and zinc exceeded the PEL in all three samples and the concentrations for copper exceeded the PEL in Samples 2 and 3.

*FS8 (Upper Hess River Tributary)*

- Concentrations for arsenic were above the comparable standards in all three samples that were collected at FS8.
- The concentration of zinc was above the comparable standards in two of the samples that were collected at FS8.
- The concentrations for cadmium and copper exceeded the standards in Sample 1.
- The PEL for arsenic concentrations was exceeded in one of the samples.

*FS9 (Lower Hess River Tributary)*

- Arsenic, cadmium, copper and zinc concentrations exceeded the acceptable standards in all three samples collected at sample site FS9.
- The nickel concentration in Sample 3 was above the comparable standards.
- The PEL for arsenic concentrations were exceeded in two samples and cadmium concentration was exceeded in one sample.

*AQ-D (Tributary D)*

- Concentrations of arsenic, cadmium, copper, nickel, and zinc were above the comparable standards in all three samples that were collected at sample site AQ-D.
- The concentration of silver in Sample 3 was higher than the guideline standards.
- Concentrations for arsenic and cadmium exceeded the PEL in all three samples. The zinc concentrations exceeded the PEL in two samples.

*AQ-E (Tributary E)*

- Concentrations of arsenic, cadmium, copper, mercury, nickel, and zinc were above the comparable standards in all three samples that were collected at sample site AQ-E.

- Silver concentrations in Samples 2 and 3 were higher than the guideline standards.
- Concentrations for arsenic and cadmium exceeded the PEL in all three samples. The copper and zinc concentrations exceeded the PEL in two samples and the mercury concentration exceeded the PEL in one sample.

### 6.1.3 Discussion

EBA found that the applicable CCME standards for arsenic, cadmium, copper and zinc were exceeded, in at least one of the three samples replicates, at each of the seven sites. Metal concentration exceedances are considered to be baseline for the Mactung project and despite the samples containing high concentrations of the metals listed above, are representative of background levels. The only exception to this is for Tributary C, which has been potentially influence by drilling and minor earthworks during the 2007 and 2008 summer seasons. Arsenic is present naturally in the aquatic and terrestrial environments from weathering and erosion of rock and soil. In areas of arsenic-enriched bedrock, background concentrations can be significantly elevated.

Historic information for sediment metal analysis was not available for comparison with results for watercourses assessed in this report. However, results from studies conducted on Dale Creek and the Tsichu River (AMAX 1983), and on the South Macmillan River (Jack and Osler 1983; Sodoka and Jack 1983) have been included for reference. Dale Creek originates near the headwaters of Tributary C, but is located across the height of land in the Northwest Territories. Previous studies indicate that Dale Creek and the Tsichu River have very different water quality characteristics, however, these watercourses appear to have similar concentrations for the metals discussed below. (Jack and Osler 1983)

All three samples collected by EBA in 2008 at each of the seven sample sites contained arsenic concentrations well above the guidelines. The CCME and BCWQ guidelines for arsenic are 5.9 mg/kg, while the CCME probable effect level (PEL) is 17 mg/kg. Arsenic concentrations at site FS10 on Tributary C were the highest of all sampled locations, with a mean concentration of 59.7 mg/kg. The arsenic concentrations for all sites ranged from 12.1 mg/kg at site FS8 to 74.9 mg/kg at site FS10. AMAX (1983) reported arsenic levels that also exceed the CCME standards in the Tsichu River and Dale Creek, located to the east of the study area. Concentrations at these sites ranged from 24.8 to 46.7 mg/L. Sediment metals analysis conducted on the South Macmillan River (Jack and Osler 1983; Soroka and Jack 1983) also found high levels of arsenic (samples ranging from 40.0 to 84.5 mg/kg).

Concentrations of copper exceeded the CCME guidelines of 35.7 mg/kg at all sites, except for two of three sample replicates at site FS8 (Upper HRT). Copper concentrations ranged from 0.47 mg/kg at site at FS8 to 261 mg/kg at FS7. Copper levels in samples collected in Dale Creek and the Tsichu River ranged from 80 mg/kg to 425 mg/kg (AMAX 1983) and ranged from 90.0 to 131.0 mg/kg in the South Macmillan River (Jack and Osler 1983; Sodoka and Jack 1983).

Zinc concentrations ranged from 122 mg/kg to 1420 mg/kg. CCME guidelines for zinc (123 mg/kg) were exceeded at all sites and concentrations were highest at sites FS6 (Tributary C) and FS7 (Tributary A). Only one sample replicate, at site FS8, was below the CCME standards. Zinc concentrations observed at these sites were slightly lower than samples collected from the Tsichu River and Dale Creek (which ranged from 160 mg/kg to 110 mg/kg) (AMAX 1983) but relatively consistent with samples from the South Macmillan River (which ranged from 383 to 839 mg/kg) (Jack and Osler 1983; Sodoka and Jack 1983).

In summary, EBA found that the level of several key metals to be highly elevated within the study area. These results, along with those of previous studies in the area, suggest that a number of local factors may influence the availability of sediment metals in the local area; including the weathering and erosion of local natural mineralizations and other unknown factors. The Upper HRT was found to consistently have lower metals concentrations in comparison to other project area watercourses, which may represent that the headwaters of this watercourse occur in a different mineralizaton type to that of the project area watercourses. EBA strongly suggests the use of timing, techniques and sampling locations for future sampling efforts that are consistent with the methods used in the report so that current data trends can be followed and compared over time.

## 6.2 STREAM PERIPHYTON ANALYSIS

Periphyton are comprised of benthic algae, bacteria, fungi, microinvertebrates and detritus that grow attached to substrate, such as rocks and larger plants, in the aquatic ecosystem. Periphyton serve as an important food source for invertebrates and fish, and are often used as indicator of primary productivity and water quality (US EPA, 2007). Because they are sensitive to environmental change and the tolerance and sensitivity to changes in environmental conditions for some species are known, periphyton composition and abundance can be used to assess the health of aquatic ecosystems.

### 6.2.1 Methods

Periphyton samples were collected at each of the seven sample sites relative to proposed road and receiving environment, as shown in Figure 4. At each site, three separate rocks were haphazardly retrieved from riffle habitat (at least 1 m apart from each other). Two standard size circles (5.5 cm diameter) were etched into the surface of each rock, following which the periphyton was scraped from inside one circle on each rock using a knife and small brush and washed into a container. A first conglomerate sample was collected, chilled, kept dark in aluminum foil casing, and sent for analysis of Chlorophyll a, b, c and phaeophytin to Maxxam Analytics Ltd., to assess levels of primary productivity. A second conglomerate sample was preserved with Lugol's solution, and sent for laboratory taxonomic analysis to Fraser Environmental Services.

### 6.2.2 Results

This section presents the results of the periphyton community sampling completed during the EBA's 2008 Mactung Fisheries and Aquatics baseline assessment. Sample locations are consistent with the fisheries stations shown in Figure 4. The results for chlorophyll and phaeophyton are presented in Table 15. All results are presented in μg/cm$^2$.

*Productivity*

Primary productivity, which is the biomass of periphyton (reported as the concentration of chlorophyll a), was highly variable throughout the sites (ranging from <0.03 to 0.65 μg/cm2) (Table 15). The chlorophyll a concentrations at all sample sites were below the BCWQG (10.0 μg/cm2), indicating generally low productivity (oligotrophy) in all watercourses.

Levels of primary productivity at sites FS6 and FS10 on the Tributary C were the highest, with Chlorophyll a levels of 0.65 μg/cm2. The primary productivity on the upper HRT (site FS8) was moderately high with 0.36 μg/cm2 of chlorophyll a. In contrast, the primary productivity at sites FS7 (Tributary A), FS9 (lower HRT), AQ-E (Tributary E), and AQ-D (Tributary D) were all very low with levels of 0.06 μg/cm2 or lower.

*Taxonomic Analysis*

At the time of the production of this baseline report and its delivery to NATC, the results of taxonomic analyses were not yet available. These results will be summarized and appended to this report when available.

### 6.2.3 Discussion

Based on EBA's periphyton data collected in 2008, the overall productivity of periphyton was variable and ranged between < 0.03 to 0.65 μg/cm$^2$. Primary productivity, as represented by abundance of chlorophyll a, was highest on Tributary C at sites FS6 and FS10. However, chlorophyll a concentrations at all sample sites were below the BCWQG of 10.0 μg/cm$^2$, indicating generally low productivity (oligotrophy) in all watercourses. Primary productivity at sites on Tributary A (site FS7), lower HRT (FS9), Tributary E (AQ-E), and Tributary D (AQ-D) were all very low with levels of less than 0.06 μg/cm$^2$.

No previous stream periphyton data could be found for prior studies in the Mactung region. AMAX (1983) stated that periphyton samples were collected for future analysis, but no record of that analysis could be found. Consequently, no comparisons are available for the project area.

As mentioned above, the taxonomic analyses of periphyton were not yet available.

## 6.3 STREAM BENTHIC MACROINVERTEBRATE ANALYSIS

The abundance and diversity of benthos can be used as indicators of changing environmental conditions. The distribution and abundance of benthic invertebrate species can be influenced by a wide variety of physical parameters such as hydrology, substrate composition, metal concentrations (both in sediment and in the water column), water temperature, dissolved oxygen, pH, salinity, and sediment C/N ratios. Many types of benthos are sensitive to pollutants, such as metals and organic wastes, and the presence and/or composition of certain feeding groups (such as scrapers and filterers) are often used as an indicator of aquatic health.

The majority of sampling for benthic macroinvertebrates was conducted over two years (2006 and 2007) for most of the Mactung receiving environment. In 2008, samples were collected from Tributary D on September 7, 2008 for the proposed road (Figure 4). Attempts were made to collect benthic macroinvertebrate samples on Tributary E at site AQ-E. Due to the nature of the stream bed (i.e. boulders) and high flows, EBA was not able to collect samples at site AQ-E. The results for AQ-D on Tributary D are described below.

### 6.3.1 Methods

Benthic sampling was conducted at all sites using a Hess substrate invertebrate sampler with an area of 0.086 $m^2$ and 363 μm mesh size. The sampler was inserted into the substrate to a depth of ~ 10 cm, and the substrate was washed for 5 minutes (RIC 1997). Contents were preserved on site in 80% ethanol solution for taxonomic analysis. At each site, 3 replicate stations with similar flow, depth and substrate characteristics were sampled moving in an upstream direction (each spaced a minimum of 2 m from the previous).

Preserved samples were all identified and enumerated by Sue P. Salter, R.P.Bio. of Cordillera Consulting. The guidelines used for taxonomic analysis were those provided in the MMER Guidance Document for Aquatic Environmental Effects Monitoring (Environment Canada 2002). Re-sorts were conducted of the sub-samples, thus effectively achieving a Quality Control check on approximately 10% of the samples, as specified in the MMER Guidance Document.

Simpson's Diversity Index was used as a measure of taxonomic diversity in the samples. This index takes into account both the richness and abundance of the invertebrate community, by determining the relative mean contribution of individuals to the site total. The index ranges from 0 to 1, representing low to high diversity, respectively.

### 6.3.2 Results

This section summarizes the results of the benthic invertebrate community surveys conducted during the 2008 Mactung Fisheries and Aquatics Studies. Sites AQ-D and AQ-E were not sampled in 2007 and attempts were made to collect samples at these sites in 2008.

As noted above, EBA was unable to collect samples at AQ-E due to environmental constraints.

*AQ-D (Tributary D)*

Aquatic invertebrate results from AQ-D are summarized in Tables 16-19. Total abundance from all three samples was 57 individuals (Table 16). The density was 220.9 individuals/$m^2$ with samples ranging from 151.2 to 314.0 individuals/$m^2$ (Tables 17 and 18)

The benthic macroinvertebrate community at station AQ-D was mainly comprised of Diptera (77%) and Plecoptera (19%)(Table 19). Ephemeroptera and Trichoptera were also present with one individual from each order present (2% each of total abundance). In total, 57 individuals were collected from the three samples at station AQ-D. A mean species richness of 10.0 species and mean diversity of 0.93 (Simpson's index; Table 18) was recorded.

### 6.3.3 Discussion

Overall benthic macroinvertebrate abundance was low at site AQ-D on Tributary D. Despite the low abundance at AQ-D, species richness and diversity was high in comparison with results collected from other sites in the study area during 2006 and 2007. The results from 2006 (EBA 2007a) and 2007 (EBA 2007b) indicate that sites FS6 (lower Tributary C) and FS8 (upper Hess Tributary) had high invertebrate abundance, invertebrate density, species richness and diversity (Simpson's index) (2006 results only). In contrast, sites FS7 (Tributary A) and FS9 (lower Hess Tributary) had low abundance, density, species richness and diversity (FS7 only). Interestingly, although diversity was high, the composition was comprised solely of four orders, unlike previous years when up to twelve orders were present.

EBA (2007b) suggests that the reductions in abundance and diversity were noted in tributaries with upstream acid rock drainage (ARD). The headwaters of Tributary D are also likely to influenced by upstream ARD as the results, other than species richness and diversity, are similar to Tributary A and the lower Hess Tributary. The lower Hess Tributary site (FS9) is located downstream of the confluence with Tributary A.

The macroinvertebrate samples collected at AQ-D were dominated by Dipterans (including chironomids) in all three samples. The most abundant genera within this group were Rhabdomastix and genera within the family Diamesinae. Plecopterans are the second most abundant order present. Single individuals from the orders Ephemeroptera and Trichoptera were also noted. In terms of macroinvertebrate composition, this site is most similar to FS7 with Dipterans being the most abundant organisms.

## 7.0 QUALIFICATIONS OF CONTRIBUTORS

Mr. Chris Jastrebski, M.Sc., R.P.Bio. coordinated and conducted the 2008 aquatic baseline studies programs, data analysis and reporting. Mr. Jastrebski is a biologist with EBA's Whitehorse Environmental Group, and has over eight years of applicable professional experience. Mr. Jastrebski has been involved in numerous aquatic environment baseline study programs in the north, as well as research programs focusing on fisheries, limnology and biodiversity indicators.

Ms. Audrey Sanfacon, B.Sc., contributed to the data collection and analysis as well as report production for the 2008 Fisheries and Aquatics baseline studies program. Ms. Sanfacon is a biologist with EBA, and has over 5 years of professional experience in the natural sciences field. Ms. Sanfacon has been involved in conducting numerous species inventories and habitat assessments, as well as other aspects of baseline study programs.

Ms. Lea Menzies, B.Sc., B.I.T., A.Sc.T. contributed to the data collection and report production for the 2008 Fisheries and Aquatics baseline studies program. Ms. Menzies is a biologist with EBA, and has over 5 years of professional experience in the natural sciences field. Ms. Menzies has been involved in numerous fisheries and wildlife related projects for a variety of sectors including mining, forestry, wind farms, and industrial and residential development.

Mr. Shawn Martin, B.Sc., P. Biol. CCEP is the senior technical reviewer for 2008 fisheries and aquatic resources baseline studies report. Mr. Martin is the Natural Sciences Team Leader in EBA's Riverbend Environmental Group, and has over 12 years of environmental assessment and fisheries experience. Mr. Martin has provided senior review of environmental assessments for northern mining projects and several hundred fisheries assessment reports.

## 8.0 REPORT LIMITATIONS AND CLOSURE

This report and its contents are intended for the sole use of North American Tungsten Corporation Ltd. and their agents. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than North American Tungsten Corporation Ltd., or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. This report has been prepared according to current professional standards, and incorporates and is subject to the EBA Environmental Report General Conditions (attached), which form part of this report.

EBA is pleased to present North American Tungsten Corporation Ltd. with this 2008 aquatic resource baseline report for the MacTung mine. We trust that this report meets your requirements at this time. If you have any questions or require additional information, please contact the undersigned.

Respectfully submitted,
EBA Engineering Consultants Ltd.



Chris Jastrebski, M.Sc., R.P.Bio., P. Biol.
Biologist, Natural Sciences Team Leader
Whitehorse Environmental Group
Direct Line: 867.668.2071 ext. 243
cjastrebski@eba.ca

Shawn Martin, B.Sc., P. Biol., CCEP
Biologist, Natural Sciences Team Leader
Riverbend Environmental Group
Direct Line: 403.203.335 ext. 843
shmartin@eba.ca

## REFERENCES

Allan, J.D. 1995. Stream Ecology: Structure and function of running waters. Chapman and Hall, London.

AMAX Northwest Mining Company Limited (AMAX). 1983. Initial Environmental Evaluation – MacTung Project Yukon and Northwest Territories.

British Ministry of Environment. 1989. Fish Habitat Inventory and Information Program.

Canadian Council of Ministers of the Environment (CCME). 2003. Canadian water quality guidelines for the protection of aquatic life: Colour Updated. In: Canadian environmental quality guidelines, 1999. Canadian Council of Ministers of the Environment, Winnipeg.

EBA Engineering Consultants Ltd. 2007a. Mactung Project, 2006 Environmental Baseline Studies, Fisheries and Aquatics Resources. Prepared for the North American Tungsten Corporation Ltd.

EBA Engineering Consultants Ltd. 2007b. Mactung Project, 2007 Environmental Baseline Studies, Fisheries and Aquatics Resources. Prepared for the North American Tungsten Corporation Ltd.

Environment Canada. 2002. Metal Mining Effluent Regulations (MMER) Guidance Document for Aquatic Environmental Effects Monitoring.

Jack, M.E. and T.R. Osler. 1983. Baseline study of the watersheds near that Jason Property, Macmillan Pass, Yukon Territory. Regional Program Report No 83-08. Department of Indian Affairs and Northern Development, Whitehorse, YT.

MPERG (prepared by Gartner Lee Limited). 2007. Regional Water Quality, Sediment and Benthic Invertebrate Assessment in the South McMillan River Watershed, MacMillan Pass. Yukon.

Resources Inventory Committee (RIC). 2001. Reconnaissance (1:20,000) Fish and Fish habitat Assessment Inventory: Standards and Procedures. Version 1.1, RIC April 1998.

Resources Inventory Committee (RIC). 2001. Reconnaissance (1:20,000) Fish and Fish habitat Assessment Inventory: Data forms and User's notes. Version 1.1, RIC April 1998.

Resources Inventory Committee (RIC). 1997. Fish Collection Methods and Standards. 1997.

Soroka, I.K. and M.E. Jack. 1983. Baseline study of the watersheds near that Tom Property, Macmillan Pass, Yukon Territory. Regional Program Report No 83-14. Department of Indian Affairs and Northern Development, Whitehorse, YT.

US EPA. 2007. Biological Indicators of Watershed Health: Periphyton as indicators. Available at http://www.epa.gov/bioiweb1/html/periphyton.html. [accessed on November 16, 2008].

## GEO-ENVIRONMENTAL REPORT – GENERAL CONDITIONS

This report incorporates and is subject to these "General Conditions".

### 1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of EBA's client. EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than EBA's Client unless otherwise authorized in writing by EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of EBA. Additional copies of the report, if required, may be obtained upon request.

### 2.0 ALTERNATE REPORT FORMAT

Where EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EBA. The Client warrants that EBA's instruments of professional service will be used only and exactly as submitted by EBA.

