Appendix F5

Aquatic Effects Monitoring Program – Habitat Compensation Monitoring 2009, March 2010

Final

Aquatic Effects Monitoring Program – Habitat Compensation Monitoring 2009

Meadowbank Gold Project

Prepared for

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- Gary Mann (Azimuth) – Gary was responsible for overall management of this project and reviewed the final report. He also provided direction to field crews during data collection.
- Randy Baker (Azimuth) – Randy developed the Standard Operating Procedure (SOP), with input from Gary Mann and Ryan Hill, based on monitoring requirements specified in the Habitat Compensation Monitoring Plan (Azimuth, 2008a). Randy assisted in implementation of the field program and authored the report with Laura Nendick (Azimuth).
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ACRONYMS

AEM – Agnico-Eagle Mines Ltd.

AEMP – Aquatic Effects Management Program

BAER – Baseline aquatic ecosystem report

BG – Bay-Goose

BL – Boat launch

CCME – Canadian Council of Ministers of the Environment

CPUE – Catch-per-unit-effort

CREMP – Core receiving environment monitoring program

DFO – Department of Fisheries and Oceans

DOC – Dissolved organic carbon

DT – Drilltrail

DQO – Data Quality Objective

ED – East Dike

GPS – Global Positioning System

HADD – Harmful alteration, disruption or destruction

HCF – Habitat compensation features

HDPE – High density polyethylene

HVH – High value habitat

IF – Iron formation rock

IV – Intermediate volcanic rock

MDL – Method detection limit

NNLP – No net loss plan

NTU – Nephelometric turbidity units

PW – Pore water

QA/QC – Quality Assurance / Quality Control

RPD – Relative percent difference

SOP – Standard Operating Procedure

SP – Second Portage Lake

TKN – Total Kjeldahl Nitrogen

TP– Third Portage Lake

TSS – Total suspended solids

UM – Ultramafic rock

UTM – Universal Transverse Mercator

EXECUTIVE SUMMARY

This executive summary provides a summary of results and conclusions as well as a list of recommendations for changes to future monitoring programs based on success / failure of methods followed in 2009 as described in the habitat compensation monitoring plan (HCMP) (Azimuth, 2008a).

Under terms of the Department of Fisheries and Oceans Canada *Fisheries Act* Authorization (NU-03-0191), long-term monitoring following the HCMP is required to document the functionality of habitat compensation features (HCFs) constructed to offset habitat losses associated with development of the Meadowbank Gold Project. The HCMP describes the physical and ecological monitoring requirements, the schedule for monitoring implementation (**Table 1**) and decision criteria for evaluating the success of HCF functionality. This report documents results of ecological monitoring of the East Dike HCF[1] during year C+1 monitoring.

The monitoring strategy of the HCMP (Azimuth, 2008a) follows a tiered framework consisting of quantitative and qualitative tools (**Figure 1**). The first tier focuses on identifying constraints to HCF functionality; higher tiers involve more specialized tools and are only triggered if the success criteria specified in the HCMP are not met. Tier 1 results for the East Dike HCF are briefly summarized below, along with key conclusions and recommendations.

Interstitial (Pore) Dike Water Quality

To address the issue of potential metal leaching from dike construction material as identified in the environmental assessment process, a suite of water quality parameters was analyzed in water collected from interstitial spaces between rocks along the East Dike face. Despite care during sampling some sediment was re-suspended from rock surfaces and entrained into the water sampler, resulting in elevated TSS concentrations. Several nutrients appeared to be associated with TSS (nitrate, TKN, total phosphorus), but only total phosphorus was elevated relative to a CCME trigger (n.b., there is no CCME guideline for total phosphorus) for ultra-oligotrophic waters. This is likely not an ecologically relevant issue given that rocks are an important source of phosphorus and that orthophosphate, the bioavailable form of phosphorus, was less than the detection limit. Follow-up monitoring will be conducted in 2010 to confirm these results.

Consistent with the results of other programs (e.g., dike construction monitoring) for

[1] Monitoring under the HCMP was supposed to have started in the year of construction (i.e., year C) with an initial round of Tier 1 pore water sampling. This was attempted in 2008, but was unsuccessful due to thick ice along the East Dike face.

water samples with elevated TSS, total concentrations of some metals were also associated with TSS. Dissolved metals were rarely found to exceed detection limits or CCME guidelines. The only case was dissolved aluminum, which exceeded the CCME guideline for the protection of aquatic life at one location, primarily due to a marginally low pH (6.42) in that sample. The CCME guideline for aluminum is pH dependent and increases considerably from 0.005 mg/L to 0.1 mg/L at pH 6.5 (i.e., at higher pH values the higher aluminum guideline is used). Given that pH ranged from 6.85 to 6.92 in the other samples, this value may be anomalous.

The decision whether to escalate monitoring to Tier 2 will be made after reviewing the results of follow-up monitoring in 2010.

Periphyton Community

To verify that periphyton growth is not impaired by metals leaching from dike construction material, the HCMP includes periphyton community as a qualitative Tier 1 monitoring tool. Given the young age of the HCF, we do not expect a well developed periphyton community, but hoped to see the initial stages of colonization.

Periphyton community monitoring was conducted using different tools depending on whether dike face substrates were directly accessible. In deeper areas underwater video was used to qualitatively compare rock surfaces from the East Dike HCF with hard substrate at high-value habitats in Second and Third Portage lakes. In shallow zones were periphyton can be quantitatively sampled a specialized sampler was used to sample individual rocks for abundance (cells/cm^2) and biomass ($\mu g/cm^2$). East Dike results were compared to periphyton communities on natural substrates at three other areas in Second Portage Lake and to historical CREMP results.

Interpretation of the video footage on the dike face was confounded to some degree by the presence of settled sediment. Notwithstanding, no obvious signs of community development could be identified from video footage.

Quantitative periphyton sampling along the dike face on new material on the other hand, identified the presence of an early stage periphyton community. While community biomass at the East Dike HCF was low relative to other sampling areas, diversity was fairly high. There were some differences in community composition based on major taxa groups, with the newly colonized communities on the East Dike comprised primarily of diatoms. At this stage these differences are related to ecological succession and that over time the community should become similar to communities found on natural substrates. The pattern of change observed in subsequent monitoring events will determine how this is occurring or if any substrate-related impairment by colonizing periphyton.