Electronic files submitted by EBA have been prepared and submitted using specific software and hardware systems. EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

### 3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by EBA in its reasonably exercised discretion.

# TABLES

| TABLE 1. 2008 FOOTPRINT FISH PRESENCE ASSESSMENT EFFORT AND HABITAT | | | | |
|---|---|---|---|---|
| Location | Habitat type | Total seconds | Electrofishing setup (Volts/Hz/DC/Hz) | Number of fish caught |
| Trib C, Reach 6 | Step-pools boulder dominated. Small to medium vegetation cover. | 814 | 260/50/20/55 | 0 |
| Trib C, feeder channel and pool | Small vacant beaver lodge and pond. Chanel and pond dominated by fines. | 182 | 260/50/20/55 | 0 |
| Trib C, Reach 8 | Bedrock canyon with large cascades, high energy flow. No vegetation cover. | 469 | 260/50/20/55 | 0 |
| Trib C9 | Small intermittent channel – frequent sub-vegetation flows. Substrate dominated by gravel/cobble. | 758 | 260/50/17/50-60 | 0 |

| TABLE 2: SUMMARY OF 2008 HESS RIVER TRIBUTARY SEINE NETTING DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Site | Month | No. Sites | No. Efforts (Pulls) | Total Effort ($m^2$) | Number of Fish Captured | | | |
| | | | | | *SaMa* | *ThAr* | *PrCy* | *CoCo* |
| PS-1 | July | 2 | 3 | 72 | | | 1 | 4 |
| | September | 3 | 3 | 38 | | | | |
| | Total | 5 | 6 | 110 | | | 1 | 4 |
| PS-2 | July | 5 | 10 | 265 | | 11 | 1 | 3 |
| | September | 4 | 5 | 108 | | 2 | | 1 |
| | October | 2 | 4 | 110 | | | | |
| | Total | 11 | 19 | 483 | | 13 | 1 | 4 |
| PS-3 | October | 2 | 4 | 160 | | | | |
| | Total | 2 | 4 | 160 | | | | |
| PS-4 | July | 3 | 7 | 190 | | 5 | | 1 |
| | October | 2 | 3 | 120 | | | | |
| | Total | 5 | 10 | 310 | | 5 | | 1 |

Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – round whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

| TABLE 3: SUMMARY OF 2008 HESS RIVER TRIBUTARY ELECTROFISHING EFFORT AND CATCH RESULTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Watercourse | Site | Month | Effort (Seconds) | No. Fish Captured (No. Observed But Not Captured) | | | |
| | | | | *SaMa* | *ThAr* | *PrCy* | *CoCo* |
| Tributary C | Footprint Area | July | 2223 | | | | |
| | Tributary C Total | | 2223 | | | | |
| Upper Hess River Tributary | PS2 | July | 1055 | | 5 | | 3 |
| | | September | 121 | | | | |
| | PS3 | September | 799 | | | | 7 |
| | PS4 | July | 745 | | 4 | | 3 |
| | | September | 572 | | | | |
| | Upper Hess Trib. Total | | 3292 | | 9 | | 13 |
| Lower Hess River Tributary | PS1 | July | 499 | | | | 1 |
| | Lower Hess Trib. Total | | 499 | | | | 1 |

Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – round whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

| TABLE 4. SUMMARY OF 2008 ANGLING EFFORT AND CATCH DATA | | | | | |
|---|---|---|---|---|---|
| Site | Month | Effort (Person*hour) | Number Caught | CPUE | Species |
| PS-1 | 5 September | 0.42 | 0 | 0 | |
| | 23 September | 0.50 | 0 | 0 | |
| PS-2 | 4 September | 2.80 | 7 | 2.50 | ThAr |
| | 24 September | 0.33 | 0 | 0 | |
| | 10 October | 0.75 | 0 | 0 | |
| PS-3 | 5 September | 1.36 | 11 | 8.09 | ThAr |
| | 10 October | 0.33 | 0 | 0 | |
| PS-4 | 5 September | 3.10 | 3 | 0.97 | ThAr |
| | 24 September | 0.25 | 0 | 0 | |
| | 10 October | 1.47 | 0 | 0 | |
| | **Total** | **11.32** | **21** | | |

Species codes: *ThAr* – Arctic grayling (*Thymallus arcticus*); CPUE = Catch per Unit Effor

| TABLE 5. SUMMARY OF GILLNETTING EFFORT FROM THE HESS RIVER TRIBUTARY, 23-24 SEPTEMBER 2008 | | |
|---|---|---|
| SITE | EFFORT (HOURS) | MESH SEIZE (CM) (NET HEIGHT = 1.83 M) |
| PS-1a | 2 | 2.54 |
| PS-1b | 2 | 2.54 |
| PS-2 | 3 | 2.54 |
| PS-4 | 2.75 | 2.54 3.81 5.08 6.35 7.62 10.16 |

| TABLE 6: SUMMARY OF WATERCOURSE CROSSING FISHERIES ASSESSMENT EFFORT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Watercourse | Crossings On Proposed Road Route | | | No. Other Adjacent Sites Assessed | No. Sites Assessed For: | | |
| | Total No. of Access Road Intersections (Mapped) | No. Crossing Sites Assessed | No. Mapped Sites w. No Distinct Channel | | Fish Presence/ Absence | Habitat | Water Quality |
| Tributary A | 3 | 1 | 2 | 1 | 1 | 1 | 2 |
| Tributary B | 1 | 1 | 0 | 3 | 1 | 1 | 4 |
| Tributary C | 5 | 2 | 3 | 0 | 2 | 2 | 3 |
| Tributary D | 6 | 3 | 3 | 7 | 4 | 3 | 5 |
| Tributary E | 7 | 4 | 3 | 3 | 4 | 4 | 6 |
| South Macmillan River | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

TABLE 7: SUMMARY OF WATERCOURSE CROSSING STREAM CHANNEL HABITAT CHARACTERISTICS

| Watercourse | Site Type | Channel Characteristics (Avg.) | | | | Gradient (%) | Channel Type | Substrate (Dom./ Subdom) | Fish Habitat Cover | | Fish Status | General Habitat Attributes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Residual Pool Depth (cm) | Bankfull Depth (cm) | Channel Width (m) | Wetted Width (m) | | | | % | Dominant Types | | |
| South MacMillan River | Road | N/A | N/A | 14.7 | 23.05 | <1 | $RP_g$ | Gravel / Fines | 45 | Deep Water / Surface Turbulence | NB (Water Quality) | Upper reaches heavily impacted by ARD, low productivity documented in the area. Simple channel/habitat structure. |
| D13 | Road | 12 | 61 | 3.73 | 2.44 | 9 | $CP_b$ | Boulder / Cobble | 70 | Overstream Veg. / Surface Turbulence | CF - *SaMa* | Excellent pool habitat structure supported by overhead cover and limited large woody debris (LWD). |
| D9 | Road | 27 | 97 | 3.95 | 3.53 | 7 | $CP_b$ | Boulder / Gravel | 33 | Surface Turbulence/ Undercut Bank | CF - *SaMa* | High discharge stream with good pool habitat availability. Overwintering and spawning potential if water quality allows. |
| D6 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| D4 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| D3 | Road | 20 | 38 | 1.67 | 1.19 | 12.5 | $CP_b$-w | Gravel / Boulder | 70 | Overstream Veg. / LWD | CF - *SaMa* | Small channel confined by vegetation and LWD. Network of many small drainages join the mainstem at various locations. |
| D1 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| E (Lower) | Road | 13 | 99 | 3.92 | 3.80 | 1 | $RP_b$ | Boulder / Gravel | 40 | Surface Turbulence/ Small Woody Debris | NB | Fast, deep channel has good habitat attributes, but water quality is limited (upstream ARD). |
| E1 | Road | 12 | 42 | 1.43 | 0.83 | 18 | $CP_b$ | Fines / Boulder | 40 | Undercut Bank / Overstream Veg. | NB | Good summer fish habitat, but lacks over-wintering habitat. Fish access to site limited by poor water quality of Tributary E. |
| E4 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| E6 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| E7 | Road | 12 | 39 | 1.7 | 1.21 | 3.5 | $RP_g$ | Gravel / Cobble | 45 | Overstream Veg. / Surface Turbulence | NB | Low energy, low slope stream near the proposed crossing. Habitat and water quality suitable, but lacks over-wintering hab. |
| E9 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| E (Upper) | Road | 21 | 42 | 3.03 | 2.1 | 13.5 | $CP_b$ | Boulder / Cobble | 20 | Surface Turbulence/ Overstream Veg. | NB | High energy, steep slope stream with little fish habitat value. |
| B1 | Road | 18 | 77 | 14.9 | 2.06 | N/A | $CP_c$ | Cobble / Boulder | 35 | Surface Turbulence / Overstream Veg. | NB | High energy, steep slope stream with little fish habitat value. Water quality unsuitable. |
| A4 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| A3 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| A | Road | 75 | 35* | 14.8 | 7.2 | N/A | RPc | Cobble / Fines | 25 | Surface Turbulence/ Deep Water | NB† | Fast flowing channel offering migration and feeding habitat, but restricted by water quality. No fish captured or observed. |
| C1 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| C2 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | Mapped watercourse, but no distinct channel found. |
| C4 | Road | -- | -- | -- | -- | -- | -- | -- | -- | -- | NB | Channelized in upper reaches, but channel sub-ground prior to junction with Tributary C. No overwintering habitat observed. |
| C6 | Road | 19 | 56 | 3.99 | 2.72 | 8 | $CP_b$ | Boulder / Gravel | 46 | Surface Turbulence/ Overstream Veg. | NB | Water quality and habitat suitable for feeding, but passage downstream is unlikely. Steam likely fish bearing nearer to mainstem of Tributary C (*SaMa*), but unconfirmed. |
| C7 | Road | 8 | 41 | 1.18 | 0.84 | 10.5 | $RP_c$ | Cobble | 15 | Undercut Bank/ Overstream Veg. | NB | Small meandering channel confined by vegetated banks. Habitat seasonally suitable. Size and low cover lower habitat suitability. |

* Mean riffle depth

† Seasonal early summer fish usage or migration suspected, but unconfirmed.

Channel Habitat descriptors: $RP_b$ = riffle-pool, boulder dominated; $RP_c$ = riffle-pool, cobble dominated; $SP_r$ = step-pool, rock based; $SP_b$ = step-pool, boulder based; $CP_b$ = cascade-pool, boulder dominated. The –w modifier indicated functional large woody debris.

Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – Round Whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

| TABLE 8: STREAM HABITAT ASSESSMENT DATA | | | | | | | |
|---|---|---|---|---|---|---|---|
| UTM | 09V 437541 7002993 | 09V 424117 7008714 | 09V 431507 7004665 | 09V 426020 7008262 | 09V 428456 7006962 | 09V 431779 7004737 | 09V 424489 7011668 |
| Watercourse | South MacMillan River | Lower Tributary D | D2 | D3 | D9 | D13 | E1 |
| Sampling Date / Time | 06/08/2008; 14:09 | 07/09/2008; 10:30 | 08/08/2008; 13:44 | 07/08/2008; 11:30 | 05/08/2008; 19:35 | 06/08/2007; 09:46 | 07/08/2008; 15:13 |
| **Stream Characteristics** | | | | | | | |
| Residual Pool Depth (cm)– Max./Min./Avg. (n) | N/A | 140 / 45 / 81.8 (6) | N/A | 0.3 / 0.09 / 0.2 (6) | 0.51 / 0.17 / 0.27 (6) | 0.23 / 0.05 / 0.12 (6) | 0.21 / 0.03 / 0.12 (6) |
| Channel Width (cm)– Max./Min./Avg. (n) | 33.8 / 12.5 / 23.05 (6) | 29.3 / 11.6 / 17.5 (6) | N/A | 2.5 / 1.02 / 1.67 (6) | 5.85 / 2.77 / 3.95 (6) | 6.17 / 2.12 / 3.73 (6) | 1.65/1.24 / 1.43 (6) |
| Wetted Width (cm)– Max. Min./ Avg. (n) | 30 / 9.5 / 14.7 (6) | 18.2 / 10.25 / 13.99 (6) | N/A | 1.78 / 0.76 / 1.19 (6) | 5.16 / 2.58 / 3.53 (6) | 3.58 / 1.51 / 2.44 (6) | 1.05/ 0.48 / 0.83 (6) |
| Mean Bankfull Depth (cm) – Avg. (n) | N/A | 92.3 (6) | N/A | 0.38 (6) | 0.97 (6) | 0.61 (5) | 0.42 (6) |
| Mean Bank Stability [1] (Left, Right) | 0.75 0.75 | 0.5 1 | 1 1 | 1 1 | 1 1 | 1 1 | 1 1 |
| Mean Bank Slope/Veg. Cover (L, R) (°/%) | 20/77.5 5/60 | 9/88 8/86 | 76.7 / 83.3 75 / 60 | 10 / 68.5 30 / 86.7 | 76.7 / 83.3 75 / 60 | 90/66.7 58.3/76.7 | 36.7/100 30/100 |
| **Substrate Composition** | | | | | | | |
| Dominant Substrate (D) | Gravel | Cobble | N/A | Pebble | Boulder | Boulder | Fines |
| Subdominant Substrate (subD) | Fines | Boulder | N/A | Boulder | Gravel | Cobble | Boulder |
| D95 (cm) | N/A | N/A | N/A | N/A | 75 | 63 | N/A |
| D (cm) | 6.5 | N/A | N/A | 8.8 | N/A | 27 | 0.72 |
| **Major Habitat Units (average)** | | | | | | | |
| Cascade/Rapid (%) | 0 | 0 | N/A | 15 | 45 | 50 | 40 |
| Riffle (%) | 45 | 71.5 | N/A | 65 | 40 | 30 | 42 |
| Run (%) | 40 | 11.6 | N/A | | 0 | 0 | 0 |
| Pool (%) | 15 | 16.7 | N/A | 20 | 15 | 20 | 20 |
| **Water Quality** | | | | | | | |
| Water Temperature(°C) | 3.9 | 3.6 | 7.5 | 4.9 | 6.6 | 4.7 | 3.5 |
| pH | 4.99 | 7.75 | 7.3 | 8.4 | 8.6 | 8.69 | 8.96 |
| Conductivity (µscm$^{-1}$) | 4.28 | 326 | 259 | 454 | 515 | 291 | 626 |
| Dissolved Oxygen (mg/l)/(%Saturation) | 8.5 / 73.7 | 10.83 / 81.0 | 9.6/76.2 | 10.4 / 81.1 | 10.52.4 | 10.4 / 81.6 | 10.5 / 80.0 |
| Turbidity (NTU) | 30.2 | 11.1 | 2.78 | 6.37 / 6.16 | 15.2 | 2.81 | 0.76 |
| **Cover / Habitat Value** | | | | | | | |
| Total Fish Habitat Cover (%) | 45 | 11.3 | | 70 | 33 | 70 | 40 |
| Primary Fish Habitat Components (%) | • Deep Water/Pools (38)<br>• Surface Turbulence (3)<br>• Undercut Bank (2)<br>• Instream Vegetation (2) | • Deep water (5.3)<br>• Surface Turbulence (3)<br>• Undercut Bank (1.6)<br>• Large Woody Debris (0.6) | N/A | • Overstream Vegetation (40)<br>• Large Woody Debris (10)<br>• Undercut Bank (7)<br>• Small Woody Debris (7)<br>• Surface Turbulence (5)<br>• Insteam Vegetation (1) | • Surface Turbulence (20)<br>• Overstream Vegetation (5)<br>• Undercut (5)<br>• Large Woody Debris (1)<br>• Small Woody Debris (1)<br>• Deep Water (1) | • Overstream Vegetation (30)<br>• Surface Turbulence (25)<br>• Large Woody Debris (5)<br>• Small Woody Debris (5)<br>• Undercut Bank (5) | • Undercut Bank (15)<br>• Overstream Vegetation (15)<br>• Surface Turbulence (5)<br>• Small Woody Debris (3)<br>• Large Woody Debris (2) |
| Riparian Habitat Composition | • Veg. Type - Shrub<br>• Stage - Shrub | Veg. Type – Grass, Shrubs<br>Stage - Shrubs | N/A | • Veg. Type – Grass, Shrub, Conifer<br>• Stage – Mature Forest | • Veg. Type – Shrub, Conifer<br>• State – Mature Forest | • Veg. Type – Grass, Shrub, Mixed<br>• Stage – Shrub | • Veg. Type – Shrub, Conifer, Mixed<br>• Stage – Mature Forest |
| Crown Closure (%) | 0; 1-20 | 1-20 | N/A | 41-70 | 1-20 | 41-70 | 21-40 |
| Channel Characteristic | • Pattern – Regular meanders<br>• Islands – Frequent, irregular<br>• Bars – Side<br>• Coupling – Decoupled<br>• Confinement – Unconfined | • Pattern – Irregular Meander<br>• Islands – Frequent, Irregular<br>• Bars – Side<br>• Coupling – Decoupling<br>• Confinement – Occasional | N/A | • Pattern – Irregular Meander<br>• Islands – None<br>• Bars – Side<br>• Coupling – Decoupling<br>• Confinement – Unconfined | • Pattern – N/A<br>• Islands –Occasional<br>• Bars – Side<br>• Coupling – N/A<br>• Confinement – Confined | • Pattern – N/A<br>• Islands – None<br>• Bars – Side<br>• Coupling – N/A<br>• Frequently Confined | • Pattern – Irrregular Meanderin<br>• Islands – None<br>• Bars – Side<br>• Coupling – N/A<br>• Confinement – N/A |

[1] A qualitative scale for bank stability was used where 1 = stable, 0.5 = Moderately stable, and 0 = Unstable.

† Stream flow measurements were estimated visually at the site, and are provided as a probable value.

| TABLE 8: STREAM HABITAT ASSESSMENT DATA | | | | | | |
|---|---|---|---|---|---|---|
| UTM | 09V 423452 7010382 | 09V 431175 7014480 | 09V 429011 7014803 | 09V 435031 701634 | 09V 439228 7017604 | 09V 439317 7017449 |
| Transect Location | Tributary E | E2 | E7 | B1 | C6 | C7 |
| Sampling Date / Time | 08/05/2008; 13:45 | 08/08/2008; 08:45 | 05/08/2008; 10:54 | 04/08/2008; 19:48 | 08/08/2008; 9:30 | 08/08/2008; 11:19 |
| **Stream Characteristics** | | | | | | |
| Residual Pool Depth (cm)– Max./Min./ Mean (n) | 0.2 / 0.09 / 0.13 (3) | 0.36 / 0.13 / 0.21 (6) | 0.27/ 0.1 / 0.12 (4) | 0.46 / 0.05 / 0.18 (6) | 0.38 / 0.02 / 0.19 (6) | 0.14 / 0.2 / 0.08 (6) |
| Channel Width (cm)– Max./Min./ Mean (n) | 5.16 / 3.35 / 3.92 (5) | 4.88 / 1.86 / 3.03 (6) | 2.3 / 0.95 / 1.7 (6) | 23.9 / 8.55 / 14.9 (6) | 4.99 / 2.97 / 3.99 (6) | 1.72 / 0.94 / 1.18 (6) |
| Wetted Width (cm)– Max. Min./ Mean (n) | 5.16 / 3.16 / 3.80 (5) | 4.22 / 1.41 / 2.1 (6) | 1.7 / 0.74 / 1.21 (6) | 2.76 / 1.6 / 2.06 (6) | 3.52 / 1.99 / 2.72 (6) | 1.02 / 0.6 / 0.84 (6) |
| Mean Bankfull Depth (cm) – Mean (n) | 0.98 (5) | 0.42 (6) | 0.39 (6) | 0.77 (6) | 0.56(6) | 0.41 (5) |
| Mean Bank Stability [1] (Left, Right) | 1.0 | 0.67 1.0 | 1.0 0.5 | 0.5 0.5 | 1 1 | 1 1 |
| Mean Bank Slope/Veg.Cover (L, R) (m/%) | 79.6 / 33.75 87.5 / 33.75 | 38.3 / 43.3 | 46.7 / 46.7 36.7 / 35 | 38.3 / 43.3 31.6 / 56.7 | 70/46.7 36.7/35 | 71.6/65 68.3/71.6 |
| **Substrate Composition** | | | | | | |
| Dominant Substrate (D) | Boulder | Boulder | Gravel | Cobble | Boulder | Cobble |
| Subdominant Substrate (subD) | Gravel | Cobble | Cobble | Boulder | Gravel | N/A |
| D95 (cm) | 1.32 | 41 | 40 | 69 | 73 | 51 |
| D (cm) | N/A | 31 | 8.5 | 14 | 19.5 | 21 |
| **Major Habitat Units** | | | | | | |
| Cascade/Rapid (%) | 45 | 65 | 13 | 60 | 45 | 7 |
| Riffle (%) | 45 | 10 | 80 | 10 | 20 | 60 |
| Run (%) | 0 | 0 | 0 | 0 | 0 | N/A |
| Pool (%) | 10 | 25 | 2 | 30 | 30 | 33 |
| **Water Quality** | | | | | | |
| Water Temperature(°C) | 6.3 | 3.5 | 6.0 | 7.0 | 5.7 | 4.1 |
| pH | 7.87 | 4.5 | 3.36 | 3.75 | 8.56 | 8.09 |
| Conductivity (µscm$^{-1}$) | 456 | 113 | 652 | 335 | 235 | 337 |
| Dissolved Oxygen (mg/l)/(%Saturation) | 9.73 / 78.5 | 9.61/78.1 | 9.13 / 75.7 | 8.59/76.7 | 9.65 / 77 | 10.4 / 79.5 |
| Turbidity (NTU) | 36.1 | 0.55 | 0.64 | 0.43 | 0.58 | 2.03 |
| **Cover / Habitat Value** | | | | | | |
| Total Fish Habitat Cover (%) | 40 | 20 | 45 | 35 | 46 | 15 |
| Primary Fish Habitat Components (%) | • Deep water (5)<br>• Surface Turbulence (20)<br>• Undercut Bank (5)<br>• Overstream Vegetation (5) | • Surface Turbulence (18)<br>• Overstream Vegetation (2) | • Overstream Vegetation (35)<br>• Surface Turbulence (7)<br>• Undercut Bank (2)<br>• Small Woody Debris (1) | • Surface Turbulence (30)<br>• Overstream Vegetation (5) | • Surface Turbulence (20)<br>• Overstream Vegetation (15)<br>• Small Woody Debris (10)<br>• Instream Vegetation (1) | • Undercut Banks (7)<br>• Surface Turbulence (4)<br>• Overstream Vegetation (4) |
| Riparian Habitat Composition | • Veg. Type – Grass, Shrub, Conifer<br>• Stage – Shrub and Mixed Forest | | • Veg. Type – Grass, Shrub<br>• Stage - Shrub | • Veg. Type – Shrub<br>• Stage – Shrub | • Veg. Type – Grass, Shrub<br>• Stage – Mature Forest | • Veg. Type – Grass, Shrub<br>• Stage - Shrub |
| Crown Closure (%) | 1-20 | | 1-20 | 1-20 | 21-40 | 1-20 |
| Channel Characteristic | • Pattern – N/A<br>• Islands – None<br>• Bars – None<br>• Coupling – Decoupling<br>• Confinement – Entrenched | | • Pattern – Irregular Meandering<br>• Islands – Frequent<br>• Bars – Side<br>• Coupling – Decoupling<br>• Confinement – Unconfined | • Pattern – Irregular Meandering<br>• Islands – Occasional<br>• Bars – Side<br>• Coupling – Partially Coupled<br>• Confinement – Unconfined | • Pattern – Irregular Meandering<br>• Islands – Occasional<br>• Bars – None<br>• Coupling – Decoupling<br>• Confinement – Confined | • Pattern – Irregular Meanderi<br>• Islands – None<br>• Bars – Side<br>• Coupling – Decoupling<br>• Confinement – Confined |

[1] A qualitative scale for bank stability was used where 1 = stable, 0.5 = Moderately stable, and 0 = Unstable.