Fish Use

HCFs were designed to provide habitat for spawning, egg incubation and nursery areas for lake trout, round whitefish and Arctic char. Recognizing the nutrient-limited status of the project lakes, the HCMP monitoring strategy for evaluating HCF function focuses on capability rather than actual use. Nevertheless, monitoring of fish use is a Tier 1 qualitative tool that provides information that is complementary to the other Tier 1 tools.

Due to the relatively low fish abundance in the project lakes, a variety of methods were used to monitor fish use of the East Dike HCF relative to other high-value habitats in Second Portage Lake. Furthermore, because some of these methods had never been used at the site before, an adaptive approach was used to test and assess a variety of ways in which they might yield useful data. Key results were:

- Hydroacoustic Surveys – Linear, focused area and random, lake-wide hydroacoustic surveys were used. Linear transects did not identify meaningful numbers of fish, regardless of where they were conducted. Focused area surveys were more effective and identified fish in close proximity to the East Dike, as well as in other HVH areas. Random surveys were meant simply to provide the monitoring team with information regarding fish use of Second Portage Lake in general. Unfortunately, this tool has limited capability to demonstrate fish use, especially in shallow waters because engine noise, shadow and the mere presence of the boat is likely to scare fish away from the sonar cone or into the rocks beneath the cone where they avoid detection.
- Minnow Traps and Gill Netting – Minnow traps (n=34) set at various locations and depths along the East Dike and HVH locations did not capture any fish. This result is consistent with previous attempts to capture fish using minnow traps and this technique should be abandoned. Gill nets were much more effective than other methods and provided better quantitative measures of fish utilization than hydroacoustics. Gill net catch-per-unit-effort (CPUE) was generally higher at the East Dike than at other HVH areas in Second Portage Lake.
- Visual Observations - Visual observations of fish presence along the East Dike and at various parts of Second Portage Lake were attempted both from shore and from a boat. No fish could be observed and this method too should be abandoned.

Overall, the hydroacoustic survey (focused area surveys) and gill netting results indicate that fish were present in and around the vicinity of the East Dike at densities or frequencies that were not lower than HVH habitats elsewhere in Second Portage Lake.

The following refinements are recommended for the next scheduled (i.e., year C+3 in 2011) monitoring event:

- Snorkel Surveys – the shallow, linear nature of the East Dike HCF make it a good candidate area for snorkeling.

- Electrofishing – this method was part of the HCMP, but was not conducted due to concerns regarding its lethality in water with very low conductivity. A SOP for similar lakes was developed for another northern mine (Dave Balint, pers. comm. 2010); this will be tested in 2010.

1. INTRODUCTION

1.1. Background

Fisheries and Oceans Canada (DFO) issued Agnico-Eagle Mines Ltd. (AEM) an Authorization for Works or Undertakings Affecting Fish Habitat (NU-03-0191) under the *Fisheries Act* for the Meadowbank Gold Project on 30 July 2008. The *No-Net-Loss Plan* (NNLP) (Azimuth, 2006) for the project quantified the harmful alteration, disruption or destruction (HADD) of fish habitat and documented a habitat compensation strategy to comply with DFO's No-Net-Loss of Habitat policy. The *Aquatic Effects Management Plan Targeted Monitoring – Habitat Compensation Monitoring Plan* (HCMP; Azimuth, 2008a) describes the physical and ecological monitoring requirements and decision criteria for evaluating the success of habitat compensation features (HCFs). This report addresses the ecological monitoring component for 2009.

There are four primary types of habitat compensation features (HCFs) planned for the Meadowbank Gold Project:

- *Dike Faces* – in addition to their primary purposes supporting mining activities, all dikes have been designed to serve as productive fish habitat.
- *Finger Dikes* – these features are extensions built off the dikes; their only purpose is to serve as fish habitat.
- *Habitat Mounts* – while similar to finger dikes in purpose (i.e., fish habitat only), these are isolated features located away from dike structures.
- *Shoals, Reefs and Boulder Gardens* – these features are targeted to improve habitat quality in the open basin areas immediately adjacent to the open pits (i.e., the un-mined areas impounded by the dikes) and will become functional at the end of mine life, after re-flooding of the impoundments.

The East Dike, one of the dike face HCFs, was constructed during the open water season of 2008 (i.e., for that feature, 2008 = "C", the year of construction). As per the HCMP, monitoring (interstitial water along the dike face) was meant to be initiated after dike construction in 2008, but was unsuccessful due to the long duration of dike construction activity by AEM and ice formation within the interstitial spaces along the dike face in mid-October. Consequently, this report documents monitoring conducted in 2009 (i.e., year C+1) for the East Dike HCF.

1.2. Monitoring Strategy Overview

HCFs have been designed (to serve as productive fish habitat Azimuth, 2006; Golder, 2008). To determine their capability to support fish, long-term monitoring will be undertaken to document water quality, colonization by algae (i.e., the base of the food chain) and ultimately, utilization by fish.

The HCMP (Azimuth, 2008a) describes a tiered monitoring strategy that involves a combination of qualitative and quantitative measures to assess the capability of the HCFs to function as intended (**Figure 1**) and monitored according to the schedule provided in **Table 1**. Quantitative measures start with simple tools such as interstitial water quality/chemistry, and may lead to more specialized tools such as toxicity testing and/or *in situ* studies, should Tier 1 or Tier 2 studies fail, respectively (**Figure 1**). The quantitative Tier 1 tool involves comparing interstitial (pore) water quality (based on a suite of parameters, principally dissolved metals) to CCME (2007) water quality guidelines for the protection of aquatic life and to reference area chemistry. These comparisons will help determine whether interstitial water along the dike face HCF is of suitable quality to support aquatic life, particularly the early life history stages of salmonid fish. Success criteria for all quantitative monitoring tiers were provided in the HCMP (Azimuth, 2008a).

Qualitative tools include visual/functional components including fishing, visual surveys, minnow trapping and measuring periphyton growth. Ultimately, the results of both quantitative and qualitative tools will be evaluated using a weight-of-evidence approach to determine whether HCFs are functioning as intended.