† Stream flow measurements were estimated visually at the site, and are provided as a probable value.

TABLE 9. SUMMARY OF WATER QUALITY SAMPLES IN THE RECEIVING ENVIRONMENT AND THE ROAD STUDY AREA

| Site | Northing | Easting | Date | Time (24H) | pH | Do (mg/l) | Do (%) | Temperature (°C) | Conductivity (µs) | Turbidity (NTU) |
|---|---|---|---|---|---|---|---|---|---|---|
| Upper A | 437238 | 7014298 | 8-Aug-08 | 1557 | 5.25 | 8.52 | 73.6 | 8.7 | 285 | 20.3 |
| AQ-D | 424117 | 7008714 | 7-Sep-08 | 1030 | 7.75 | 10.83 | 81 | 3.6 | 326 | 11.1 |
| AQ-E / Lower E | 423452 | 7010382 | 5-Aug-08 | 2130 | 6.3 | 9.73 | 78.5 | 6.3 | 456 | 36.1 |
| Upper B | 434260 | 7013586 | 7-Aug-08 | 2200 | 8.47 | 9.48 | 76.4 | 6.3 | 467 | 4.87 |
| B1 | 435031 | 7014634 | 4-Aug-08 | 2110 | 3.75 | 8.59 | 76.7 | 7 | 335 | 0.43 |
| B2 | 433168 | 7013971 | 8-Aug-08 | 1515 | 7.65 | 9.55 | 77.2 | 6 | 119.5 | 0.6 |
| B2:1 | 433249 | 7013907 | 8-Aug-08 | 1511 | 7.64 | 10 | 78.8 | 5.3 | 116.4 | 0.38 |
| C6 | 439317 | 7017449 | 8-Aug-08 | 1119 | 8.09 | 10.4 | 79.5 | 4.1 | 337 | 2.03 |
| C7 | 439228 | 7017064 | 8-Aug-08 | 0930 | 8.56 | 9.65 | 77 | 5.7 | 235 | 0.58 |
| D12 | 431070 | 7004484 | 8-Aug-08 | 1316 | 5.3 | 9.64 | 78.8 | 6.4 | 109 | 9.53 |
| D13 | 431779 | 7004737 | 6-Aug-08 | 0947 | 8.69 | 10.4 | 81.6 | 4.7 | 291 | 2.81 |
| D2 | 431507 | 7004665 | 8-Aug-08 | 1344 | 7.3 | 9.6 | 76.2 | 7.5 | 259 | 2.78 |
| D3 | 426020 | 7008262 | 7-Aug-08 | 1135 | 8.4 | 10.4 | 81.1 | 4.9 | 454 | 6.27 |
| D9 | 428456 | 7006962 | 5-Aug-08 | 1921 | 8.6 | 10.05 | 82.4 | 6.6 | 515 | 15.2 |
| D9 | 428456 | 7006962 | 6-Aug-08 | 1015 | 7.4 | 9.3 | | | 164 | 6.76 |
| Mainstem E | 426338 | 7013566 | 7-Aug-08 | 2150 | 7.02 | 9.05 | 74.9 | 7.5 | 375 | 20.4 |
| Upper E | 431174 | 7014480 | 5-Aug-08 | 0845 | 4.5 | 9.61 | 78.1 | 3.6 | 113 | 0.55 |
| E1 | 424489 | 7011668 | 7-Aug-08 | 1510 | 8.96 | 10.5 | 80 | 3.5 | 626 | 0.76 |
| E10 | 430131 | 7014050 | 8-Aug-08 | 1540 | 6.81 | 9.72 | 77.1 | 5.5 | 86 | 0.52 |
| E10 | 430280 | 7014332 | 8-Aug-08 | 1535 | 5.94 | 9.43 | 76.7 | 6.5 | 761 | 0.61 |
| E3 | 426422 | 7013303 | 7-Aug-08 | 2155 | 7.93 | 9.38 | 76.5 | 6.6 | 684 | 97 |
| E7 | 429011 | 7014803 | 5-Aug-08 | 1049 | 3.36 | 9.13 | 75.7 | 6 | 652 | 0.64 |
| FS10 | 439887 | 7016751 | 6-Sep-08 | | 7.72 | 9.89 | 78 | 5.4 | 289 | 0.5 |
| PS1 | 432525 | 7020876 | 8-Jul-08 | 1600 | 7.8 | 8.1 | 72 | 7.4 | 151.2 | |
| PS1 | 432234 | 7020870 | 5-Sep-08 | 1315 | 7.55 | 10.34 | 80.8 | 5.1 | 218 | 7.21 |
| PS1 | 432234 | 7020870 | 23-Sep-08 | 1300 | | 11.35 | 82.7 | 2.2 | 228 | 7.21 |
| PS1 (Side channel) | 432525 | 7020876 | 8-Jul-08 | 1800 | 7 | 5.9 | 46.4 | 5.3 | 443 | |
| PS2 | 433664 | 7021195 | 7-Jul-08 | 0935 | 8.18 | 9 | 76.3 | 8.1 | 95.8 | |
| PS2 | 433664 | 7021195 | 4-Sep-08 | | 7.98 | 10.06 | 82.4 | 7.2 | 168 | 4.59 |
| PS2 | 433664 | 7021195 | 24-Sep-08 | 1345 | | 11.54 | 82.9 | 1.8 | 183 | 3.83 |
| PS3 | 434284 | 7021475 | 10-Oct-08 | 1635 | 7.34 | 12.45 | 85.4 | 0.3 | 177 | 5.11 |
| PS4 | 436813 | 7022884 | 8-Jul-08 | 1121 | 8.06 | 9.32 | 77.6 | 7.4 | 94.6 | |
| PS4 | 436964 | 7023048 | 24-Sep-08 | 1715 | | 11.19 | 82.4 | 2.8 | 191 | 3.13 |
| S_Macmillan River | 437541 | 7002993 | 6-Aug-08 | 1409 | 4.99 | 8.5 | 73.7 | 3.9 | 428 | 30.2 |

| TABLE 10. SUMMARY OF 2008 WATERCOURSE CROSSING ELECTROFISHING EFFORT AND CATCH RESULTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Watercourse | Month | Watercourse | Effort (Seconds) | No. Fish Captured | | | |
| | | | | *SaMa* | *ThAr* | *PrCy* | *CoCo* |
| Tributary B | September | B2 | 450 | | | | |
| Tributary C | August | C6 | 403 | | | | |
| | | C7 | 470 | | | | |
| Tributary D | August | D | 400 | 2 | | | |
| | | D3 | 193 | 2 | | | |
| | | D9 | 406 | 5 | | | |
| | | D13 | 924 | 6 | | | |
| Tributary E | August | Trib E | 261 | | | | |
| | | Trib E1 | 403 | | | | |
| | | Trib E7 | 241 | | | | |
| | | **Total** | **4151** | **15** | | | |

Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – round whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

| TABLE 11: SUMMARY OF REACH MAPPING DATA FOR TRIBUTARIES A AND C | | | | |
|---|---|---|---|---|
| Watercourse | Reach | | Channel Type | Habitat Description |
| | Number | Length (m) | | |
| Tributary C | 1 | 1190 | $RP_b$ | Channel dominated by boulder riffles with irregular pools. Consistent slope and irregular meander. Riparian vegetation is a mixture of small shrub and conifer. |
| | 2 | 1566 | $RP_b$-w/ $SP_r$ | Slope increases, riffle pool with a moderate LWD component (forming plunge pools). Channel narrows overall under tall shrub (willow) with high canopy closure. Several bedrock outcrops were noted, and add confinement areas. |
| | 3 | 390 | $RP_c$ | Dominant substrate shifts from boulder to cobble, stream channel slightly wider, shallower. Irregular meander with tall shrub (willow) cover. |
| | 4 | 1281 | $SP_b$ | Noticeable slope increase, substrate 60-70% boulder, forming a narrower step pool pattern. Several potential barriers to fish passage noted. Low to tall shrub cover continues. |
| | 5 | 1465 | $SP_b$ | Slope consistent above barrier, although channel width narrows. Boulder dominated step-pool distribution continues. Vegetation cover thins noticeably as elevation reaches the extent of the treeline. |
| | 6 | 576 | $SP_b/RP_c$ | Area of tributary within footprint. Slope remains consistently steep, largely dominated by boulder step pool, although some more level areas have cobble riffles. This reach is above the treeline extent, and cover is reduced to a minimum (small to medium height shrubs only). |
| | 7 | 357 | $SP_r$/ Canyon | Bedrock controlled canyon with large cascades, high energy flow. Considered another barrier to fish passage. No vegetation cover. |
| | 8 | | Riffle-Run | Stream generally level or low-slope across alpine plateau. Deep channel dominated by fines and gravel, confined by deep vegetated banks. Little overhead cover, although overhanging banks are frequent. Many small tributary feeders form a network of streams. |
| Tributary A | 1 | 1780 | $RP_c$ | Cobble dominated channel with low gradient. Braided frequently with side bars and eroding outer banks indicating mobile channel. Deep pools relatively frequent at base of riffles. Low canopy cover, riparian vegetation consists of birch shrub and conifer (mature). |
| | 2 | 1200 | $CP_b$ | More boulder cascades with several bedrock outcrops. Overall gradient is increased, with riffles still cobble dominated. Deep pools relatively frequent at base of riffles. Low canopy cover, riparian vegetation consists of birch shrub and conifer (mature). |
| | 3 | 1030 | $RP_c$ | Gradient reduced from reach 2, and braided riffle-dominated channel resumes. Channel appears mobile, with frequent side bars of gravel/cobble. Reach extends to the junction of Tributary C. |

Channel Types: RP = Riffle Pool; CP = Cascade Pool; SP = Step Pool

Channel Type Subscripts are the dominant substrate type: b = boulder; c = cobble; r= bedrock;

| TABLE 12: PHYSICAL SEDIMENT ANALYSIS RESULTS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Stream | Tributary C | | | | | | Tributary A | | |
| Sample ID | FS10 | | | FS6 | | | FS7 | | |
| | S1 | S2 | S3 | S1 | S2 | S3 | S1 | S2 | S3 |
| Sampling Date | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 |
| Physical Properties (% weight fraction) | | | | | | | | | |
| Loss on Ignition | 4 | 6 | 8 | 3 | 5 | 4 | 6 | 5 | 14 |
| Sieve - #16 (>1.18mm) | 43.0 | 7.6 | 2.7 | 30.1 | 25.0 | 5.6 | 15.0 | 4.1 | 3.2 |
| Sieve - #30 (>0.60mm) | 30.0 | 11.5 | 6.0 | 40.9 | 33.8 | 36.7 | 25.7 | 33.1 | 13.8 |
| Sieve - #50 (>0.300 mm) | 10.9 | 11.8 | 12.3 | 16.8 | 23.8 | 46.4 | 16.3 | 48.9 | 34.2 |
| Sieve - 100 Mesh (>.15 mm) | 4.7 | 17.4 | 24.4 | 7.0 | 11.6 | 9.8 | 15.3 | 9.0 | 20.5 |
| Sieve - #140 (>0.106mm) | 2.8 | 16.8 | 16.3 | 2.2 | 2.5 | 0.6 | 11.0 | 1.8 | 8.4 |
| Sieve - #200 (>0.075mm) | 2.5 | 11.3 | 10.3 | 1.2 | 1.5 | 0.3 | 6.6 | 1.1 | 6.4 |
| Sieve - #270 (>0.053mm) | 2.1 | 10.3 | 10.5 | 1.0 | 0.8 | 0.3 | 5.0 | 0.9 | 6.6 |
| Sieve - #400 (>0.030 mm) | 1.5 | 5.5 | 6.8 | 0.3 | 0.3 | <0.1 | 2.5 | 0.5 | 4.1 |
| Sieve - Pan | 2.6 | 7.7 | 10.8 | 0.4 | 0.7 | 0.3 | 2.6 | 0.6 | 2.8 |

| TABLE 12: PHYSICAL SEDIMENT ANALYSIS RESULTS (CON'T) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stream | Hess River Tributary | | | | | | Tributary E | | | Tributary D | | |
| Sample ID | FS8 | | | FS9 | | | AQ-E | | | AQ-D | | |
| | S1 | S2 | S3 | S1 | S2 | S3 | S1 | S2 | S3 | S1 | S2 | S3 |
| Sampling Date | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 |
| Physical Properties (% weight fraction) | | | | | | | | | | | | |
| Loss on Ignition | 2 | 3 | 2 | 2 | 2 | 2 | 4 | 5 | 5 | 4 | 3 | 4 |
| Sieve - #16 (>1.18mm) | 10.4 | 0.7 | 9.6 | 1.5 | 12.7 | 6.3 | 27.1 | 7.3 | 9.1 | 4.9 | 4.8 | 2.4 |
| Sieve - #30 (>0.60mm) | 66.2 | 1.7 | 35.1 | 24.8 | 43.8 | 38.9 | 50.0 | 35.6 | 28.7 | 40.2 | 42.6 | 30.5 |
| Sieve - #50 (>0.300 mm) | 18.8 | 8.5 | 46.4 | 66.5 | 27.0 | 39.3 | 16.0 | 31.8 | 30.6 | 47.6 | 44.8 | 45.2 |
| Sieve - 100 Mesh (>.15 mm) | 3.7 | 31.5 | 7.8 | 6.9 | 12.2 | 13.3 | 4.6 | 12.9 | 17.8 | 4.8 | 5.2 | 14.8 |
| Sieve - #140 (>0.106mm) | 0.5 | 20.3 | 0.5 | <0.1 | 2.2 | 1.4 | 1.1 | 4.3 | 5.7 | 1.0 | 1.0 | 3.3 |
| Sieve - #200 (>0.075mm) | 0.2 | 11.3 | 0.1 | <0.1 | 1.0 | 0.4 | 0.5 | 2.7 | 3.1 | 0.7 | 0.7 | 1.5 |
| Sieve - #270 (>0.053mm) | 0.1 | 11.2 | 0.2 | <0.1 | 0.6 | 0.2 | 0.3 | 2.3 | 2.6 | 0.3 | 0.3 | 1.1 |
| Sieve - #400 (>0.030 mm) | <0.1 | 6.6 | <0.1 | <0.1 | 0.2 | <0.1 | 0.2 | 1.6 | 1.4 | 0.3 | 0.3 | 0.6 |
| Sieve - Pan | 0.1 | 8.2 | 0.2 | 0.1 | 0.3 | 0.1 | 0.2 | 1.4 | 1.1 | 0.3 | 0.3 | 0.6 |

| TABLE 13: COEFFICIENT OF VARIATION VALUES FROM GRAIN SIZE ANALYSIS RESULTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Tributary C | | Tributary A | Hess River Tributary | | Tributary E | Tributary D |
| Site | FS10 | FS6 | FS7 | FS8 | FS9 | AQ-E | AQ-D |
| Sieve - #16 (>1.18mm) | 1.24 | 0.64 | 0.88 | 0.78 | 0.82 | 0.76 | 0.35 |
| Sieve - #30 (>0.60mm) | 0.79 | 0.10 | 0.40 | 0.94 | 0.28 | 0.29 | 0.17 |
| Sieve - #30 (>0.60mm) | 0.06 | 0.53 | 0.49 | 0.80 | 0.46 | 0.34 | 0.03 |
| Sieve - #50 (>0.300 mm) | 0.64 | 0.24 | 0.39 | 1.05 | 0.32 | 0.57 | 0.68 |
| Sieve - #100 (>.15 mm) | 0.66 | 0.58 | 0.67 | 1.61 | 0.86 | 0.64 | 0.75 |
| Sieve - #140 (>0.106mm) | 0.60 | 0.62 | 0.66 | 1.66 | 0.92 | 0.67 | 0.48 |
| Sieve - #200 (>0.075mm) | 0.63 | 0.52 | 0.71 | 1.66 | 0.88 | 0.72 | 0.82 |
| Sieve - #270 (>0.053mm) | 0.60 | 0.49 | 0.76 | 1.66 | 0.43 | 0.71 | 0.43 |
| Sieve - #400 (>0.030 mm) | 0.59 | 0.45 | 0.61 | 1.64 | 0.69 | 0.69 | 0.43 |
| Sieve - Pan | 0.33 | 0.25 | 0.59 | 0.25 | 0.00 | 0.12 | 0.16 |

Coefficient of Variation > 1.0

Coefficient of Variation >0.75, <1.0

TABLE 14: STREAM SEDIMENT METALS RESULTS

| Stream | Tributary E | | | Tributary D | | | Tributary C | | | Tributary A | | | BCWQG [1] | CCME [2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | AQE-S1 | AQE-S2 | AQE-S3 | AQD-S1 | AQD-S2 | AQD-S3 | FS6-S1 | FS6-S2 | FS6-S3 | FS7-S1 | FS7-S2 | FS7-S3 | | ISQG[3] | PEL[4] |
| Sampling Date | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | | | |
| **Misc. Inorganics** | | | | | | | | | | | | | | | |
| Soluble (2:1) pH | 7.50 | 7.63 | 7.52 | 7.60 | 7.39 | 7.40 | 7.64 | 7.87 | 7.93 | 6.90 | 6.97 | 7.06 | | | |
| **Total Metals by ICPMS (mg/kg)** | | | | | | | | | | | | | | | |
| Total Aluminum (Al) | 7050 | 8140 | 9330 | 7540 | 6560 | 10600 | 15600 | 16200 | 15800 | 21000 | 14300 | 28900 | - | - | - |
| Total Antimony (Sb) | 5.0 | 5.5 | 6.1 | 4.8 | 4.5 | 5.1 | 4.0 | 5.1 | 4.3 | 5.4 | 4.2 | 4.9 | - | - | - |
| Total Arsenic (As) | **52.3** | **51.6** | **51.6** | **30.8** | **33.4** | **38.8** | **26.6** | **31.4** | **27.8** | **36.0** | **32.3** | **52.9** | 5.9 | 5.9 | 17 |
| Total Barium (Ba) | 429 | 589 | 708 | 566 | 271 | 471 | 384 | 400 | 468 | 426 | 327 | 388 | - | - | - |
| Total Beryllium (Be) | 0.6 | 0.8 | 0.9 | 0.7 | 0.8 | 0.9 | 1.3 | 1.4 | 1.5 | 1.7 | 1.2 | 2.4 | - | - | - |
| Total Bismuth (Bi) | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 1.7 | 0.3 | 0.6 | 0.3 | 0.3 | 0.5 | - | - | - |
| Total Cadmium (Cd) | **7.97** | **9.64** | **10.7** | **8.31** | **13.1** | **15.5** | **11.3** | **14.6** | **8.33** | **14.4** | **8.37** | **20.4** | 0.6 | 0.6 | 3.5 |
| Total Calcium (Ca) | 3240 | 3680 | 3200 | 6200 | 5430 | 6210 | 12200 | 10200 | 16300 | 4500 | 3990 | 9730 | - | - | - |
| Total Chromium (Cr) | 10 | 12 | 13 | 10 | 8 | 11 | 29 | 29 | 29 | 21 | 22 | 25 | 37.3 | 37.3 | 90 |
| Total Cobalt (Co) | 31.4 | 40.2 | 38.9 | 62.2 | 101 | 117 | 70.0 | 89.0 | 43.6 | 75.9 | 53.2 | 73.6 | - | - | - |
| Total Copper (Cu) | **193** | **209** | **223** | **75.9** | **88.0** | **93.8** | **114** | **130** | **104** | **206** | **131** | **261** | 35.7 | 35.7 | 197 |
| Total Iron (Fe) | 33400 | 34200 | 39000 | 31900 | 31000 | 44100 | 20700 | 20700 | 22400 | 46800 | 32900 | 51900 | - | - | - |
| Total Lead (Pb) | 19.2 | 19.7 | 20.8 | 22.7 | 21.8 | 23.5 | 11.2 | 11.3 | 12.1 | 15.3 | 13.9 | 18.1 | 35 | 35 | 91.3 |
| Total Magnesium (Mg) | 528 | 759 | 893 | 2020 | 1830 | 2470 | 6690 | 6530 | 6880 | 4530 | 4060 | 4860 | - | - | - |
| Total Manganese (Mn) | 496 | 590 | 607 | 964 | 1700 | 1790 | 1510 | 1970 | 942 | 1160 | 858 | 1270 | - | - | - |
| Total Mercury (Hg) | **0.28** | **0.99** | **0.24** | 0.07 | <0.05 | 0.08 | 0.06 | 0.09 | <0.05 | **0.17** | 0.10 | 0.16 | 0.17 | 0.17 | 0.486 |
| Total Molybdenum (Mo) | 15.8 | 13.5 | 16.9 | 14.5 | 15.0 | 17.6 | 26.7 | 26.6 | 21.4 | 25.0 | 19.5 | 21.2 | - | - | - |
| Total Nickel (Ni) | **99.9** | **118** | **120** | **144** | **215** | **235** | **215** | **242** | **171** | **200** | **154** | **267** | 75 | - | - |
| Total Phosphorus (P) | 1590 | 1730 | 1340 | 2160 | 1980 | 1890 | 2280 | 2350 | 3650 | 1660 | 1570 | 1500 | - | - | - |
| Total Potassium (K) | 770 | 512 | 650 | 621 | 499 | 660 | 3120 | 2860 | 3180 | 1490 | 1570 | 1290 | - | - | - |
| Total Selenium (Se) | 5.1 | 2.8 | 4.0 | 2.9 | 3.3 | 3.3 | 3.7 | 3.2 | 2.2 | 2.8 | 2.2 | 6.3 | 5 | - | - |
| Total Silver (Ag) | 0.48 | **0.51** | **0.55** | 0.47 | 0.45 | **0.51** | **0.60** | **0.64** | **0.59** | **0.77** | **0.52** | **1.15** | 0.5 | - | - |
| Total Sodium (Na) | <100 | <100 | <100 | <100 | <100 | <100 | 185 | 177 | 204 | <100 | <100 | <100 | - | - | - |
| Total Strontium (Sr) | 71.9 | 78.4 | 57.8 | 37.0 | 30.2 | 38.3 | 60.2 | 56.6 | 73.3 | 57.7 | 47.8 | 63.6 | - | - | - |
| Total Thallium (Tl) | 0.71 | 0.74 | 0.81 | 0.52 | 0.59 | 0.70 | 1.06 | 1.15 | 0.81 | 0.64 | 0.71 | 0.59 | - | - | - |
| Total Tin (Sn) | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.4 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | - | - | - |
| Total Titanium (Ti) | 125 | 54 | 67 | 125 | 87 | 202 | 243 | 234 | 255 | 194 | 154 | 217 | - | - | - |
| Total Vanadium (V) | 66 | 53 | 65 | 62 | 47 | 66 | 281 | 353 | 267 | 138 | 151 | 139 | - | - | - |
| Total Zinc (Zn) | **482** | **564** | **625** | **700** | **921** | **1190** | **1260** | **1420** | **957** | **1150** | **673** | **1090** | 123 | 123 | 315 |
| Total Zirconium (Zr) | 2.1 | 2.4 | 2.6 | 1.9 | 2.0 | 2.4 | 2.4 | 2.5 | 2.6 | 3.3 | 2.7 | 6.2 | - | - | - |

[1]British Columbia Water Quality Guidelines (BCWQG) for the Protection of Freshwater Aquatic Life, 2001

[2]Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life, 2003

[3]ISQG = Interim Sediment Quality Guideline

[4]PEL = Probable Effect Level

"-" Indicates no analysis conducted or no applicable standard available.

**BOLD** indicates parameter exceeds BC Water Quality Guidelines

indicates parameter exceeds ISQG Guideline

Indicates parameter exceeds PEL and ISQG Guidelines

TABLE 14. STREAM SEDIMENT METALS RESULTS (CONTINUED)

| Stream | Hess River Tributary | | | Hess River Tributary | | | Tributary C | | | BCWQG [1] | CCME [2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample ID | FS8-S1 | FS8-S2 | FS8-S3 | FS9-S1 | FS9-S2 | FS9-S3 | FS10-S1 | FS10-S2 | FS10-S3 | | ISQG[3] | PEL[4] |
| Sampling Date | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | 9/6/08 | | | |
| **Misc. Inorganics** | | | | | | | | | | | | |
| Soluble (2:1) pH | 7.20 | 6.86 | 6.91 | 6.95 | 6.83 | 7.10 | 7.33 | 7.43 | 7.49 | | | |
| **Total Metals by ICPMS (mg/kg)** | | | | | | | | | | | | |
| Total Aluminum (Al) | 7420 | 11800 | 9750 | 7630 | 8800 | 8700 | 13300 | 18600 | 19300 | - | - | - |
| Total Antimony (Sb) | 0.9 | 0.9 | 0.7 | 1.3 | 1.8 | 1.5 | 2.0 | 2.9 | 3.6 | - | - | - |
| Total Arsenic (As) | **13.8** | **17.9** | **12.1** | **15.4** | **17.5** | **18.1** | **40.2** | **74.9** | **64.1** | 5.9 | 5.9 | 17 |
| Total Barium (Ba) | 71.8 | 120 | 91.4 | 138 | 158 | 126 | 161 | 289 | 430 | - | - | - |
| Total Beryllium (Be) | 0.4 | 0.5 | 0.3 | 0.5 | 0.5 | 0.5 | 0.9 | 1.7 | 1.5 | - | - | - |
| Total Bismuth (Bi) | 0.2 | 0.5 | 0.3 | 0.3 | 0.3 | 0.2 | 0.7 | 2.6 | 2.1 | - | - | - |
| Total Cadmium (Cd) | **0.76** | 0.58 | 0.47 | **3.27** | **3.39** | **4.50** | **3.24** | **4.19** | **4.62** | 0.6 | 0.6 | 3.5 |
| Total Calcium (Ca) | 2040 | 2440 | 1880 | 2920 | 3510 | 2560 | 17000 | 10700 | 8440 | - | - | - |
| Total Chromium (Cr) | 10 | 16 | 13 | 10 | 13 | 12 | 25 | 26 | 29 | 37.3 | 37.3 | 90 |
| Total Cobalt (Co) | 29.5 | 20.2 | 24.4 | 24.4 | 24.0 | 36.2 | 11.5 | 17.7 | 14.5 | - | - | - |
| Total Copper (Cu) | **55.6** | 26.8 | 23.9 | **39.9** | **43.3** | **52.2** | **117** | **114** | **98.1** | 35.7 | 35.7 | 197 |
| Total Iron (Fe) | 26400 | 31000 | 32300 | 20400 | 23200 | 23700 | 25700 | 32900 | 30600 | - | - | - |
| Total Lead (Pb) | 18.0 | 16.2 | 17.7 | 9.1 | 10.7 | 10.9 | 18.9 | 26.8 | 23.3 | 35 | 35 | 91.3 |
| Total Magnesium (Mg) | 3080 | 4630 | 3610 | 2630 | 3080 | 3190 | 7570 | 9020 | 9440 | - | - | - |
| Total Manganese (Mn) | 1100 | 670 | 841 | 537 | 538 | 780 | 343 | 466 | 364 | - | - | - |
| Total Mercury (Hg) | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.06 | 0.17 | 0.17 | 0.486 |
| Total Molybdenum (Mo) | 2.2 | 1.5 | 1.2 | 4.7 | 5.6 | 5.6 | 8.9 | 8.7 | 12.4 | - | - | - |
| Total Nickel (Ni) | 55.8 | 38.3 | 40.8 | 61.5 | 68.4 | **82.7** | 72.7 | **112** | **110** | 75 | - | - |
| Total Phosphorus (P) | 676 | 684 | 638 | 1110 | 1400 | 910 | 4880 | 3220 | 1980 | - | - | - |
| Total Potassium (K) | 381 | 881 | 333 | 616 | 844 | 688 | 3410 | 2780 | 2470 | - | - | - |
| Total Selenium (Se) | <0.5 | <0.5 | <0.5 | 1.0 | 0.7 | <0.5 | 1.8 | 1.4 | 1.2 | 5 | - | - |
| Total Silver (Ag) | 0.07 | 0.10 | 0.05 | 0.17 | 0.19 | 0.16 | **0.78** | **0.64** | **0.68** | 0.5 | - | - |
| Total Sodium (Na) | <100 | <100 | <100 | <100 | <100 | <100 | 111 | 157 | 157 | - | - | - |
| Total Strontium (Sr) | 14.3 | 17.1 | 12.9 | 30.1 | 33.0 | 23.9 | 48.5 | 62.6 | 79.9 | - | - | - |
| Total Thallium (Tl) | 0.13 | 0.15 | 0.07 | 0.21 | 0.22 | 0.23 | 0.33 | 0.37 | 0.52 | - | - | - |
| Total Tin (Sn) | 0.2 | 0.4 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.8 | 0.7 | - | - | - |
| Total Titanium (Ti) | 79 | 367 | 85 | 91 | 153 | 143 | 200 | 417 | 442 | - | - | - |
| Total Vanadium (V) | 23 | 25 | 16 | 38 | 47 | 46 | 99 | 92 | 143 | - | - | - |
| Total Zinc (Zn) | **142** | **144** | 122 | **239** | **279** | **318** | **293** | **444** | **521** | 123 | 123 | 315 |
| Total Zirconium (Zr) | 1.1 | 1.2 | 1.1 | 1.0 | 1.3 | 1.5 | 2.3 | 1.4 | 1.4 | - | - | - |

[1]British Columbia Water Quality Guidelines (BCWQG) for the Protection of Freshwater Aquatic Life, 2001

[2]Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines for the Protection of Freshwater Aquatic Life, 2003

[3]ISQG = Interim Sediment Quality Guideline

[4]PEL = Probable Effect Level

"-" Indicates no analysis conducted or no applicable standard available.

**BOLD** indicates parameter exceeds BC Water Quality Guidelines

indicates parameter exceeds ISQG Guideline

Indicates parameter exceeds PEL and ISQG Guidelines

| TABLE 15. PERIPHYTON PRODUCTIVITY (CHLOROPHYLL LEVELS IN µg/cm²) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Stream | Lower Tributary C | Upper Tributary C | Tributary A | Upper Hess River Tributary | Lower Hess River Tributary | Tributary E | Tributary D |
| Samping Station | FS-6 | FS-10 | FS-7 | FS-8 | FS-9 | AQ-E | AQ-D |
| Sampling Date | 9/6/2008 | 9/6/2008 | 9/6/2008 | 9/6/2008 | 9/6/2008 | 9/6/2008 | 9/6/2008 |
| Chlorophyll a | 0.65 | 0.65 | <0.03 | 0.36 | <0.03 | 0.06 | 0.12 |
| Chlorophyll b | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| Chlorophyll c | 0.06 | 0.09 | <0.03 | 0.04 | <0.03 | <0.03 | <0.03 |
| Phaeophytin A | <0.03 | 0.06 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |

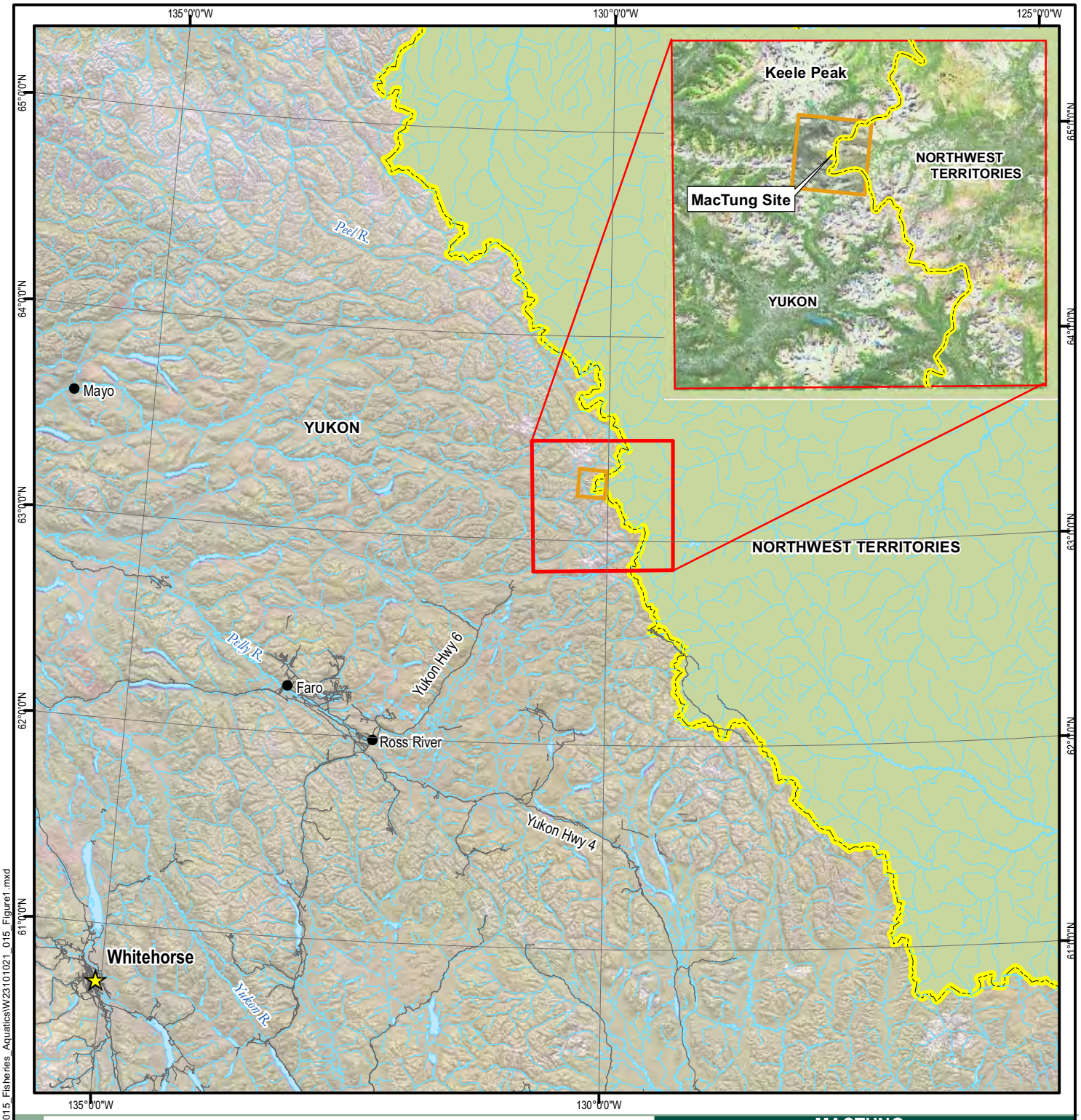
| TABLE 16: ABUNDANCE OF BENTHIC MACROINVERTEBRATES BY REPLICATE AND FISHERIES STATION | | | | |
|---|---|---|---|---|
| Station | Replicate | Abundance (Number/Replicate) | Mean Abundance (Per Replicate) | Total Abundance (per Station) |
| AQ-D | 1 | 27 | 19 | 57 |
| | 2 | 17 | | |
| | 3 | 13 | | |

| TABLE 17. BENTHIC MACROINVERTEBRATE ABUNDANCE, DENSITY AND SPECIES RICHNESS | |
|---|---|
| Stream | Tributary D |
| Site | AQ-D |
| Sample Year | 2008 |
| Mean Density (#/$m^2$) | 220.9 |
| Mean Species Richness | 21 |
| Number of orders present | 4 |
| Total Abundance (# of individuals) | 57 |
| Simpson's Index | 0.936 |

| TABLE 18: DESCRIPTIVE STATISTICS FOR BENTHIC MACROINVERTEBRATE COMMUNITY SURVEYS | | |
|---|---|---|
| Variable | | AQ-D |
| Density (#/m²) n=3 | Mean: | 220.9 |
| | Median: | 197.7 |
| | Std. Deviation | 83.9 |
| | Std. Error | 48.4 |
| | Min: | 151.2 |
| | Max: | 314.0 |
| Species Richness n=3 | Mean: | 10.0 |
| | Median: | 9.5 |
| | Std. Deviation | 2.6 |
| | Std. Error | 1.7 |
| | Min: | 7.0 |
| | Max: | 12.0 |
| Simpson's Diversity Index | Mean: | 0.93 |
| | Median: | 0.99 |
| | Std. Deviation | 0.10 |
| | Std. Error | 0.06 |
| | Min: | 0.81 |
| | Max: | 0.99 |

| TABLE 19. BENTHIC COMMUNITY COMPOSITION OF FISHERIES SITES BY MAJOR TAXONOMIC GROUP | | |
|---|---|---|
| | AQ-D | |
| Class/Order | # Individuals* | % |
| Ephemeroptera | 1 | 1.8 |
| Plecoptera | 11 | 19.3 |
| Trichoptera | 1 | 1.8 |
| Diptera | 44 | 77.2 |
| Collembola | 0 | 0 |
| Copepoda | 0 | 0 |
| Oligochaeta | 0 | 0 |
| Arachnida | 0 | 0 |
| Total | 57 | - |
| *The number of individuals per fisheries station represents the total sum in three replicates | | |