1.3. Objectives

The objective of 2009 monitoring under the HCMP was to conduct the year C+1 ecological monitoring of the East Dike HCF, which comprised the following elements:

- Tier 1 Pore water quality
- Tier 1 Periphyton community
- Tier 1 Fish use

This program is focused on the ecological functionality of the dike and not physical features related to design. Habitat compensation monitoring is a long-term program that assesses the capability of designed HCFs to function as intended. Interpretation of results for quantitative tools is made relative the success criteria specified in the HCMP (Azimuth, 2008a).

2. METHODS

2.1. Interstitial (Pore) Water Quality

The East Dike face has been constructed with the intention of providing high value fish habitat, including the potential for salmonid spawning habitat at depths greater than 2 m. Rock that has low potential for metal leaching or acid-generation was purportedly used to construct the dike. Leaching of metals from construction materials can potentially impact periphyton colonization or fish use (largely by affecting incubating eggs) and this was raised as a potential concern during the environmental impact assessment process (Azimuth, 2005a)

To determine water quality within dike pore water spaces, five (5) independent water samples plus one field duplicate were collected from along the dike face within interstitial pore spaces at the locations noted above, at 100 m; 250 m; 400 m; 550 m and 750 m from the south end of the dike (**Table 2**, **Figure 2**). The standard operating procedure (SOP) for interstitial dike water sampling is provided in **Appendix B**, and photos of the procedure can be found in **Appendix A**.

Water was analyzed by ALS Environment (Vancouver, BC) for conventional parameters (hardness, conductivity, pH, and total dissolved and suspended solids), anions (alkalinity, chloride and sulfate), nutrients (ammonia, nitrate, nitrite, total Kjeldahl nitrogen, orthophosphate and total phosphate), organic parameters (chlorophyll-*a*, dissolved and total organic carbon) and total and dissolved metals.

2.2. Qualitative Periphyton Assessment

Underwater video was used to document and describe periphyton coverage of rocks on the East Dike face HCF relative to natural coverage on other high-value habitats (HVH) in Second Portage Lake and Third Portage Lake. The rock used to construct the East Dike was prescribed to be non-acid generating or metal leaching IF and UM rock and was not predicted to limit periphyton growth. To confirm this hypothesis, the current study was designed to qualitatively assess the progress in periphyton colonization over time, relative to natural high-value habitats.

Given the possibility that sedimentation from East Dike construction in 2008 may have affected periphyton growth in Second Portage Lake, this study was expanded to include high-value habitats in the east basin of Third Portage Lake (i.e., the video was conducted in advance of Bay-Goose dike construction activities). Imagery of rocks at different depths and distances along the dike are compared to rocks at similar depths in both Second and Third Portage lakes.

Video imagery was acquired using a 'Deep Blue Pro' underwater camera system manufactured by Ocean Systems, Inc. (Everett, Washington). The camera was deployed from a boat at various locations along the East Dike face HCF and at other HVH locations in Second and Third Portage Lake **(Table 2, Figure 2).** Groups of individual small areas were filmed at depths of 1 – 4 m. Five video segments of approximately 30 seconds each were taken at different locations within each station. Representative photographs from each of the areas filmed are presented in **Appendix C**. To gauge rock size, a section of rebar was marked with 0.5 m increments and lowered over the side of the boat to provide scale. Third Portage Lake was sampled as part of the 'before' dike construction monitoring database, and also to provide perspective and reference on typical periphyton coverage of the project lakes to contrast with what is observed in Second Portage Lake subsequent to the 2008 sedimentation event.

2.3. Quantitative Periphyton Assessment

Periphyton density (cells/cm^2) and biomass (µg/cm^2) was measured based on quantitative samples of periphyton collected from 4 areas in Second Portage Lake (**Figure 2**):

- East Dike (SP-ED)
- Second Portage Lake Boat Launch (SP-BL), a near-field area
- Second Portage CREMP location (SP-CREMP), a far-field area and
- Drilltrail Arm (SP-DT) a reference area

UTM coordinates for each sample are presented in **Table 2**. Five replicate samples were collected from each area and analyzed independently. Sampling locations were chosen according to the following criteria: a sufficient number of large, flat rocks from a water depth of 0.5 m with a flat surface facing upwards as much as possible, and with uniform algal coverage, not uniformly dense or sparse. Periphyton growth is naturally variable due to differences in wave action, aspect to sun, water depth and clarity, nutrient availability, rock type, water temperature and other factors.

Periphyton samples were collected using a specially designed algae scrubber (**Appendix D, photos D-5 and D-6**). The procedures for collecting the samples are outlined in detail in the SOP for Periphyton Sampling (AEM, 2009). Periphyton samples were preserved in the field with a small amount of Lugol's solution and sent to Plankton R Us Inc. (Winnipeg, MB) for taxonomic identification and biomass (µg/cm^2) estimation.

In the laboratory, each periphyton sample was well mixed and 2-mL sub-samples of suspension were sonicated for 10 to 20 seconds using a Sonifer Cell Disruptor (model w140) and gravity settled for 24 h in an Ütermohl chamber (Findlay et al., 1999). Counts were performed on an inverted microscope at magnifications of 125X, 400X, and 1200X with phase contrast illumination. Cells were identified, counted and measured from random fields until 100 cells of the dominant species were found. Cell counts were

converted to wet weight biomass by approximating cell volume. Estimates of cell volume for each species were obtained by measurements of up to 50 cells of an individual species and applying the geometric formula best fitted to the shape of the cell (Vollenweider, 1968; Rott, 1981). Data were reported in terms of abundance (number of cells/cm^2) and biomass ($\mu g/cm^2$).

Simpson's diversity index was calculated for each station to quantify periphyton species diversity among stations and replicate samples (Washington, 1984). Simpson's diversity (D) is calculated as follows:

$$D = \sum \frac{n_i(n_i - 1)}{N(N-1)}$$

where: N is the total number of organisms/station; n_i is the total number of organisms of the *ith* taxa/station. The number of species occurring per sample was calculated to measure the species richness among stations and sampling events.