# FIGURES




## LEGEND

- Territorial Boundary
- Local Study Area
- Watercourse
- Waterbody
- Roads

N
W E
S

NOTES Landsat TM imagery Earthsat acquired Sept,17, 1995
Bands 432 enhanced

ISSUED FOR USE

# MACTUNG
# 2008 FISHERIES AND AQUATICS BASELINE STUDIES

## Site Location

| PROJECTION | DATUM |
|---|---|
| UTM Zone 9 | NAD83 |

0 12.5 25 50 75 100
Kilometres

FILE NO.
W23101021_015_Figure1.mxd

| PROJECT NO. | DWN | CKD | REV |
|---|---|---|---|
| W23101021.015 | KMW | TA | 1 |

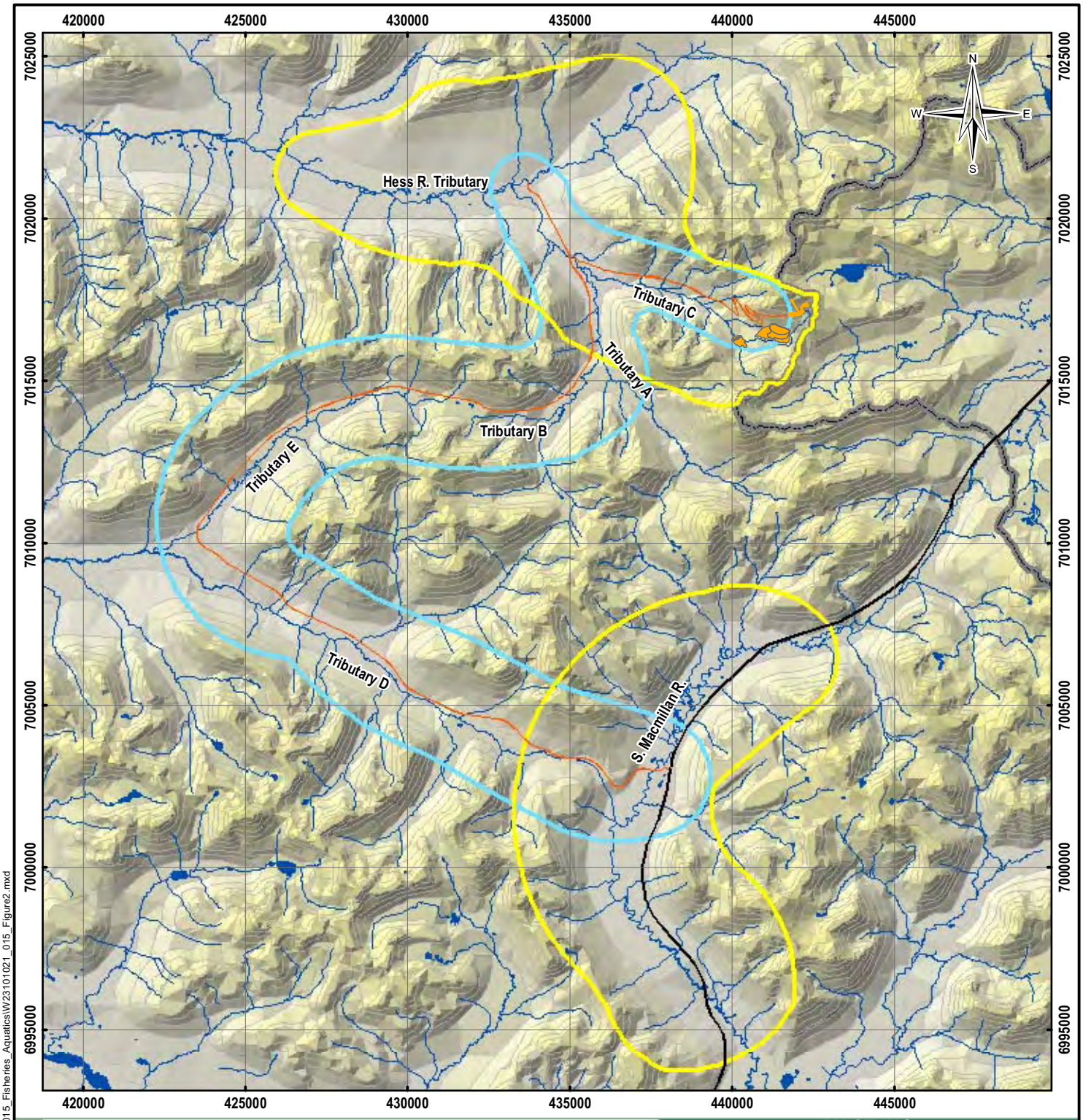
| OFFICE | DATE |
|---|---|
| EBA-VANC | December 10, 2008 |

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd. eba

**Figure 1**

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101021_MacTung\Maps\015_Fisheries_Aquatics\W23101021_015_Figure1.mxd




## LEGEND

- Project Aquatic Study Area
- Road Aquatic Study Area
- Watercourses
- Waterbodies
- Access Road Route
- Proposed Mine Site Infrastructure
- North Canol Road
- NWT - Yukon Territory Border

**NOTES**

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

# MACTUNG
# 2008 FISHERIES AND AQUATICS BASELINE STUDIES

## Aquatics Study Areas

| PROJECTION | DATUM |
|---|---|
| UTM Zone 9 | NAD83 |

Scale: 1:170,000
2 1 0 2
Kilometres

FILE NO.: W23101021_015_Figure2.mxd

| PROJECT NO. | DWN | CKD | REV |
|---|---|---|---|
| W23101021.015 | MEZ | CJJ | 0 |

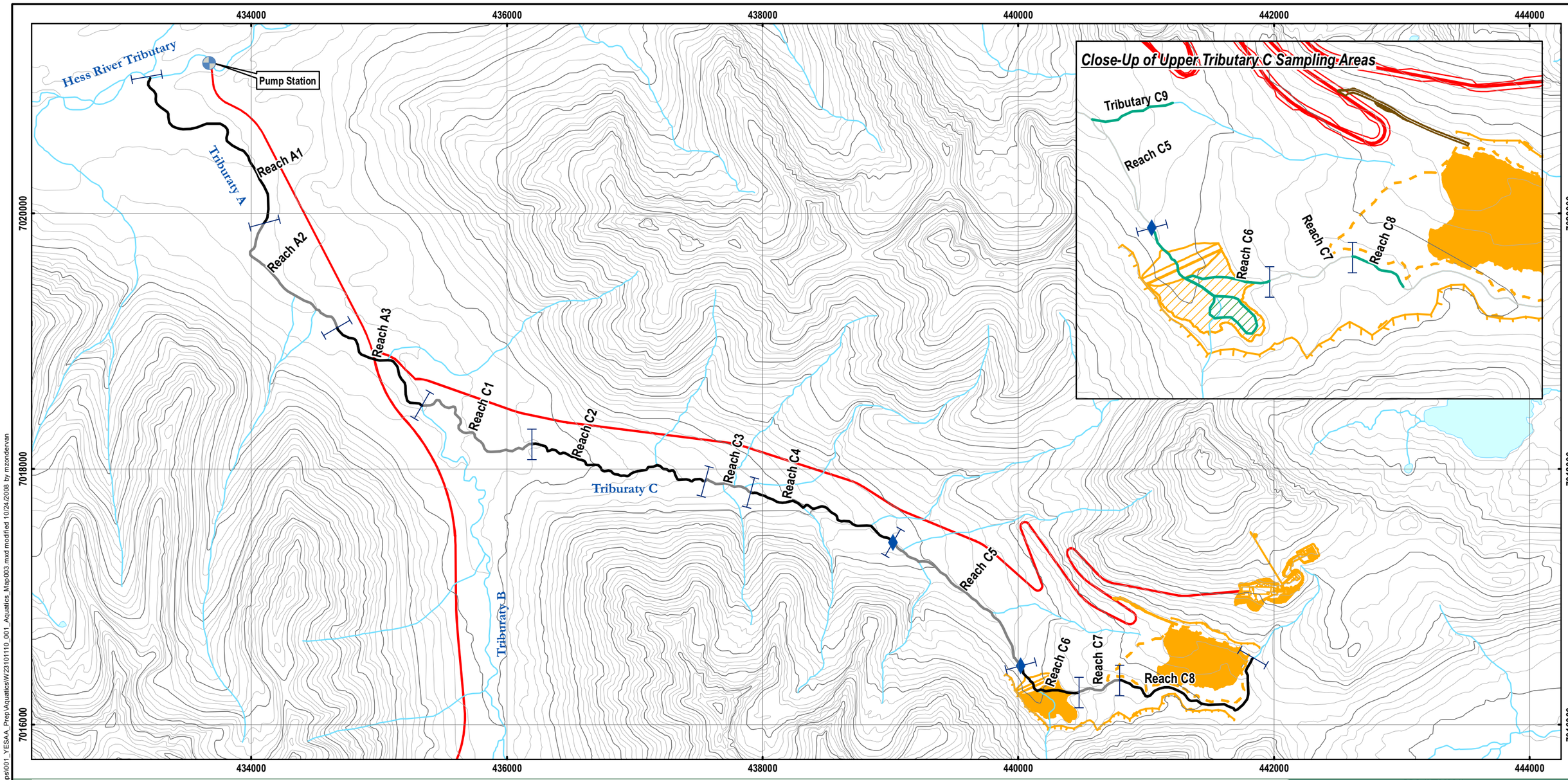
| OFFICE | DATE |
|---|---|
| EBA-VANC | December 10, 2008 |

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd. eba

**Figure 2**

Q:\Vancouver\GIS\ENVIRONMENTAL\W231\W23101021_MacTung\Maps\015_Fisheries_Aquatics\W23101021_015_Figure2.mxd




**LEGEND**

- Reach Breaks
- Barrier
- Reach
- Reach
- Sampled Area
- Contours (100m)
- Contours (20m)
- Proposed Access Road
- Proposed Mine Site Infrastructure
- Watercourse
- Waterbody

| Reach | Length (m) |
|---|---|
| A1 | 1780 |
| A2 | 1200 |
| A3 | 1030 |
| C1 | 1188 |
| C2 | 1566 |
| C3 | 390 |
| C4 | 1281 |
| C5 | 1465 |
| C6 | 576 |
| C7 | 358 |
| C8 | 1501 |

**NOTES**

Base data source: NTDB 1:50,000
Site Plan adapted from original provided by Wardrop

N
W
E
S

ISSUED FOR USE

# MACTUNG
# 2008 FISHERIES AND AQUATICS BASELINE STUDIES

## Stream Reaches and Upper Sampling Locations Tributary A and Tributary C

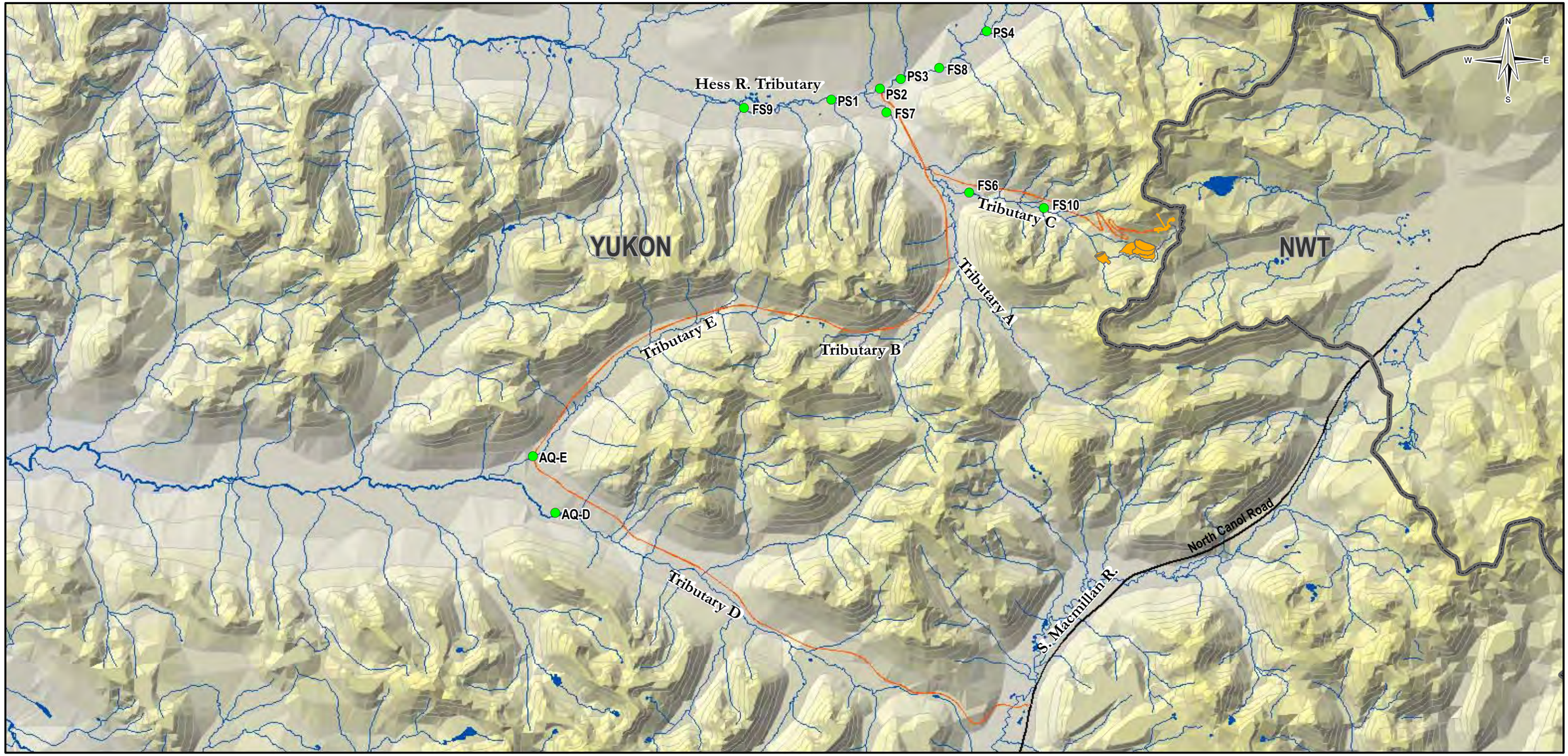
| | | | |
|---|---|---|---|
| PROJECTION: UTM Zone 9 | DATUM: NAD83 | | |
| Scale: 1:30,000 (0.5 0.25 0 0.5 Kilometres) | | | |
| FILE NO.: W23101021_015_Figure3.mxd | | | |
| PROJECT NO.: W23101021.015 | DWN: MEZ | CKD: CJJ | REV: 0 |
| OFFICE: EBA-VANC | DATE: December 10, 2008 | | |

NORTH AMERICAN TUNGSTEN CORPORATION LTD

EBA Engineering Consultants Ltd.

**Figure 3**

Q:\Vancouver\GIS\ENVIRONMENTAL\W2301\W23101110_MacTung_APIM\gis\001_YESAA_Prep\Aquatics\W23101110_001_Aquatics_Map003.mxd modified: 10/24/2008 by mzondervan




## LEGEND

- Sampling Locations
- Proposed Mine Site Infrastructure
- NWT - Yukon Territory Border
- Access Road Route
- North Canol Road
- Watercourses
- Waterbodies

**Sample Type**

**FS** Fisheries Sample Site
**PS** Pumping Station Sample Site
**AQ** Aquatics Sample Site

**NOTES**

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

**MACTUNG**
**2008 FISHERIES AND AQUATICS BASELINE STUDIES**

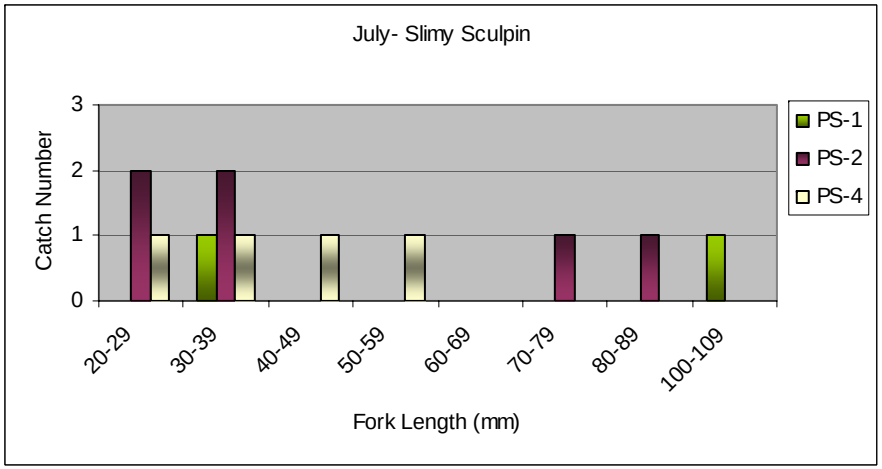
# Receiving Environment Aquatics Study Area Sampling Locations

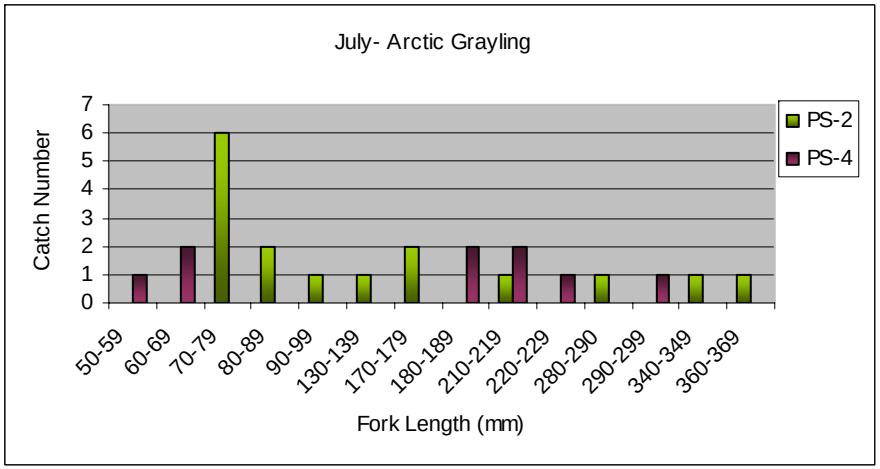
| | | | |
|---|---|---|---|
| PROJECTION: UTM Zone 9 | DATUM: NAD83 | | |
| Scale: 1:115,000 (2 1 0 2 Kilometers) | | | |
| FILE NO.: W23101021_015_Figure4.mxd | | | |
| PROJECT NO.: W23101021.015 | DWN: MEZ | CKD: CJJ | REV: 0 |
| OFFICE: EBA-VANC | DATE: December 10, 2008 | | |

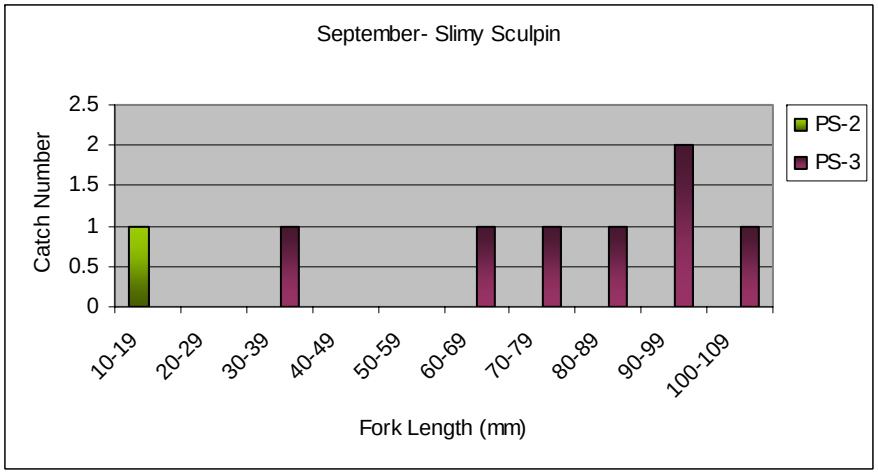
NORTH AMERICAN TUNGSTEN CORPORATION LTD
EBA Engineering Consultants Ltd. eba

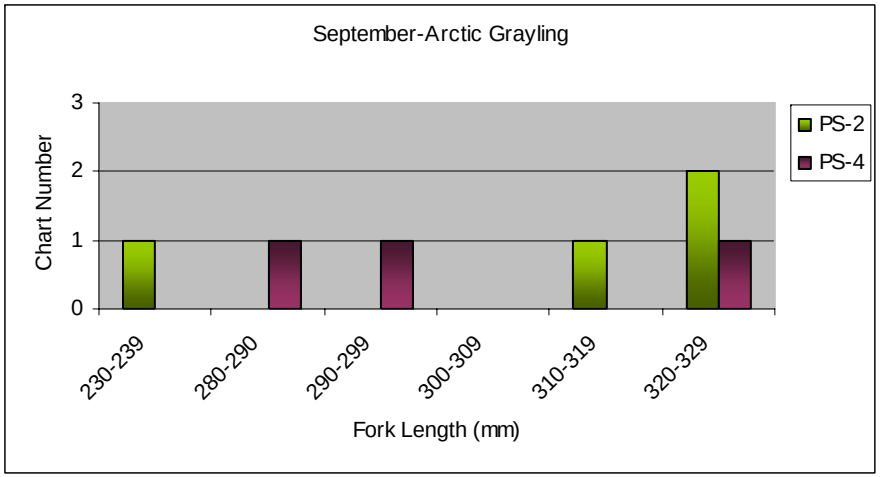
**Figure 4**

Q:\Vancouver\GIS\ENVIRONMENTAL\W2311\W23101110_MacTung_APIM\gis\001_YESAA_Prep\Aquatics\W23101110_001_Aquatics_Map001.mxd modified 11/21/2008 by mzondervan




CLIENT

North American Tungsten Corporation Ltd.