2.4. Fish Use

While the HCMP (Azimuth, 2008a) focuses primarily on habitat capability due to the nutrient-limited status of the project lakes, the increased presence of high-value habitat should give fish more options and help optimize productivity of these lakes in the long term. Consequently, fish usage data is used as a complementary qualitative tool to support the assessment of HCF functionality. The dike faces were designed to provide habitat for spawning, nursery, shelter and foraging in order that they function as natural features and replace habitat lost as a result of development. Demonstration of the presence of fish is an indirect measure that fish are using the habitat for one of the above purposes. In addition, given the relative age of the East Dike HCF, expectations for use in the short-term would be fairly low since it will take time for periphyton and invertebrates to colonize the structure and attract fish for feeding purposes. In order to demonstrate utilization by fish and establish functionality several measures were used including hydroacoustic surveys, gill netting, minnow trapping and visual observations.

2.4.1. Hydroacoustic Assessment

Hydroacoustic surveys were used to evaluate fish presence around the East Dike face area, in comparison to high value habitat areas elsewhere in Second Portage Lake. A Lowrance HDS-10 fish finder with digital color display and 83/200 kHz transducer was used to detect fish, with the following settings:

- Fish finder function turned on
- Ping speed = max

- Noise reduction = high
- Sensitivity = Auto -4
- Fish detection = General Use
- Frequency = 200
- Color Line = 76%

The transducer was aimed straight down to get a full arch signature for a fish. Three survey methods of hydroacoustic assessment were used:

- Linear transects
- Focused-area based
- Random lake-wide

This is the first time that hydroacoustic methods were tested on the project lakes, so we were not sure what to expect with respect to densities of fish. We suspected that frequency of encounters with fish would be small given the relatively low abundance of fish in the project lakes. Furthermore, given that the dike face has a steep slope (~2:1) and was constructed mostly through shallow water, the surface area of dike face beneath the bottom of the boat was relatively narrow over most of the length of the dike. This, combined with the possibility of scaring fish away because of boat shadow and boat noise in shallow water challenged our ability to fully assess the presence/absence of fish along much of the dike face. Similar challenges would be faced in shallow areas of high value habitats elsewhere in the lake. For this reason gill nets and minnow traps were also used to augment hydroacoustic methods.

Linear Transects

Linear hydroacoustic transects were carried out parallel to the East Dike to evaluate relative fish density based on return signals. Three areas were surveyed along the East Dike plus three reference areas. Reference areas targeted high value habitats in Second Portage Lake within the vicinity of HVH2 and HVH4 (Site A), HVH5 (Site B), and HVH6 (Site C) (**Figure 3**). Given the steep slope of the East Dike and in HVH areas, it was not possible to maintain a constant depth during each transect, nor was it possible to remain above the dike face at all times except in deeper sections of the dike. That is, because of the shallow depth of much of the dike and the steep slope, the boat would drift back and forth over ‘natural’ substrate and dike materials. Most high value habitat is in depths of 2 to 6 meters, and shallow depth, boat noise and ‘interference’ in the sonar output at shallow depth makes detection of fish in depths of less than 2 meters challenging. Furthermore, shallow depth is hazardous to the engine propeller; therefore surveys were mostly conducted in water depths of 3 – 6 m. Various speeds were tested, including drifting along the dike when winds were parallel with the dike to minimize boat

noise. However, after trial and error we determined that a speed of 10 km/h was a suitable speed to allow detection of fish before engine and sonar noise disturbed fish to move away from the boat.

For each transect, the start and end time, start and end coordinates, number of fish detected, and the depth at which each fish was detected relative to total depth were recorded. Catch-per-unit-effort (CPUE) was calculated as the number of fish detected per minute of hydroacoustic time to determine a relative index of abundance. CPUE was compared for transects run along the East Dike relative to HVH areas. Given the small number of fish detected overall, no quantitative analysis could be undertaken.

Focused Area-Based Surveys

To supplement transect data, particularly in light of the short duration of transects especially along the East Dike, surveys of the same areas by randomly boating around each area for 15 minute blocks of time was undertaken on September 21 and 22, 2009. Area A was separated into two areas since it comprised two separate high value habitat areas. Surveys were conducted at slightly slower speed (6 km/h), and there was no intent to keep within a particular depth range. Using this method a larger number of fish was detected than with transects. Similarly, CPUE (fish detected per minute) was calculated for each area.

Random Lake-Wide Surveys

In addition to area-based surveys, random lake-wide surveys that involved motoring around the lake with no particular pattern and in shallow and deeper depths were also conducted to determine abundance of fish away from the dike or HVH areas. Over a period of about 3-4 hours on September 9 and 10, a boat was driven around Second Portage Lake at various speeds, in depths ranging from 1 m to 20 m. No quantitative data were collected, although subjective observations were made.

2.4.2. Gill Netting and Minnow Traps

Fine mesh gill nets were used to quantitatively determine the species composition, size and catch-per-unit-effort (CPUE; # fish/100 m/hr) of fish along the East Dike relative to reference HVH habitats in Second Portage Lake. Panels of ½ inch (8 mm), ¾ inch (12 mm), 1 ½ inch (24 mm) and 3 inch (48 mm) stretch mesh gill nets were attached to one another in various combinations to create gangs of net. Gangs were set on Aug 14, 17, 21-23, all of varying set times, durations and net mesh sizes. Procedures were generally the same on all dates and are as follows.

Nets were set along the southern sections of the East Dike and in HVH reference areas (**Figure 3**) in Second Portage Lake generally where water depths were between 3 and 7 m. Gangs of net, usually made up of two or more panels, were set by boat, with the start

time, depth and UTM coordinate of the beginning and end of the set recorded. Dike net sets were positioned perpendicular to the East Dike face, to cover the full range of depths where dike face material was present. Nets set in the approximate mid-point of the East Dike face were relatively deep in depth (up to 7 m), located at the approximate midpoint of the dike, while the sets located in the southwest section of the East Dike were relatively shallow in depth (2 – 4.5 m). The nets set in the reference locations were set near or on HVH habitat, along a length of shoreline with similar depth and substrate as the dike locations. Nets were left for approximately 4-7 hours (with the exception of the overnight sets conducted on Aug 17), after which time they were pulled. Fish captured were identified by species and measured for fork length (mm) before being returned to the lake.

Standard Gee minnow traps were set along the East Dike and at HVH locations in Second Portage Lake between August 25 and September 10, 2009 (**Figure 3**). Six traps were set at three locations along the East Dike near the north, middle and south ends of the dike from August 25 - 31. Traps were moved to the HVH locations and fished September 3 – 10. Traps were baited with a variety of food items in an attempt to attract fish. Based on our experience with minnow traps during previous years, CPUE (#fish/day) is extremely low; baiting traps assumes that if fish are present they might be captured in the traps.

2.4.3. Visual Observations

Visual observations of fish presence along the East Dike and at various parts of Second Portage Lake were attempted both from shore and from a boat. Because of the small number of fish in the project lakes we did not rely on a single method of fishing (e.g., netting or hydroacoustics) and attempted visual observations as a potential means of detecting fish presence and habitat utilization in addition to the more quantitative methods described above.

Shoreline Observations – We followed a protocol whereby two people would walk along shore to an area that afforded a good vantage point into the clear water from which an observer could sit or stand still and scan the water for movements by fish. Two observers would find a location, and within two minutes of remaining still, begin observing the water for movements by fish for five minutes. After this time, the observers would move along shore to another vantage point and repeat the observation process. The number of fish observed per minute, if any, would be recorded. Observation times were split between the East Dike and locations along the shoreline of Second Portage within 1 km of the dike.

Boat Observations – Two different methods were followed for boat observations: (1) remaining still in one location, and (2) drifting. When stationary, the boat was anchored to shore from the bow and stern if necessary in case of wind so that the boat was situated

directly over high value habitat along the shore or the dike. Position was recorded and after remaining stationary for two minutes, a five minute observation period would begin. One person would look through the Plexiglas box into the bottom from one side of the boat while the second person would observe the bottom without the box while wearing polarizing sunglasses. This process was repeated every 100 m along the East Dike (8 locations) and at different locations along the shoreline of Second Portage.

Moving Observations – During a period of light winds the boat was allowed to drift or gently paddled along the axis of the East Dike from north to south while two observers looked into the water, one with the Plexiglas viewer and the other with polarizing sunglasses. The location and number of fish observed, if any, were recorded to qualitatively determine presence and utilization by fish.

2.5. Quality Assurance / Quality Control

The objective of quality assurance and quality control (QA/QC) data is to assure that chemical and biological data collected are representative of the material or populations being sampled, are of known quality, are properly documented, and are scientifically defensible. Data quality was assured throughout the collection and analysis of samples using specified standardized procedures, by the employment of laboratories that have been certified for all applicable methods, and by staffing the program with experienced technicians and biologists.

Laboratory QA/QC – Data Quality Objectives (DQOs) are numerically definable measures of analytical precision and completeness. Analytical precision is a measurement of the variability associated with duplicate analyses of the same sample in the laboratory. Completeness for this study is defined as the percentage of valid analytical results. Results that were made uncertain due to missed hold times, improper calibration, contamination of analytical blanks, or poor calibration verification results were deemed invalid.

Duplicate results were assessed using the relative percent difference (RPD) between measurements. The equation used to calculate a RPD is:

$$RPD = \frac{(A - B)}{((A + B)/2)} \times 100$$

where: A = analytical result; B = duplicate result.

The laboratory DQOs for this project were:

- Analytical Precision = 25% RPD for concentrations that exceed 10x the method detection limit (MDL).

- Completeness = 95% valid data obtained.

RPD values may be either positive or negative, and ideally should provide a mix of the two, clustered around zero. Consistently positive or negative values may indicate a bias. Large variations in RPD values are often observed between duplicate samples when the concentrations of analytes are very low and approaching the detection limit. The reason for this is apparent if one considers duplicate samples with concentrations of an analyte of 0.0005 and 0.0007 mg/L. In absolute terms, the concentration difference between the two is only 0.0002 mg/L, a very tiny amount; however, the RPD value is 33.3%. This may sometimes lead to a belief that the level of precision is less than it actually is.

Field and Laboratory QA/QC: Water Sampling – Field QA/QC standards during water sampling were maintained for every sample. For example, only clean sampling equipment including silicon tubing and plastic connectors were used to collect water samples. Standard QA/QC procedures included thoroughly flushing the flexible tubing and pump to prevent cross-contamination between stations and thoroughly rinsing the sample containers with site water prior to sample collection. Distilled water was used to run through the equipment and analyzed for a suite of metals.

A field duplicate was collected at station PW-4 to assess sampling variability and sample homogeneity; a RPD of 50% for concentrations that exceed 10x the MDL is considered acceptable. Laboratory replicates were randomly chosen for certain parameters. Data quality objectives (DQO) for replicates should be within ± 25% of the first count (i.e., the RPD).

Laboratory QA/QC: Biota Sampling – Standard procedures were used to collect periphyton samples. Sampling gear was thoroughly rinsed between sampling stations to ensure that there was no inadvertent introduction of biota tissue from one station to another.

Laboratory replicate counts (density and biomass) for periphyton were performed on ~10% of all samples and were chosen at random. Data quality objectives (DQO) for replicates should be within ± 25% of the first count (i.e., the RPD).

3. RESULTS AND DISCUSSION

3.1. Quality Assurance / Quality Control

QA/QC procedures consisted of a combination of careful field collection and sample handling, the collection of field duplicate samples and the analysis of laboratory replicates and standard reference materials. Results of the QA/QC analyses are presented in **Tables 3 and 4**, for pore water and quantitative periphyton sampling, respectively.

3.1.1. Interstitial Water

ALS Environmental is an analytical laboratory accredited by the Canadian Association of Environmental Analytical Laboratories. This accreditation ensures that laboratories achieve and demonstrate the highest levels of technical and management excellence for their services. Laboratory QA/QC procedures performed on the pore water samples met all of the laboratory's internal data quality objectives for precision and completeness defined for this project.

A single field duplicate water sample was collected from a random station on a different day during the dike pore water sampling event. The results of the RPD analysis (for conventional parameters, anions and nutrients, organic parameters and total metals; **Table 3**) revealed that field duplicate results were very consistent with the original sample, with the exception of turbidity, which exceeded the DQO of 50%. The result for turbidity is not surprising considering that the samples were collected from within the interstitial spaces between the rocks along the East Dike face. Despite efforts to minimize sediment introduction, it was nearly impossible to avoid re-suspending sediments within the pore spaces (e.g., by contacting the rocks with the sampling device). Given the focus on dissolved metals, the observed turbidity value difference does not affect the interpretation of the results. Furthermore, despite the above, these overall results suggest that the field collection method provided reliable results that could be replicated.