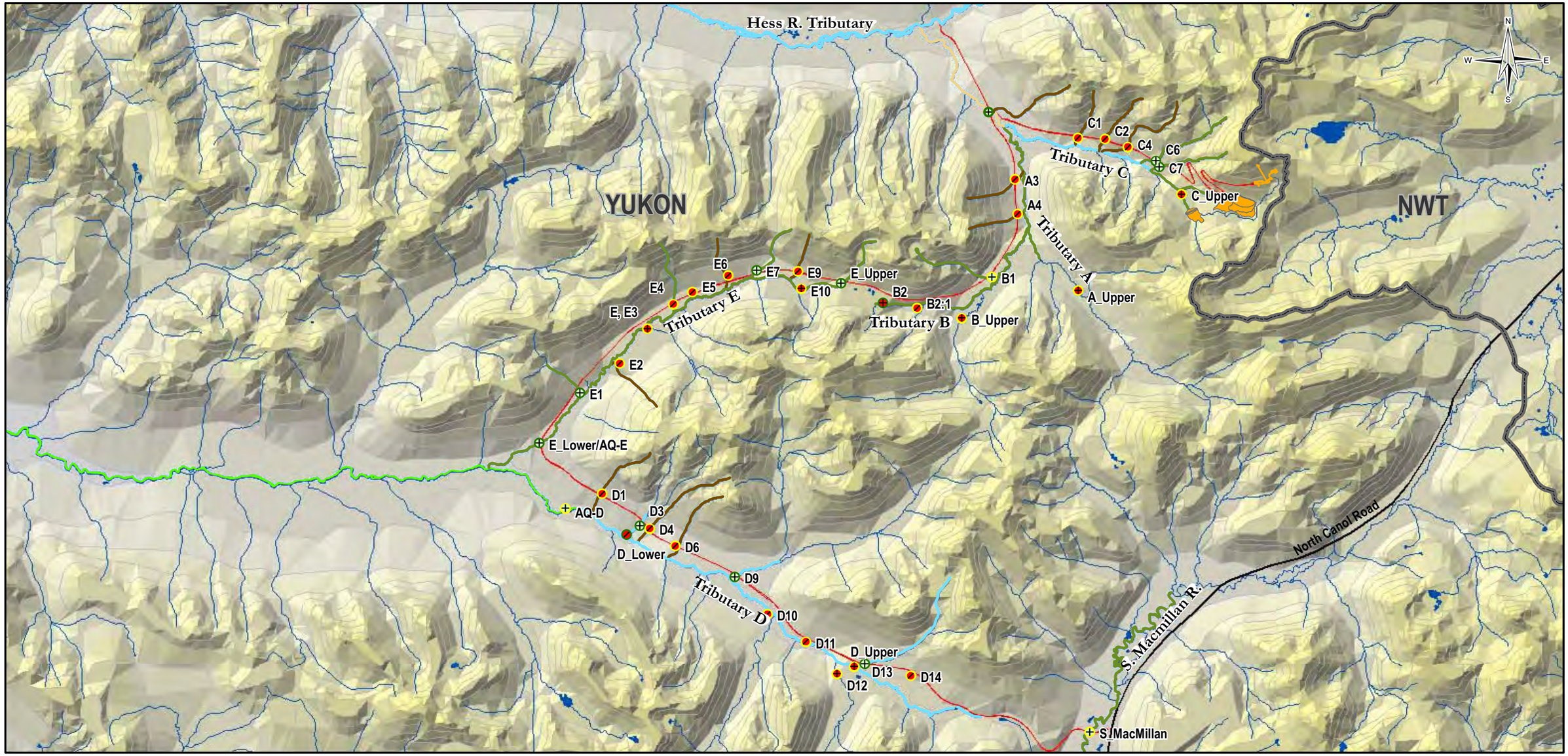
Mactung Project
2008 Fisheries and Aquatics Baseline Studies

2008 Hess River Tributary
Arctic Grayling Size Distribution

EBA Engineering Consultants Ltd.

| PROJECT NO. | DWN | CKD | REV |
|---|---|---|---|
| W23101021.014 | ARS | LSM | 0 |
| OFFICE: EBA-Whitehorse | DATE: December 2008 | | |

Figure 5




## LEGEND

- NWT - Yukon Territory Border
- Access Road Route
- Proposed Mine Site Infrastructure
- Existing Road
- Waterbody
- Unassessed Watercourses

**Streams**

- Fish Bearing
- Mapped, but no Channel
- Marginal or Unconfirmed
- Non-Fish Bearing

**Sampled for Water Quality**

- No
- Yes

**Sampled for Full Habitat**

- No
- Yes

**Sampled for Fish**

- No
- Yes

**NOTES**

Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

# MACTUNG
# 2008 FISHERIES AND AQUATICS BASELINE STUDIES

## Road Aquatics Study Area
## Fish Presence and Sample Locations

| | | | |
|---|---|---|---|
| PROJECTION: UTM Zone 9 | DATUM: NAD83 | | |
| Scale: 1:100,000 (2 1 0 2 Kilometers) | | | |
| FILE NO.: W23101021_015_Figure6.mxd | | | |
| PROJECT NO.: W23101021.015 | DWN: MEZ | CKD: CJJ | REV: 0 |
| OFFICE: EBA-VANC | DATE: December 10, 2008 | | |

NORTH AMERICAN TUNGSTEN CORPORATION LTD
EBA Engineering Consultants Ltd. eba

**Figure 6**

YUKON

NWT

Hess R. Tributary

Tributary A

Tributary B

Tributary C

Tributary D

Tributary E

North Canol Road

S. Macmillan R.

7/7/2008
Temp: 8.1
pH: 8.18
D.O.: 9
T: n/a
C: 95.8

10/10/2008
Temp: 0.3
pH: 7.34
D.O.: 12.45
T: 5.11
C: 177

9/24/2008
Temp: 2.8
pH: n/a
D.O.: 11.19
T: 3.13
C: 191

7/8/2008
Temp: 7.4
pH: 8.06
D.O.: 9.32
T: n/a
C: 94.6

9/24/2008
Temp: 1.8
pH: n/a
D.O.: 11.54
T: 3.83
C: 183

9/4/2008
Temp: 7.2
pH: 7.98
D.O.: 10.06
T: 4.59
C: 168

8/8/2008
Temp: 4.1
pH: 8.09
D.O.: 10.4
T: 2.03
C: 337

9/23/2008
Temp: 2.2
pH: n/a
D.O.: 11.35
T: 7.21
C: 228

9/5/2008
Temp: 5.1
pH: 7.55
D.O.: 10.34
T: 7.21
C: 218

7/8/2008
Temp: 7.4
pH: 7.8
D.O.: 8.1
T: n/a
C: 151.2

7/8/2008
Temp: 5.3
pH: 7
D.O.: 5.9
T: n/a
C: 443

8/8/2008
Temp: 6.5
pH: 5.94
D.O.: 9.43
T: 0.61
C: 761

8/8/2008
Temp: 6
pH: 7.65
D.O.: 9.55
T: 0.6
C: 119.5

8/8/2008
Temp: 5.3
pH: 7.64
D.O.: 10
T: 0.38
C: 116.4

8/7/2008
Temp: 7.5
pH: 7.02
D.O.: 9.05
T: 20.4
C: 375

8/5/2008
Temp: 6
pH: 3.36
D.O.: 9.13
T: 0.64
C: 652

8/7/2008
Temp: 6.6
pH: 7.93
D.O.: 9.38
T: 97
C: 684

8/7/2008
Temp: 3.5
pH: 8.96
D.O.: 10.5
T: 0.76
C: 626

8/8/2008
Temp: 5.5
pH: 6.81
D.O.: 9.72
T: 0.52
C: 86

8/5/2008
Temp: 3.6
pH: 4.5
D.O.: 9.61
T: 0.55
C: 113

8/7/2008
Temp: 6.3
pH: 8.47
D.O.: 9.48
T: 4.87
C: 467

8/4/2008
Temp: 7
pH: 3.75
D.O.: 8.59
T: 0.43
C: 335

8/8/2008
Temp: 8.7
pH: 5.25
D.O.: 8.52
T: 20.3
C: 285

8/8/2008
Temp: 5.7
pH: 8.56
D.O.: 9.65
T: 0.58
C: 235

9/6/2008
Temp: 5.4
pH: 7.72
D.O.: 9.89
T: 0.5
C: 289

8/5/2008
Temp: 6.3
pH: 6.3
D.O.: 9.73
T: 36.1
C: 456

9/7/2008
Temp: 3.6
pH: 7.75
D.O.: 10.83
T: 11.1
C: 326

8/7/2008
Temp: 4.9
pH: 8.4
D.O.: 10.4
T: 6.27
C: 454

8/6/2008
Temp: n/a
pH: 7.4
D.O.: 9.3
T: 6.76
C: 164

8/5/2008
Temp: 6.6
pH: 8.6
D.O.: 10.05
T: 15.2
C: 515

8/8/2008
Temp: 6.4
pH: 5.3
D.O.: 9.64
T: 9.53
C: 109

8/8/2008
Temp: 7.5
pH: 7.3
D.O.: 9.6
T: 2.78
C: 259

8/6/2008
Temp: 4.7
pH: 8.69
D.O.: 10.4
T: 2.81
C: 291

8/6/2008
Temp: 3.9
pH: 4.99
D.O.: 8.5
T: 30.2
C: 428

N
W
E
S

## LEGEND

- Sampling Locations
- Proposed Mine Site Infrastructure
- NWT - Yukon Territory Border
- Access Road Route
- North Canol Road
- Watercourses
- Waterbodies

**Water Quality Parameters**
Temp = Temperature (°C)
D.O. = Dissolved Oxygen (mg/L)
T = Turbidity (NTU)
C = Conductivity (µs•cm$^{-1}$)

**NOTES**
Base data source: 1:50K NTDB
Site Plan adapted from original provided by Wardrop

ISSUED FOR USE

# MACTUNG
# 2008 FISHERIES AND AQUATICS BASELINE STUDIES

## Aquatics Sampling
## Water Quality Results

| | |
|---|---|
| PROJECTION: UTM Zone 9 | DATUM: NAD83 |
| Scale: 1:115,000 (2 1 0 2 Kilometers) | |
| FILE NO.: W23101021_015_Figure7.mxd | |
| PROJECT NO.: W23101021.015 | DWN: MEZ / CKD: CJJ / REV: 0 |
| OFFICE: EBA-VANC | DATE: December 10, 2008 |

North American Tungsten Corporation Ltd.
EBA Engineering Consultants Ltd. eba

**Figure 7**

Q:\Vancouver\GIS\ENVIRONMENTAL\W2311\W23101110_MacTung_API\Maps\001_YESAA_Prep\Aquatics\W23101110_001_Aquatics_Map005.mxd modified 11/3/2008 by m.zondervan

# PHOTOGRAPHS

Photo 1
Hess River Tributary in early June, 2008, looking upstream.

Photo 2
Preparing the seine net for soaking on the Hess River Tributary, looking downstream, June 2008.

Photo 3
Processing catch from electrofishing at site D13, July 2008.

Photo 4
Round whitefish caught at site PS2 on the Hess River Tributary using a seine net, July 2008.

Photo 5
Artic grayling caught at site PS2 on the Hess River Tributary in July, 2008.

Photo 6
Looking downstream at site PS4, on the Upper Hess River Tributary, July 2008.

Photo 7
Looking upstream on the Upper Hess River Tributary on October 10, 2008. Ice is beginning to form.

Photo 8
Site PS2, proposed site of the pump station on the Hess River Tributary, October 10, 2008.

Photo 9
Site PS 3, Upper Hess River Tributary, October 10, 2008.

Photo 10
Existing bridge crossing on the South Macmillan River, west of the airstrip, August 2008.

Photo 11
South Macmillan River, note the wide channel consisting mostly of fines and gravel, August 2008.

Photo 12
Aerial photo of Tributary D3, August 7, 2008.

Photo 13
Abundant overstorey vegetation covers Tributary D3. Photo taken on August 7, 2008.

Photo 14
Tributary D3 is characterized by cascade pool pattern with gravel and boulder substrate, August 7, 2008.

Photo 15
The approximate area of a proposed watercourse crossing on Tributary D9, August 5, 2008.

Photo 16
Tributary D9 is moderate in size, consists mainly of cascade pool pattern and often has high discharge. Photo taken on August 5, 2008.

Photo 17
Tributary D13, in the vicinity of a proposed bridge crossing.

Photo 18
Tributary D13 is characterized by a cascade pool pattern with high discharge and is dominated by boulders interspersed with gravel

Photo 19
Aerial photograph of a confined reach of Tributary D13, August 6, 2008.

Photo 20
Dolly Varden caught at site D13 by electrofishing, August 6, 2008.

Photo 21
Tributary E, in the vicinity of a proposed bridge crossing, August 6, 2008.

Photo 22
Overstorey cover is abundant on Tributary E. Photo taken August 6, 2008.

Photo 23
Aerial photograph of Tributary E on August 6, 2008.

Photo 24
Tributary E7 is characterized as a low energy, riffle pool stream that is dominated by gravel and cobble, August 5, 2008.

Photo 25
Tributary E7 in an area with low gradient, August 5, 2008.

Photo 26
Aerial view of Tributary E7. Photo taken on August 5, 2008.

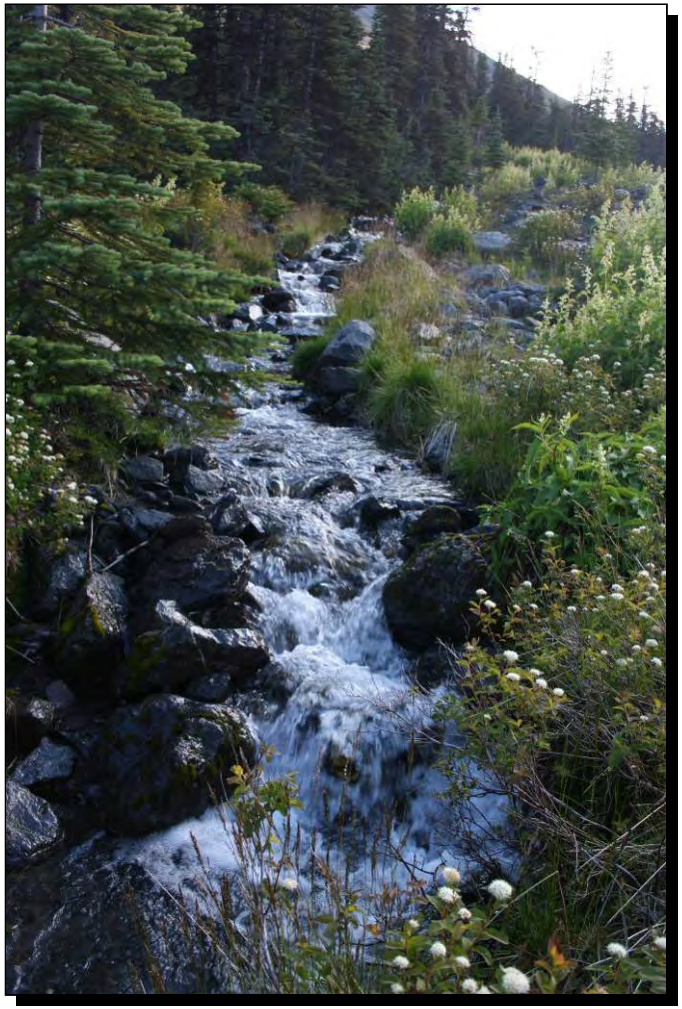


Photo 27
Upper Tributary E is characterized as a high gradient, cascade pool stream dominated by boulders and cobble.

Photo 28
Looking down stream on the upper reaches of Tributary E.

Photo 29
Aerial view of the upper reaches of Tributary E. Photo taken on August 8, 2008

Photo 30
Tributary B1 is dominated by a cascade pool pattern with boulder/cobble substrate, August 4, 2008.

Photo 31
Looking downstream on Tributary B1 in the vicinity of a proposed crossing. Photo taken on August 4, 2008.

Photo 32
The upper reaches of Tributary B1 are steep with high energy and contained low quality fish habitat, August 4, 2008.

Photo 33
Tributary C6 is dominated by boulders and cobble in a cascade pool channel type. Overstorey vegetation is abundant, August 8, 2008.

Photo 34
Looking upstream on Tributary C6 in the vicinity of a proposed crossing, August 8, 2008.

Photo 35
An aerial photo of looking upstream on Tributary C6. Photo taken on August 8, 2008.

Photo 36
Tributary C6 - a barrier that is likely impassible to fish,
located downstream of the sample site on Tributary C6, August 8, 2008.

Photo 37
Tributary C7 is characterized by riffle pool channel type, August 8, 2008.

Photo 38
Tributary C7 a small meandering channel confined by vegetated banks. Photo taken on August 8, 2008.

Photo 39
Aerial photograph of Tributary C7, taken on August 8, 2008.

Photo 40
Looking upstream at aquatic sampling site AQ-D, located on lower Tributary D.
Photo taken on September 6, 2008.

Photo 41
Down stream view at aquatic sampling site AQ-E. Photo taken on September 6, 2008.

# APPENDIX A

APPENDIX A FISHERIES COLLECTION PERMIT CL-08-26

06/27/2008 13:38 FAX 867 393 6738 002

**License to Collect Fish**
**Pursuant to Part VII of the Fishery (General) Regulations**
**Yukon/Transboundary Rivers Area**
**Fisheries and Oceans Canada**
**PHONE (867)393-6722**
**FAX (867)393-6738**

**License No.** CL-08-26 **Date Issued:** June 27, 2008

**License Holder:** Chris Jusrebski
**Company/Institution:** EBA Engineering Services

**Address:** 6 – 151 Industrial Road
Whitehorse, YT
Y1A 2V3
Phone: 668-3068
Fax : 668-4349
Email : cjusrebski@eba.ca

**Assistants:** Byron Gale, Audrey Suncon, Dave Desmarais, Barb Crawford, David-scott McQuinn & others to be noted in summary

The following conditions will apply to this license:

1. **Purpose:** to collect biophysical information on aquatic resources in the Andrew mining project area.
2. **Samplers:** It is the responsibility if the license holder to ensure that samplers are experienced and competent in the fish collection methods authorized in this license.
3. **Collection Period:** Date of issue to September 30, 2008. This license is subject to immediate termination upon written or verbal notice from a representative of the Yukon Government- Department of Environment, or of Fisheries and Oceans Canada.
4. **Species/Life Stages/Quantity:** All species. A total of 30 of each of the following species may be retained: arctic grayling, mountain/round whitefish, slimy sculpin and dolly varden. All lake trout must be returned to the waters from which they were captured.
5. **Collection Area:** Watershed of the South and North Macmillan Rivers.
6. **Collection Methods:** Electrofishing, angling, seine & dip nets, and short set gill nets. Electrofishing must not occur where adult salmon, or salmon redds, are apparent. Gill nets must be tended, and length of sets be such that mortality of salmon or lake trout does not occur.
7. **Marking of gear:** All gear must be tended, and marking will therefore not be required.
8. **Notice:** Prior to commencing sampling, notice is to be given to:
   - Fisheries and Oceans Canada, Yukon/Transboundary Rivers Area
     Tel: (867) 393-6722 Fax (867) 393-6738
   - Susan Thompson, YTG Fisheries
     Tel: (867) 667-5199 Fax (867) 393-6263
   - Appropriate First Nation governments.

Page 1 of 2

2-20 Sept add Hwy

- **Note:** Notice is also to be given to the Government of Yukon Conservation Officer responsible for any area where sampling is to take place at least 24 hours prior to the start of sampling.

**The following information is to be included:**

i. The Collection License number,
ii. The watercourse or water body on which, and the location where the sampling is to take place,
iii. The dates on which sampling will occur
iv. The names of all assistants which will be engaged in the sampling,
v. In cases where angling is included as a method and if angling is to be conducted in the presence of, or for, adult salmon the Fishery Officer in Whitehorse is to be notified a minimum of 24 hours prior to the sampling providing the locations and time this activity will occur. The officer can be contacted by fax (867-393-6738) or telephone (867-393-6722).

9. **Disposition of fish:** Any fish captured and retained under the authority of this license are not to enter any commercial markets or establishments. Any fish collected and retained, or incidental mortalities associated with non-lethal sampling, are not to be utilized for human consumption or personal use purposes unless authorized by Fisheries & Oceans Canada.

10. **Release of fish:** All live fish must be released unharmed into the water body or course from which they originated and as near as possible to the location from which they were sampled. Exception to this is where fish are retained for identification or forensic purposes.

11. **Transport or transplant of live fish and/or eggs/milt:** Live fish and/or eggs (spawn) cannot be transported without prior written approval of the transplant committee or transplanted without a licence granted pursuant to Section 56 of the Fishery (General) Regulations.

12. **Need to carry and produce permit:** A copy of this license must be in the immediate possession of the samplers during sampling, and must be produced upon the request of any representative designated as a Fishery Officer or Fishery Guardian pursuant to the Fisheries Act (Canada).