Laboratory duplicates were performed on randomly chosen samples for select parameters. None of the RPD's for the laboratory duplicates exceeded the DQO of 25%.

Finally, parameters analyzed in the equipment blanks were all below detection limits, with the exception of turbidity, which was detected at 0.32 NTU. Technically, no parameter measured in an equipment blank should exceed detection. Possible sources of the turbidity are: (1) impurities in the laboratory-supplied distilled water, (2) introduction of materials from within the pump or the pumping process, and (3) cross-contamination from previously sampled water remaining inside the pump. The latter two are unlikely in that the pump is thoroughly rinsed between sampling events and with distilled water prior to collecting the equipment blank (i.e., cross-contamination is unlikely). Furthermore, turbidity would not be an expected "introduced" parameter if the pump itself was a

source (i.e., metals would be more expected). This was discussed with the laboratory and a reason for this exceedence was not apparent. Notwithstanding, even with the "addition" of small levels of turbidity alone (i.e., since no other parameters were detected) to existing samples, the interpretation of the results would not be affected. Consequently, the data meet the QA/QC data quality objectives for the project.

3.1.2. Quantitative Periphyton

Quantitative periphyton samples collected from prescribed areas of rock surface were quantified by biomass (µg/cm^2) and density (cells/cm^2). Randomly chosen laboratory duplicates were run on 10% of the samples (n = 2). There were numerous exceedences of the RPD's (DQO <25%) for the laboratory duplicates (**Table 4**). Most high RPD values were associated with taxa groups that represented a minority of the community. Furthermore, periphyton communities within the project lakes are known to be quite variable. Overall, while certain elements of the community may be variable, RPDs for total biomass, total density, species richness, and Simpson's diversity were all well within the range of acceptability.

3.2. Interstitial (Pore) Water Quality

This component was included in the HCMP (Azimuth, 2008a) to address a concern raised during the environmental assessment process regarding the potential for metals to leach from the dike construction material. Interstitial water quality has the potential to be affected depending on the rock type used.

Three main types of rock make up local geology, including iron formation (IF), ultramafic (UM) and intermediate volcanic (IV). Different rock types were proposed to construct specific parts of the HCFs. IF rock is potentially acid generating in oxygen-rich environments (e.g., in air), but has very low metals leaching underwater. According to the NNLP (Azimuth, 2006), this rock was to be used for all HCFs at water depths greater than 1 m. UM rock is not potentially acid generating, but may leach some arsenic when in contact with water and was to be used to cap all dikes and extend down the faces to a depth of 1 m below the baseline lake elevation. IV rock has the potential to be acid generating and was not to be used as cap material where it might come into contact with air and water.

Constructing the East Dike according to design criteria required the use of appropriate rock types for core and cap material, slope, stability, and sizing. Golder (2008) prepared preliminary design plans, profiles, sections, technical specifications and construction quantities for implementation of these works. However, in the Golder (December 2009) report 'East Dike Construction As-Built Report, Meadowbank Gold Project Nunavut' there is no information regarding whether design specifications were followed. Although

a mixture of rock types was used to construct the dike, there is no information on rock type used to construct core and cap material. The report stated that 'rock fill materials for East Dike construction were geochemically classified as non-potentially acid generating supplied by AEM from on-site'. There is no further information available that describes rock types and sizes or whether other design specifications were adhered to. Lack of this information may constrain our ability to fully interpret the meaning of some Tier 1 components such as dike interstitial water chemistry or periphyton growth.

Assuming that the above measures were followed, modeling conducted during the environmental impact assessment stage (summarized in Golder, 2007) predicted that post-construction interstitial water quality would generally meet Canadian Council of Ministers of the Environment (CCME, 2007) guidelines for the protection of aquatic life. In general, the modeling showed that water quality at the dike faces is expected to be similar to that of lake water, the only possible exceptions identified were fluoride in IF rock and aluminum in IV rock. Thus, in addition to meeting physical design specifications, acceptable water quality is essential if HCFs are to function as intended.

3.2.1. Conventional Parameters and Nutrients

Results of water samples collected from interstitial spaces of the East Dike face HCF on August 6 and 10, 2009 are presented in **Table 5** (raw data are in **Appendix F**). Water was collected from within dike pore spaces from at least 2 m water depth below the freezing depth and within the depth zone where fish eggs might be deposited. Because it was our understanding that dike construction materials were not stratified by rock type (i.e., IV, IF or UM) according to water depth, there was no requirement for stratifying water sampling collection in the 0-2 m and >2 m range. A series of photographs (**Appendix B**) depict the water sampling procedure. Despite the care in sampling, turbidity and total suspended solids (TSS), concentrations in the samples were higher than desired, ranging from 1.8 – 29 NTU and 3.9 to 56 mg/L, respectively. It is likely that sediment generated during dike construction settled within the pore spaces of the East Dike became entrained into the water sample during the sampling process. Based on patterns observed during dike construction monitoring (Azimuth, 2009; 2010a), elevated TSS contributes to higher total metals concentrations. This is supported by the dissolved metals results, which were below detection limits for nearly all metals at all locations. This suggests that exceedences for total metals were likely due to suspended sediment particles entrained from off of the rock surfaces during the sampling process and was not caused by metals dissolved from the dike material itself. This is discussed in more detail below.

Interstitial pore water pH ranged from 6.42 (PW-1) to 6.92 (PW-4), which is similar to the range in pH from 2009 water samples collected during the CREMP program (pH 6.7 – 7.0). These results indicate that pore water pH is no more acidic than lake water and is within the range that is safe for incubating fish eggs and other biota. Conductivity was

slightly higher (22.9 – 30.7 µS/cm) within the East Dike than in open water at CREMP stations in August 2009 (13.7 – 21.8 µS/cm) and is a reflection of the greater amount of solids in the water sample than open water.

TSS concentrations were high in interstitial water from all stations, especially PW-1 (56.1 mg/L). In fact, PW-1 was re-sampled because the first sample contained an excessive amount of sediment and was discarded. Sedimentation at the north end of the dike and along the lake shore near the dike appeared to be higher than elsewhere in the lake. This can also be seen from the underwater video imagery (Section 3.3). It is possible that wind-generated currents during future open water seasons may re-suspend sediment that has settled on rock surfaces and transport it to depositional areas.