13. **Report:** A report must be submitted after completion of sampling. The report may be in the form of scanned data sheets or field notes, or as the final report for the project, and must include the following:

a. The Collection License number
b. The location(s) of the sampling. GPS coordinates are preferred however a map may be used, or the location described in detail;
c. The dates on which the sampling occurred;
d. The number of fish sampled, by species;
e. Any mortalities

The report is to be submitted electronically by December 31, 2008 to:

Jody Mackenzie-Grieve
FCS Biologist
Fisheries and Oceans Canada
100-419 Range Rd
Whitehorse Yukon, Y1A 3V1
Email: Jody.Mackenzie-Grieve@dfo-mpo.gc.ca

Authorized by:

Frank Quinn
Area Director, Yukon / Transboundary Rivers Area

# APPENDIX B

## APPENDIX B SUMMARY OF FISH COLLECTION DATA FOR 2008 BASELINE STUDIES

| APPENDIX B. SUMMARY OF FISH CATCH DATA FROM 2008 BASELINE STUDIES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site | Date Sampled | Sampling Method‡ | UTM Location | | | Species† | Fork Length (mm) | Weight (g) | Released Status |
| | | | Zone | Easting | Northing | | | | |
| D13 | 6-Aug-08 | EF | 9 | 431779 | 7004737 | *SaMa* | 152 | 66 | Y |
| D13 | 6-Aug-08 | EF | 9 | 431779 | 7004737 | *SaMa* | 152 | 44 | Y |
| D13 | 6-Aug-08 | EF | 9 | 431779 | 7004737 | *SaMa* | 163 | 46 | Y |
| D13 | 6-Aug-08 | EF | 9 | 431779 | 7004737 | *SaMa* | 172 | 58 | Y |
| D13 | 6-Aug-08 | EF | 9 | 431779 | 7004737 | *SaMa* | 212 | 124 | Y |
| D13 | 6-Aug-08 | EF | 9 | 431779 | 7004737 | *SaMa* | 215 | 114 | Y |
| D3 | 7-Aug-08 | EF | 9 | 426020 | 7008262 | *SaMa* | 166 | 46 | Y |
| D3 | 7-Aug-08 | EF | 9 | 426020 | 7008262 | *SaMa* | 186 | 72 | Y |
| D9 | 6-Aug-08 | EF | 9 | 428456 | 7006962 | *SaMa* | 83 | 6 | N |
| D9 | 6-Aug-08 | EF | 9 | 428456 | 7006962 | *SaMa* | 131 | 20 | Y |
| D9 | 6-Aug-08 | EF | 9 | 428456 | 7006962 | *SaMa* | 171 | 38 | Y |
| D9 | 6-Aug-08 | EF | 9 | 428456 | 7006962 | *SaMa* | 173 | 32 | Y |
| D9 | 6-Aug-08 | EF | 9 | 428456 | 7006962 | *SaMa* | 176 | 54 | Y |
| PS-1 | 8-Jul-08 | Seine | 9 | 432665 | 7020885 | *RWH* | 158 | | Y |
| PS-1 | 8-Jul-08 | EF | 9 | 432525 | 7020876 | *CoCo* | 106 | | Y |
| PS-1 | 8-Jul-08 | Seine | 9 | 432665 | 7020885 | *CoCo* | | | Y |
| PS-1 | 8-Jul-08 | Seine | 9 | 432665 | 7020885 | *CoCo* | | | N |
| PS-1 | 8-Jul-08 | Seine | 9 | 432665 | 7020885 | *CoCo* | 37 | | Y |
| PS-1 | 8-Jul-08 | Seine | 9 | 432665 | 7020885 | *CoCo* | | | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 72 | 6 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 73 | 4 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 76 | 4 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 77 | 4 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 78 | 6 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 78 | 4 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 83 | 4 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 84 | 4 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *ThAr* | 90 | 6 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433224 | 7021067 | *ThAr* | 139 | 22 | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433224 | 7021067 | *ThAr* | 172 | 48 | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433226 | 7021063 | *ThAr* | 178 | 84 | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433468 | 7021109 | *ThAr* | 214 | 128 | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433394 | 7021080 | *ThAr* | 284 | 312 | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433394 | 7021080 | *ThAr* | 340 | 440 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433224 | 7021067 | *ThAr* | 364 | 336 | Y |

| APPENDIX B. SUMMARY OF FISH CATCH DATA FROM 2008 BASELINE STUDIES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | UTM Location | | | | | | |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *RWH* | 257 | 134 | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433224 | 7021067 | *CoCo* | 23 | | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433224 | 7021067 | *CoCo* | 24 | | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *CoCo* | 38 | | Y |
| PS-2 | 7-Jul-08 | Seine | 9 | 433462 | 7021099 | *CoCo* | 39 | | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433224 | 7021067 | *CoCo* | 79 | 4 | Y |
| PS-2 | 7-Jul-08 | EF | 9 | 433497 | 7021143 | *CoCo* | 83 | | Y |
| PS-2 | 4-Sep-08 | Seine | 9 | 433664 | 7021195 | *ThAr* | 230 | 130 | Y |
| PS-2 | 4-Sep-08 | Seine | 9 | 433664 | 7021195 | *ThAr* | 310 | 294 | Y |
| PS-2 | 4-Sep-08 | Angling | 9 | 433664 | 7021195 | *ThAr* | 322 | 366 | N |
| PS-2 | 4-Sep-08 | Angling | 9 | 433664 | 7021195 | *ThAr* | 327 | 400 | N |
| PS-2 | 4-Sep-08 | Seine | 9 | 433664 | 7021195 | *CoCo* | 16 | | Y |
| PS-2 | 4-Sep-08 | Seine | 9 | 433664 | 7021195 | *UNID* | | | N |
| PS-3 | 5-Sep-08 | Angling | 9 | 434284 | 7021475 | *ThAr* | | | Y |
| PS-3 | 5-Sep-08 | Angling | 9 | 434284 | 7021475 | *ThAr* | | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 92 | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 84 | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 104 | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 73 | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 90 | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 68 | | Y |
| PS-3 | 5-Sep-08 | EF | 9 | 434284 | 7021475 | *CoCo* | 34 | | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *ThAr* | 56 | | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *ThAr* | 61 | | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *ThAr* | 65 | 6 | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *ThAr* | 185 | 96 | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *ThAr* | 189 | 98 | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *ThAr* | 211 | 120 | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *ThAr* | 216 | 144 | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *ThAr* | 228 | 158 | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *ThAr* | 294 | 292 | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *CoCo* | 26 | | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *CoCo* | 37 | | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *CoCo* | 49 | <1 | Y |
| PS-4 | 8-Jul-08 | EF | 9 | 436813 | 7022884 | *CoCo* | 59 | | Y |
| PS-4 | 8-Jul-08 | Seine | 9 | 436813 | 7022884 | *ThAr* | 29 | n/a | N |
| PS-4 | 5-Sep-08 | Angling | 9 | 436813 | 7022884 | *ThAr* | 285 | | Y |
| PS-4 | 5-Sep-08 | Angling | 9 | 436813 | 7022884 | *ThAr* | 295 | | Y |
| PS-4 | 5-Sep-08 | Angling | 9 | 436813 | 7022884 | *ThAr* | 321 | | Y |

| APPENDIX B. SUMMARY OF FISH CATCH DATA FROM 2008 BASELINE STUDIES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | UTM Location | | | | | | |
| Trib D | 7-Aug-08 | EF | 9 | 425688 | 7008043 | *SaMa* | 143 | | N |
| Trib D | 7-Aug-08 | EF | 9 | 425688 | 7008043 | *SaMa* | 126 | | Y |

‡ Sampling Methods: EF - Backpack Electrofishing, Seine – 30 m seine net (3mm mesh), Angling.

†Species codes: *SaMa* – Dolly Varden (*Salvelinus malma*), *ThAr* – Arctic grayling (*Thymallus arcticus*), *PrCy* – Round Whitefish (*Prosopium cylindraceum*), *CoCo* – slimy sculpin (*Cottus cognatus*).

# APPENDIX C

## APPENDIX C SUMMARY OF LABORATORY ANALYSES FOR STREAM SEDIMENTS

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## RESULTS OF CHEMICAL ANALYSES OF SOIL

| Maxxam ID | | L52440 | L52453 | L52454 | L52455 | L52456 | L52457 | L52458 | L52459 | L52460 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date | | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | | |
| | **Units** | **16-S1** | **16-S2** | **16-S3** | **7-S1** | **7-S2** | **7-S3** | **FS10-S1** | **FS10-S2** | **FS10-S3** | **RDL** | **QC Batch** |
| **Physical Properties** | | | | | | | | | | | | |
| Loss on Ignition | % | 4 | 3 | 4 | 4 | 5 | 5 | 4 | 6 | 8 | 1 | 2577586 |
| Sieve - #16 (>1.18mm) | % | 4.9 | 4.8 | 2.4 | 27.1 | 7.3 | 9.1 | 43.0 | 7.6 | 2.7 | 0.1 | 2569150 |
| Sieve - #30 (>0.60mm) | % | 40.2 | 42.6 | 30.5 | 50.0 | 35.6 | 28.7 | 30.0 | 11.5 | 6.0 | 0.1 | 2569150 |
| Sieve - #50 (>0.300 mm) | % | 47.6 | 44.8 | 45.2 | 16.0 | 31.8 | 30.6 | 10.9 | 11.8 | 12.3 | 0.1 | 2569150 |
| Sieve - 100 Mesh (>.15 mm) | % | 4.8 | 5.2 | 14.8 | 4.6 | 12.9 | 17.8 | 4.7 | 17.4 | 24.4 | 0.1 | 2569150 |
| Sieve - #140 (>0.106mm) | % | 1.0 | 1.0 | 3.3 | 1.1 | 4.3 | 5.7 | 2.8 | 16.8 | 16.3 | 0.1 | 2569150 |
| Sieve - #200 (>0.075mm) | % | 0.7 | 0.7 | 1.5 | 0.5 | 2.7 | 3.1 | 2.5 | 11.3 | 10.3 | 0.1 | 2569150 |
| Sieve - #270 (>0.053mm) | % | 0.3 | 0.3 | 1.1 | 0.3 | 2.3 | 2.6 | 2.1 | 10.3 | 10.5 | 0.1 | 2569150 |
| Sieve - #400 (>0.030 mm) | % | 0.3 | 0.3 | 0.6 | 0.2 | 1.6 | 1.4 | 1.5 | 5.5 | 6.8 | 0.1 | 2569150 |
| Sieve - Pan | % | 0.3 | 0.3 | 0.6 | 0.2 | 1.4 | 1.1 | 2.6 | 7.7 | 10.8 | 0.1 | 2569150 |

| Maxxam ID | | L52461 | L52462 | L52463 | L52464 | L52465 | L52467 | | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling Date | | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | | |
| | **Units** | **FS9-S1** | **FS9-S2** | **FS9-S3** | **FS8-S1** | **FS8-S2** | **FS8-S3** | **RDL** | **QC Batch** |
| **Physical Properties** | | | | | | | | | |
| Loss on Ignition | % | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 2577586 |
| Sieve - #16 (>1.18mm) | % | 1.5 | 12.7 | 6.3 | 10.4 | 0.7 | 9.6 | 0.1 | 2569150 |
| Sieve - #30 (>0.60mm) | % | 24.8 | 43.8 | 38.9 | 66.2 | 1.7 | 35.1 | 0.1 | 2569150 |
| Sieve - #50 (>0.300 mm) | % | 66.5 | 27.0 | 39.3 | 18.8 | 8.5 | 46.4 | 0.1 | 2569150 |
| Sieve - 100 Mesh (>.15 mm) | % | 6.9 | 12.2 | 13.3 | 3.7 | 31.5 | 7.8 | 0.1 | 2569150 |
| Sieve - #140 (>0.106mm) | % | <0.1 | 2.2 | 1.4 | 0.5 | 20.3 | 0.5 | 0.1 | 2569150 |
| Sieve - #200 (>0.075mm) | % | <0.1 | 1.0 | 0.4 | 0.2 | 11.3 | 0.1 | 0.1 | 2569150 |
| Sieve - #270 (>0.053mm) | % | <0.1 | 0.6 | 0.2 | 0.1 | 11.2 | 0.2 | 0.1 | 2569150 |
| Sieve - #400 (>0.030 mm) | % | <0.1 | 0.2 | <0.1 | <0.1 | 6.6 | <0.1 | 0.1 | 2569150 |
| Sieve - Pan | % | 0.1 | 0.3 | 0.1 | 0.1 | 8.2 | 0.2 | 0.1 | 2569150 |

RDL = Reportable Detection Limit

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## RESULTS OF CHEMICAL ANALYSES OF SOIL

| Maxxam ID | | L52468 | L52469 | L52470 | L52471 | L52472 | L52473 | | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling Date | | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | | |
| | **Units** | **FS7-S1** | **FS7-S2** | **FS7-S3** | **FS6-S1** | **FS6-S2** | **FS6-S3** | **RDL** | **QC Batch** |
| **Physical Properties** | | | | | | | | | |
| Loss on Ignition | % | 6 | 5 | 14 | 3 | 5 | 4 | 1 | 2577586 |
| Sieve - #16 (>1.18mm) | % | 15.0 | 4.1 | 3.2 | 30.1 | 25.0 | 5.6 | 0.1 | 2569150 |
| Sieve - #30 (>0.60mm) | % | 25.7 | 33.1 | 13.8 | 40.9 | 33.8 | 36.7 | 0.1 | 2569150 |
| Sieve - #50 (>0.300 mm) | % | 16.3 | 48.9 | 34.2 | 16.8 | 23.8 | 46.4 | 0.1 | 2569150 |
| Sieve - 100 Mesh (>.15 mm) | % | 15.3 | 9.0 | 20.5 | 7.0 | 11.6 | 9.8 | 0.1 | 2569150 |
| Sieve - #140 (>0.106mm) | % | 11.0 | 1.8 | 8.4 | 2.2 | 2.5 | 0.6 | 0.1 | 2569150 |
| Sieve - #200 (>0.075mm) | % | 6.6 | 1.1 | 6.4 | 1.2 | 1.5 | 0.3 | 0.1 | 2569150 |
| Sieve - #270 (>0.053mm) | % | 5.0 | 0.9 | 6.6 | 1.0 | 0.8 | 0.3 | 0.1 | 2569150 |
| Sieve - #400 (>0.030 mm) | % | 2.5 | 0.5 | 4.1 | 0.3 | 0.3 | <0.1 | 0.1 | 2569150 |
| Sieve - Pan | % | 2.6 | 0.6 | 2.8 | 0.4 | 0.7 | 0.3 | 0.1 | 2569150 |

RDL = Reportable Detection Limit

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## CSR/CCME METALS - SOIL (SOIL)

| Maxxam ID | | L52440 | L52453 | L52454 | L52455 | L52456 | L52457 | L52458 | L52459 | L52460 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sampling Date | | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | | |
| | **Units** | **16-S1** | **16-S2** | **16-S3** | **7-S1** | **7-S2** | **7-S3** | **FS10-S1** | **FS10-S2** | **FS10-S3** | **RDL** | **QC Batch** |
| **Misc. Inorganics** | | | | | | | | | | | | |
| Soluble (2:1) pH | pH Units | 7.60 | 7.39 | 7.40 | 7.50 | 7.63 | 7.52 | 7.33 | 7.43 | 7.49 | 0.01 | 2567099 |
| **Total Metals by ICPMS** | | | | | | | | | | | | |
| Total Aluminum (Al) | mg/kg | 7540 | 6560 | 10600 | 7050 | 8140 | 9330 | 13300 | 18600 | 19300 | 100 | 2569724 |
| Total Antimony (Sb) | mg/kg | 4.8 | 4.5 | 5.1 | 5.0 | 5.5 | 6.1 | 2.0 | 2.9 | 3.6 | 0.1 | 2569724 |
| Total Arsenic (As) | mg/kg | 30.8 | 33.4 | 38.8 | 52.3 | 51.6 | 51.6 | 40.2 | 74.9 | 64.1 | 0.2 | 2569724 |
| Total Barium (Ba) | mg/kg | 566 | 271 | 471 | 429 | 589 | 708 | 161 | 289 | 430 | 0.1 | 2569724 |
| Total Beryllium (Be) | mg/kg | 0.7 | 0.8 | 0.9 | 0.6 | 0.8 | 0.9 | 0.9 | 1.7 | 1.5 | 0.1 | 2569724 |
| Total Bismuth (Bi) | mg/kg | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.7 | 2.6 | 2.1 | 0.1 | 2569724 |
| Total Cadmium (Cd) | mg/kg | 8.31 | 13.1 | 15.5 | 7.97 | 9.64 | 10.7 | 3.24 | 4.19 | 4.62 | 0.05 | 2569724 |
| Total Calcium (Ca) | mg/kg | 6200 | 5430 | 6210 | 3240 | 3680 | 3200 | 17000 | 10700 | 8440 | 100 | 2569724 |
| Total Chromium (Cr) | mg/kg | 10 | 8 | 11 | 10 | 12 | 13 | 25 | 26 | 29 | 1 | 2569724 |
| Total Cobalt (Co) | mg/kg | 62.2 | 101 | 117 | 31.4 | 40.2 | 38.9 | 11.5 | 17.7 | 14.5 | 0.3 | 2569724 |
| Total Copper (Cu) | mg/kg | 75.9 | 88.0 | 93.8 | 193 | 209 | 223 | 117 | 114 | 98.1 | 0.5 | 2569724 |
| Total Iron (Fe) | mg/kg | 31900 | 31000 | 44100 | 33400 | 34200 | 39000 | 25700 | 32900 | 30600 | 100 | 2569724 |
| Total Lead (Pb) | mg/kg | 22.7 | 21.8 | 23.5 | 19.2 | 19.7 | 20.8 | 18.9 | 26.8 | 23.3 | 0.1 | 2569724 |
| Total Magnesium (Mg) | mg/kg | 2020 | 1830 | 2470 | 528 | 759 | 893 | 7570 | 9020 | 9440 | 100 | 2569724 |
| Total Manganese (Mn) | mg/kg | 964 | 1700 | 1790 | 496 | 590 | 607 | 343 | 466 | 364 | 0.2 | 2569724 |
| Total Mercury (Hg) | mg/kg | 0.07 | <0.05 | 0.08 | 0.28 | 0.99 | 0.24 | <0.05 | <0.05 | 0.06 | 0.05 | 2569724 |
| Total Molybdenum (Mo) | mg/kg | 14.5 | 15.0 | 17.6 | 15.8 | 13.5 | 16.9 | 8.9 | 8.7 | 12.4 | 0.1 | 2569724 |
| Total Nickel (Ni) | mg/kg | 144 | 215 | 235 | 99.9 | 118 | 120 | 72.7 | 112 | 110 | 0.8 | 2569724 |
| Total Phosphorus (P) | mg/kg | 2160 | 1980 | 1890 | 1590 | 1730 | 1340 | 4880 | 3220 | 1980 | 10 | 2569724 |
| Total Potassium (K) | mg/kg | 621 | 499 | 660 | 770 | 512 | 650 | 3410 | 2780 | 2470 | 100 | 2569724 |
| Total Selenium (Se) | mg/kg | 2.9 | 3.3 | 3.3 | 5.1 | 2.8 | 4.0 | 1.8 | 1.4 | 1.2 | 0.5 | 2569724 |
| Total Silver (Ag) | mg/kg | 0.47 | 0.45 | 0.51 | 0.48 | 0.51 | 0.55 | 0.78 | 0.64 | 0.68 | 0.05 | 2569724 |
| Total Sodium (Na) | mg/kg | <100 | <100 | <100 | <100 | <100 | <100 | 111 | 157 | 157 | 100 | 2569724 |
| Total Strontium (Sr) | mg/kg | 37.0 | 30.2 | 38.3 | 71.9 | 78.4 | 57.8 | 48.5 | 62.6 | 79.9 | 0.1 | 2569724 |
| Total Thallium (Tl) | mg/kg | 0.52 | 0.59 | 0.70 | 0.71 | 0.74 | 0.81 | 0.33 | 0.37 | 0.52 | 0.05 | 2569724 |
| Total Tin (Sn) | mg/kg | 0.3 | 0.2 | 0.4 | 0.3 | 0.2 | 0.3 | 0.3 | 0.8 | 0.7 | 0.1 | 2569724 |
| Total Titanium (Ti) | mg/kg | 125 | 87 | 202 | 125 | 54 | 67 | 200 | 417 | 442 | 1 | 2569724 |
| Total Vanadium (V) | mg/kg | 62 | 47 | 66 | 66 | 53 | 65 | 99 | 92 | 143 | 2 | 2569724 |
| Total Zinc (Zn) | mg/kg | 700 | 921 | 1190 | 482 | 564 | 625 | 293 | 444 | 521 | 1 | 2569724 |
| Total Zirconium (Zr) | mg/kg | 1.9 | 2.0 | 2.4 | 2.1 | 2.4 | 2.6 | 2.3 | 1.4 | 1.4 | 0.5 | 2569724 |

RDL = Reportable Detection Limit

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## CSR/CCME METALS - SOIL (SOIL)

| Maxxam ID | | L52461 | L52462 | L52463 | L52464 | L52465 | L52467 | | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling Date | | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | | |
| | **Units** | **FS9-S1** | **FS9-S2** | **FS9-S3** | **FS8-S1** | **FS8-S2** | **FS8-S3** | **RDL** | **QC Batch** |
| **Misc. Inorganics** | | | | | | | | | |
| Soluble (2:1) pH | pH Units | 6.95 | 6.83 | 7.10 | 7.20 | 6.86 | 6.91 | 0.01 | 2567099 |
| **Total Metals by ICPMS** | | | | | | | | | |
| Total Aluminum (Al) | mg/kg | 7630 | 8800 | 8700 | 7420 | 11800 | 9750 | 100 | 2569724 |
| Total Antimony (Sb) | mg/kg | 1.3 | 1.8 | 1.5 | 0.9 | 0.9 | 0.7 | 0.1 | 2569724 |
| Total Arsenic (As) | mg/kg | 15.4 | 17.5 | 18.1 | 13.8 | 17.9 | 12.1 | 0.2 | 2569724 |
| Total Barium (Ba) | mg/kg | 138 | 158 | 126 | 71.8 | 120 | 91.4 | 0.1 | 2569724 |
| Total Beryllium (Be) | mg/kg | 0.5 | 0.5 | 0.5 | 0.4 | 0.5 | 0.3 | 0.1 | 2569724 |
| Total Bismuth (Bi) | mg/kg | 0.3 | 0.3 | 0.2 | 0.2 | 0.5 | 0.3 | 0.1 | 2569724 |
| Total Cadmium (Cd) | mg/kg | 3.27 | 3.39 | 4.50 | 0.76 | 0.58 | 0.47 | 0.05 | 2569724 |
| Total Calcium (Ca) | mg/kg | 2920 | 3510 | 2560 | 2040 | 2440 | 1880 | 100 | 2569724 |
| Total Chromium (Cr) | mg/kg | 10 | 13 | 12 | 10 | 16 | 13 | 1 | 2569724 |
| Total Cobalt (Co) | mg/kg | 24.4 | 24.0 | 36.2 | 29.5 | 20.2 | 24.4 | 0.3 | 2569724 |
| Total Copper (Cu) | mg/kg | 39.9 | 43.3 | 52.2 | 55.6 | 26.8 | 23.9 | 0.5 | 2569724 |
| Total Iron (Fe) | mg/kg | 20400 | 23200 | 23700 | 26400 | 31000 | 32300 | 100 | 2569724 |
| Total Lead (Pb) | mg/kg | 9.1 | 10.7 | 10.9 | 18.0 | 16.2 | 17.7 | 0.1 | 2569724 |
| Total Magnesium (Mg) | mg/kg | 2630 | 3080 | 3190 | 3080 | 4630 | 3610 | 100 | 2569724 |
| Total Manganese (Mn) | mg/kg | 537 | 538 | 780 | 1100 | 670 | 841 | 0.2 | 2569724 |
| Total Mercury (Hg) | mg/kg | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.05 | 2569724 |
| Total Molybdenum (Mo) | mg/kg | 4.7 | 5.6 | 5.6 | 2.2 | 1.5 | 1.2 | 0.1 | 2569724 |
| Total Nickel (Ni) | mg/kg | 61.5 | 68.4 | 82.7 | 55.8 | 38.3 | 40.8 | 0.8 | 2569724 |
| Total Phosphorus (P) | mg/kg | 1110 | 1400 | 910 | 676 | 684 | 638 | 10 | 2569724 |
| Total Potassium (K) | mg/kg | 616 | 844 | 688 | 381 | 881 | 333 | 100 | 2569724 |
| Total Selenium (Se) | mg/kg | 1.0 | 0.7 | <0.5 | <0.5 | <0.5 | <0.5 | 0.5 | 2569724 |
| Total Silver (Ag) | mg/kg | 0.17 | 0.19 | 0.16 | 0.07 | 0.10 | 0.05 | 0.05 | 2569724 |
| Total Sodium (Na) | mg/kg | <100 | <100 | <100 | <100 | <100 | <100 | 100 | 2569724 |
| Total Strontium (Sr) | mg/kg | 30.1 | 33.0 | 23.9 | 14.3 | 17.1 | 12.9 | 0.1 | 2569724 |
| Total Thallium (Tl) | mg/kg | 0.21 | 0.22 | 0.23 | 0.13 | 0.15 | 0.07 | 0.05 | 2569724 |
| Total Tin (Sn) | mg/kg | 0.1 | 0.2 | 0.2 | 0.2 | 0.4 | 0.2 | 0.1 | 2569724 |
| Total Titanium (Ti) | mg/kg | 91 | 153 | 143 | 79 | 367 | 85 | 1 | 2569724 |
| Total Vanadium (V) | mg/kg | 38 | 47 | 46 | 23 | 25 | 16 | 2 | 2569724 |
| Total Zinc (Zn) | mg/kg | 239 | 279 | 318 | 142 | 144 | 122 | 1 | 2569724 |
| Total Zirconium (Zr) | mg/kg | 1.0 | 1.3 | 1.5 | 1.1 | 1.2 | 1.1 | 0.5 | 2569724 |

RDL = Reportable Detection Limit

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## CSR/CCME METALS - SOIL (SOIL)

| Maxxam ID | | L52468 | L52469 | L52470 | L52471 | L52472 | L52473 | | |
|---|---|---|---|---|---|---|---|---|---|
| Sampling Date | | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | 2008/09/06 | | |
| | **Units** | **FS7-S1** | **FS7-S2** | **FS7-S3** | **FS6-S1** | **FS6-S2** | **FS6-S3** | **RDL** | **QC Batch** |
| **Misc. Inorganics** | | | | | | | | | |
| Soluble (2:1) pH | pH Units | 6.90 | 6.97 | 7.06 | 7.64 | 7.87 | 7.93 | 0.01 | 2567099 |
| **Total Metals by ICPMS** | | | | | | | | | |
| Total Aluminum (Al) | mg/kg | 21000 | 14300 | 28900 | 15600 | 16200 | 15800 | 100 | 2569724 |
| Total Antimony (Sb) | mg/kg | 5.4 | 4.2 | 4.9 | 4.0 | 5.1 | 4.3 | 0.1 | 2569724 |
| Total Arsenic (As) | mg/kg | 36.0 | 32.3 | 52.9 | 26.6 | 31.4 | 27.8 | 0.2 | 2569724 |
| Total Barium (Ba) | mg/kg | 426 | 327 | 388 | 384 | 400 | 468 | 0.1 | 2569724 |
| Total Beryllium (Be) | mg/kg | 1.7 | 1.2 | 2.4 | 1.3 | 1.4 | 1.5 | 0.1 | 2569724 |
| Total Bismuth (Bi) | mg/kg | 0.3 | 0.3 | 0.5 | 1.7 | 0.3 | 0.6 | 0.1 | 2569724 |
| Total Cadmium (Cd) | mg/kg | 14.4 | 8.37 | 20.4 | 11.3 | 14.6 | 8.33 | 0.05 | 2569724 |
| Total Calcium (Ca) | mg/kg | 4500 | 3990 | 9730 | 12200 | 10200 | 16300 | 100 | 2569724 |
| Total Chromium (Cr) | mg/kg | 21 | 22 | 25 | 29 | 29 | 29 | 1 | 2569724 |
| Total Cobalt (Co) | mg/kg | 75.9 | 53.2 | 73.6 | 70.0 | 89.0 | 43.6 | 0.3 | 2569724 |
| Total Copper (Cu) | mg/kg | 206 | 131 | 261 | 114 | 130 | 104 | 0.5 | 2569724 |
| Total Iron (Fe) | mg/kg | 46800 | 32900 | 51900 | 20700 | 20700 | 22400 | 100 | 2569724 |
| Total Lead (Pb) | mg/kg | 15.3 | 13.9 | 18.1 | 11.2 | 11.3 | 12.1 | 0.1 | 2569724 |
| Total Magnesium (Mg) | mg/kg | 4530 | 4060 | 4860 | 6690 | 6530 | 6880 | 100 | 2569724 |
| Total Manganese (Mn) | mg/kg | 1160 | 858 | 1270 | 1510 | 1970 | 942 | 0.2 | 2569724 |
| Total Mercury (Hg) | mg/kg | 0.17 | 0.10 | 0.16 | 0.06 | 0.09 | <0.05 | 0.05 | 2569724 |
| Total Molybdenum (Mo) | mg/kg | 25.0 | 19.5 | 21.2 | 26.7 | 26.6 | 21.4 | 0.1 | 2569724 |
| Total Nickel (Ni) | mg/kg | 200 | 154 | 267 | 215 | 242 | 171 | 0.8 | 2569724 |
| Total Phosphorus (P) | mg/kg | 1660 | 1570 | 1500 | 2280 | 2350 | 3650 | 10 | 2569724 |
| Total Potassium (K) | mg/kg | 1490 | 1570 | 1290 | 3120 | 2860 | 3180 | 100 | 2569724 |
| Total Selenium (Se) | mg/kg | 2.8 | 2.2 | 6.3 | 3.7 | 3.2 | 2.2 | 0.5 | 2569724 |
| Total Silver (Ag) | mg/kg | 0.77 | 0.52 | 1.15 | 0.60 | 0.64 | 0.59 | 0.05 | 2569724 |
| Total Sodium (Na) | mg/kg | <100 | <100 | <100 | 185 | 177 | 204 | 100 | 2569724 |
| Total Strontium (Sr) | mg/kg | 57.7 | 47.8 | 63.6 | 60.2 | 56.6 | 73.3 | 0.1 | 2569724 |
| Total Thallium (Tl) | mg/kg | 0.64 | 0.71 | 0.59 | 1.06 | 1.15 | 0.81 | 0.05 | 2569724 |
| Total Tin (Sn) | mg/kg | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.1 | 2569724 |
| Total Titanium (Ti) | mg/kg | 194 | 154 | 217 | 243 | 234 | 255 | 1 | 2569724 |
| Total Vanadium (V) | mg/kg | 138 | 151 | 139 | 281 | 353 | 267 | 2 | 2569724 |
| Total Zinc (Zn) | mg/kg | 1150 | 673 | 1090 | 1260 | 1420 | 957 | 1 | 2569724 |
| Total Zirconium (Zr) | mg/kg | 3.3 | 2.7 | 6.2 | 2.4 | 2.5 | 2.6 | 0.5 | 2569724 |

RDL = Reportable Detection Limit

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## QUALITY ASSURANCE REPORT

| | | | Matrix Spike | | Spike | | Blank | | RPD | | QC Standard | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| QC Batch | Parameter | Date | % Recovery | QC Limits | % Recovery | QC Limits | Value | Units | Value (%) | QC Limits | % Recovery | QC Limits |
| 2567099 | Soluble (2:1) pH | 2008/09/12 | | | 100 | N/A | | | 0.3 | 20 | | |
| 2569150 | Sieve - #16 (>1.18mm) | 2008/09/15 | | | | | | | 3.7 | 35 | | |
| 2569150 | Sieve - #30 (>0.60mm) | 2008/09/15 | | | | | | | 8.1 | 35 | | |
| 2569150 | Sieve - #50 (>0.300 mm) | 2008/09/15 | | | | | | | 3.7 | 35 | | |
| 2569150 | Sieve - 100 Mesh (>.15 mm) | 2008/09/15 | | | | | | | 17.6 | 35 | | |
| 2569150 | Sieve - #140 (>0.106mm) | 2008/09/15 | | | | | | | 16.1 | 35 | | |
| 2569150 | Sieve - #200 (>0.075mm) | 2008/09/15 | | | | | | | NC | 35 | | |
| 2569150 | Sieve - #270 (>0.053mm) | 2008/09/15 | | | | | | | NC | 35 | | |
| 2569150 | Sieve - #400 (>0.030 mm) | 2008/09/15 | | | | | | | NC | 35 | | |
| 2569150 | Sieve - Pan | 2008/09/15 | | | | | | | NC | 35 | | |
| 2569724 | Total Arsenic (As) | 2008/09/12 | NC | 75 - 125 | 116 | 75 - 125 | <0.2 | mg/kg | 4.2 | 35 | 97 | 75 - 125 |
| 2569724 | Total Beryllium (Be) | 2008/09/12 | 106 | 75 - 125 | 114 | 75 - 125 | <0.1 | mg/kg | 3.7 | 35 | | |
| 2569724 | Total Cadmium (Cd) | 2008/09/12 | 111 | 75 - 125 | 114 | 75 - 125 | <0.05 | mg/kg | 4.3 | 35 | 98 | 75 - 125 |
| 2569724 | Total Chromium (Cr) | 2008/09/12 | NC | 75 - 125 | 111 | 75 - 125 | <1 | mg/kg | 2.9 | 35 | 94 | 75 - 125 |
| 2569724 | Total Cobalt (Co) | 2008/09/12 | 101 | 75 - 125 | 112 | 75 - 125 | <0.3 | mg/kg | 4.5 | 35 | 101 | 75 - 125 |
| 2569724 | Total Copper (Cu) | 2008/09/12 | NC | 75 - 125 | 114 | 75 - 125 | <0.5 | mg/kg | 1.4 | 35 | 99 | 75 - 125 |
| 2569724 | Total Lead (Pb) | 2008/09/12 | NC | 75 - 125 | 108 | 75 - 125 | <0.1 | mg/kg | 5.2 | 35 | 98 | 75 - 125 |
| 2569724 | Total Mercury (Hg) | 2008/09/12 | 97 | 75 - 125 | 104 | 75 - 125 | <0.05 | mg/kg | NC | 35 | | |
| 2569724 | Total Nickel (Ni) | 2008/09/12 | NC | 75 - 125 | 110 | 75 - 125 | <0.8 | mg/kg | 1.9 | 35 | 98 | 75 - 125 |
| 2569724 | Total Selenium (Se) | 2008/09/12 | 113 | 75 - 125 | 114 | 75 - 125 | <0.5 | mg/kg | 8.8 | 35 | | |
| 2569724 | Total Vanadium (V) | 2008/09/12 | NC | 75 - 125 | 114 | 75 - 125 | <2 | mg/kg | 0.5 | 35 | 101 | 75 - 125 |
| 2569724 | Total Zinc (Zn) | 2008/09/12 | NC | 75 - 125 | 111 | 75 - 125 | <1 | mg/kg | 3.8 | 35 | 93 | 75 - 125 |
| 2569724 | Total Aluminum (Al) | 2008/09/12 | | | | | <100 | mg/kg | 3.5 | 35 | 98 | 75 - 125 |
| 2569724 | Total Antimony (Sb) | 2008/09/12 | | | | | <0.1 | mg/kg | 7.1 | 35 | 101 | 75 - 125 |
| 2569724 | Total Barium (Ba) | 2008/09/12 | | | | | <0.1 | mg/kg | 3.0 | 35 | 107 | 75 - 125 |
| 2569724 | Total Bismuth (Bi) | 2008/09/12 | | | | | <0.1 | mg/kg | NC | 35 | 88 | 75 - 125 |
| 2569724 | Total Calcium (Ca) | 2008/09/12 | | | | | <100 | mg/kg | 1.4 | 35 | 100 | 75 - 125 |
| 2569724 | Total Iron (Fe) | 2008/09/12 | | | | | <100 | mg/kg | 2.5 | 35 | 100 | 75 - 125 |
| 2569724 | Total Magnesium (Mg) | 2008/09/12 | | | | | <100 | mg/kg | 2.6 | 35 | 98 | 75 - 125 |
| 2569724 | Total Manganese (Mn) | 2008/09/12 | | | | | <0.2 | mg/kg | 3.9 | 35 | 100 | 75 - 125 |
| 2569724 | Total Molybdenum (Mo) | 2008/09/12 | | | | | <0.1 | mg/kg | 8.9 | 35 | 94 | 75 - 125 |
| 2569724 | Total Phosphorus (P) | 2008/09/12 | | | | | <10 | mg/kg | 2.0 | 35 | 99 | 75 - 125 |
| 2569724 | Total Silver (Ag) | 2008/09/12 | | | | | <0.05 | mg/kg | 6.2 | 35 | 95 | 75 - 125 |
| 2569724 | Total Strontium (Sr) | 2008/09/12 | | | | | <0.1 | mg/kg | 3.4 | 35 | 95 | 75 - 125 |
| 2569724 | Total Thallium (Tl) | 2008/09/12 | | | | | <0.05 | mg/kg | 6.6 | 35 | 86 | 75 - 125 |
| 2569724 | Total Titanium (Ti) | 2008/09/12 | | | | | <1 | mg/kg | 0.5 | 35 | 101 | 75 - 125 |
| 2569724 | Total Potassium (K) | 2008/09/12 | | | | | <100 | mg/kg | 1.3 | 35 | | |
| 2569724 | Total Sodium (Na) | 2008/09/12 | | | | | <100 | mg/kg | NC | 35 | | |
| 2569724 | Total Tin (Sn) | 2008/09/12 | | | | | <0.1 | mg/kg | NC | 35 | | |

Maxxam Job #: A846725
Report Date: 2008/09/16

EBA ENGINEERING CONSULTANTS
Client Project #: W23101021.005

Sampler Initials: CJ

## QUALITY ASSURANCE REPORT

| | | | Matrix Spike | | Spike | | Blank | | RPD | | QC Standard | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| QC Batch | Parameter | Date | % Recovery | QC Limits | % Recovery | QC Limits | Value | Units | Value (%) | QC Limits | % Recovery | QC Limits |
| 2569724 | Total Zirconium (Zr) | 2008/09/12 | | | | | <0.5 | mg/kg | 2.8 | 35 | | |
| 2577586 | Loss on Ignition | 2008/09/16 | | | | | <1 | % | NC | 35 | | |

N/A = Not Applicable
NC = Non-calculable
RPD = Relative Percent Difference

# APPENDIX D

## APPENDIX D SUMMARY OF RAW BENTHIC MACROINVERTEBRATE DATA

RAW BENTHIC MACROINVERTEBRATE DATA FROM THE 2008 MACTUNG FISHERIES AND AQUATICS PROGRAM

| | | | | | Site AQ-D | | |
|---|---|---|---|---|---|---|---|
| **Order** | **Family** | **Genus** | **Species** | **Stage** | **Replicate 1** | **Replicate 2** | **Replicate 3** |
| Ephemeroptera | Baetidae | *Baetis* | *bicaudatus* | nymph | 1 | | |
| Plecoptera | Chloroperlidae | *Suwallia sp.* | | nymph | | 1 | |
| Plecoptera | Perlodidae | *Skwala sp.* | | nymph | 1 | | |
| Plecoptera | Nemouridae | *Zapada* | *columbiana* | nymph | | | 1 |
| Plecoptera | Nemouridae | *Zapada* | *oregonensis/haysi* | nymph | | 1 | |
| Plecoptera | Leuctridae | | | nymph (dam./juv.) | 1 | | |
| Plecoptera | Capniidae | | | nymph | 1 | 1 | 3 |
| Plecoptera | Capniidae | *Capnia sp.* | | nymph | | | 1 |
| Trichoptera | Rhyacophilidae | *Rhyacophila sp.* | | larvae | 1 | | |
| Diptera | Tipulidae | *Dicranota sp.* | | larvae | | 1 | |
| Diptera | Tipulidae | *Rhabdomastix sp.* | | larvae | 9 | 2 | 1 |
| Diptera | Empididae | *Clinocera sp.* | | larvae | | 1 | |
| Diptera | Empididae | *Chelifera/Metachela sp.* | | larvae | 1 | 1 | |
| Diptera | Ceratopogonidae | *Bezzia/Palpomyia sp.* | | larvae | 3 | | |
| Diptera | Chironomidae | | | pupae | 1 | 1 | 1 |
| Diptera | Chironomidae | *Diamesinae sp* | | larvae | 6 | 4 | 5 |
| Diptera | Chironomidae | *Diamesa sp.* | | larvae | | 2 | |
| Diptera | Chironomidae | | | larvae | 2 | | |
| Diptera | Chironomidae | *Cricotopus/Orthocladius sp.* | | larvae | | 1 | |
| Diptera | Chironomidae | *Eukiefferiella* | *gracei* | larvae | | 1 | |
| | | | | **Total Individuals per Sample** | 27 | 17 | 13 |

Taxonomist: Sue Salter, Registered Professional Biologist, Cordillera Consulting