Some nutrient concentrations were either below laboratory detection limits, or, if some parameters exceeded MDLs, they were similar to or only slightly higher than the values for the CREMP sampling location SP7-S collected in August 2009 (**Table 5**). Similar to the results for dike construction monitoring in 2009 (Azimuth, 2010a), nitrate, TKN and total phosphorus were elevated at stations with high TSS. While nitrate (and nitrite) concentrations were well below CCME guidelines, total phosphorus did exceed the trigger for ultra-oligotrophic lakes (i.e., 0.004 mg/L). However, given that (1) orthophosphate (i.e., the form of phosphorus directly used by aquatic biota) concentrations were all less than the MDL, (2) total phosphorus only exceeded the CCME trigger value in two of five locations along the dike, (3) those two samples also had high TSS, and (4) that phosphate-rich rocks are an important source of phosphorus, it is likely that the total phosphorus measurements are related to sediment inputs and overestimate bioavailable phosphate across the dike face.

Dissolved organic carbon (DOC) concentration and total dissolved carbon were fairly consistent among all stations with the exception of station PW-1, which had a slightly elevated DOC (3.3 mg/L) relative to the CREMP station (1.6 mg/L) in August.

3.2.2. Metals

Of the 29 metals for which total metals analysis was conducted, all but five were consistently near or below MDLs (**Table 5**). The exceptions were for total aluminum, chromium, copper, iron and lead, which all exceeded CCME (2007) guidelines for the protection of aquatic life at one or more stations. Similar to the results of dike construction monitoring water quality (Azimuth, 2010a), the elevated total metals appear to be associated with elevated TSS. For example, all five metals exceeded guideline concentrations at PW-1, while no metals exceeded the guidelines at PW-3. At PW-2, PW-4 and PW-5, aluminum, chromium and iron (except PW-2) were all in exceedence of CCME guidelines. PW-3 had a low TSS concentration (3.9 mg/L) relative to the other stations, which likely explains why there were no exceedences.

Dissolved metals were below detection limits for all metals, except the common elements aluminum, calcium, copper (PW-1 and PW-4 only) magnesium, manganese and zinc (PW-1 and PW-2 only). Aluminum was the only metal to exceed the CCME guideline 0.005 mg/L) concentrations at PW-1 (0.109 mg/L). This was due to the pH at this location being 6.48. At pH 6.5 the guideline concentration, which is pH dependent, increases to 0.10 mg/L, which is only slightly less than the PW-1 concentration.

These data indicate that water quality within the dike face pore spaces is generally of good quality. Exceedences of CCME guidelines for a small number of total metals are due to the influence of suspended solids that were introduced into the sample from sediment that had settled into the pore spaces during dike construction. Because dissolved metals concentrations were very low, despite the high TSS concentrations and in some cases, elevated total metals concentrations, this indicates that the metals are particulate-bound and did not dissolve out of the rock used to construct the dike. Sampling will be conducted in 2010 to confirm results from 2009 monitoring. At this point, we would conclude that Tier 2 monitoring (e.g., toxicity testing) is not warranted, but additional sampling is required to provide additional data in order to make more definitive statements regarding interstitial dike water quality.

3.3. Qualitative Periphyton Assessment

Underwater video was used to qualitatively describe the periphyton community on the East Dike face substrate relative to that in HVH areas of Second Portage Lake and Third Portage Lake. Video captures (i.e., still photos "captured" from the video) were used to identify key features of the periphyton communities (**Appendix C**). **Table 6** provides a description of the site, depth, substrate composition, and the density and description of periphyton coverage.

Overall, periphyton coverage of HVH substrates did not appear to differ between Second and Third Portage lakes, with about 70% to 100% coverage of rock surfaces that could be observed from the video. Ice scour and erosion of periphyton was evident at a few locations where rocks were shallow and exposed to ice scour from wind-driven currents. Periphyton at HVH1 and HVH2 locations nearest to the dike appeared to be slightly impaired, with evidence of settled sediment on upward facing surfaces of large substrate. Smothering has slightly compressed periphyton fronds so they appear flattened (**Appendix B**). This was also particularly true for shallow substrates (~2 m depth) adjacent to and within one or two hundred meters of the East Dike. Otherwise, there did not appear to be an apparent diminishment of periphyton abundance in HVH areas as a result sediment from East Dike construction. Periphyton coverage in Third Portage Lake and most HVH locations in Second Portage Lake appeared relatively dense, luxurious and healthy.

By contrast, and as expected, there were stark differences when comparing the appearance of periphyton communities on East Dike habitat (i.e., on blasted construction material) and periphyton coverage on HVH habitats in either Second or Third Portage lakes. There was little visible evidence of colonization by periphyton on the construction material that composed the East Dike (although we know from the quantitative periphyton results that colonization has started; see **Section 3.4**). Detailed descriptions of the results of each of the three areas (East Dike, Second Portage Lake HVH and Third Portage Lake HVH) are provided in the following sections.

3.3.1. East Dike

Video footage of both natural and construction substrate of the East Dike was captured using the underwater camera and representative features are presented in video capture screens (**Appendix C Photos C-1 to C-7**).

East Dike construction material can be described as large angular boulders stacked upon one another, generally appearing perched and precarious (**Photo C-1, C-2**), with jagged cobble dispersed among and beneath the boulders (**Table 6**). The dike was constructed on top of natural boulder substrates, especially in shallow water along most of the length of the dike (i.e., in depths of < 6m). At depths deeper than ~6 m the dike face sloped and intersected with fine silt/clay sediments on the bottom. Even in shallow water however, fines were observed below and/or adjacent to the boulder and cobble. While construction of the East Dike was the direct cause of the 2008 TSS event, settled sediment was not evident on the surfaces of the shallow, newly constructed dike structure materials. This may be due to the steep slope on most of the construction substrate and shallow depth, where wave action will clean the substrate. However, dike interstitial water quality results indicate that sediment had, in the short-term, likely settled into the spaces between the rocks.

The video footage (and "captured" photos) showed no evidence of periphyton colonization of East Dike face substrate, although at times it was difficult to determine fine-scale substrate surface characteristics. In contrast, the periphyton community was easily seen in footage of natural substrates in close proximity to the dike, particularly in shallow areas (e.g., the northern section of the East Dike). Note that dike material in these shallow areas was sampled directly for periphyton using quantitative methods (see **Section 3.4** for results). The following descriptions of periphyton communities on these natural substrates is provided to give insights into the general conditions in close proximity to the East Dike, particularly in relation to construction-related sedimentation in 2008. In shallow areas adjacent to the dike, boulders tended to be smooth, rounded and covered in a thick layer of sediment (**Photo C-3 to C-7**). Flat surfaces with little or no slope appeared to have more sediment and in some cases gravel debris, making it difficult to determine what might be growing on these surfaces. Given the smooth appearance on

most of the sediment covered tops of boulder and cobble, it is unlikely that any periphyton was underneath the sediment as periphyton fronds would create a textured surface. The sides of boulders usually had moderately to highly dense periphyton mats because they resisted sedimentation. Fronds were raised, but sometimes covered with sediment (**Photo C-5, C-6**), giving it a grey colour. In some areas periphyton mats on natural substrate had suffered obvious physical damage (**Photo C-7**). This may have been due to ice scour (i.e., at depths less than 2 m).

3.3.2. Second Portage Lake HVH Habitat

Underwater video footage was taken at six HVH habitat locations in Second Portage (2PL) Lake (video frame captures of representative features are shown in **Appendix C** (**photos C-8** to **C-11**). Substrate at 2PL HVH stations was consisted primarily of boulder, with cobble and some fines. All substrate types had high percentage periphyton cover (70-100 %) and showed some evidence of fine sediment accumulation (**Photo C-8**). Periphyton mats were generally more luxuriant and thicker in shallow water (**Photo C-9**, 1 m depth) than at depth (>2 m) (**Table 6**). There was evidence of ice scour at more than half of the stations as periphyton mats were patchy, especially on large boulders in shallow water (**Photo C-10**). At depth, periphyton mats were continuous, but generally not as dense. The HVH station closest to the East Dike (HVH1) had high periphyton coverage on all substrates, but had a grayish brown colour due to a thin layer of sediment covering all flat surfaces. The next closest stations to the East Dike (HVH2 and HVH3) also had some settled sediment, but it was observed only on flat surfaces (**Photo C-11**). At these stations, periphyton mats were generally green and appeared in good health, as was periphyton at the remaining 2PL HVH stations further afield (**Table 6**).

3.3.3. Third Portage Lake HVH Habitat

Third Portage Lake (3PL) HVH habitat underwater video footage was taken as part of the 'before dike construction' monitoring database, and to provide perspective and reference on typical periphyton coverage in the project lakes. This imagery also provides a qualitative point of comparison for the assessment of the possible effects of sedimentation on periphyton communities in Second Portage Lake (discussed in greater detail in Azimuth, 2010b). Substrate features in HVH areas in Third Portage Lake were very similar to Second Portage Lake, being dominated by large boulders with some large cobble interspersed throughout (**Table 6**). At HVH2 and HVH3, boulder was the exclusive substrate because of shallow depth, while at the other HVH stations in Third Portage Lake, boulders dominated the substrate, but cobble and fines comprised a portion of the material. Generally, periphyton could be seen covering all substrates, including a layer on cobble/gravel at depths of 4 – 5 m (**Photos C-12 and C-16**) as well as on boulders (**Photos C-13 to C-15**). Periphyton was vibrant green in colour, luxuriant, had

excellent density or coverage (>70%) with raised fronds, especially on sloped surfaces. At some stations, mats were more continuous and dense at depth (**Photo C-12**) than at the surface. This may be due to ice scour at shallow depth and was evident on large boulders with periphyton bald patches (**Photo C-17**).

3.3.4. Overall Qualitative Periphyton Assessment

Periphyton coverage in Second and Third Portage lakes appeared relatively dense, luxurious and healthy based on underwater video and still camera imagery. Substrate at HVH locations at depths shallower than about 3 m was dominated by large boulder and cobble that provides an excellent surface for periphyton growth. At depths greater than 3 m, there was a transition to smaller substrate materials and periphyton growth became less abundant and luxurious. Ice scour and erosion of periphyton was evident at a few locations where rocks were shallow (less than 2 m) and exposed to ice scour from wind-driven currents.

In Second Portage Lake, periphyton at HVH locations, particularly those within several hundred metres of the East Dike, appeared somewhat impaired by settled sediment, presumably from dike construction in 2008. Upward facing surfaces of large substrate had accumulated sediment that had smothered and compressed periphyton so that fronds appeared less luxuriant and had a brown colour, not green. HVH areas further east showed less signs of sediment accumulation and correspondingly healthier appearing periphyton mats. As expected, no such spatial differences were observed in Third Portage Lake in 2008.

It was very difficult to determine from the videos if there was any periphyton growth on the new material used to construct the East Dike itself. At most, a hint of periphyton growth (10%) may have been evident on some rocks (**Table 6**). Again, this result is not surprising because the substrate has only recently been deposited into the lake and a small amount of periphyton growth was expected during the first summer post-construction. Quantitative sampling (see **Section 3.4**) did reveal that a periphyton community was in fact becoming established on the rocks, but was not sufficiently dense or abundant that it could be detected from underwater video. Overall these results indicate that periphyton growth in Second and Third Portage lakes is abundant and healthy, with the exception of shallow habitats in close proximity to the East Dike.

3.4. Quantitative Periphyton Assessment

Periphyton community structure was characterized throughout the project lakes as part of the Core Receiving Environment Monitoring Program. One of the primary reasons to conduct that sampling was to provide baseline information with which to compare periphyton community development on dike faces, finger dikes and other HCFs.

Periphyton density is subject to great natural variability due to differences in sun exposure and aspect (i.e., angle towards the sun), nutrient availability, water depth and clarity, and grazing by invertebrates and fish. Although an effort was made to select rocks with similar characteristics (e.g., depths, aspects and coverage by periphyton), this was achieved to varying degrees at each station. Furthermore, while "flat", "smooth" rocks were targeted, it was impossible to achieve total uniformity within and among stations. Indeed, these challenges are often raised as reasons not to use periphyton in long-term monitoring programs. Because of the large natural variation, it is very difficult to discern between natural changes, sampling bias and real effects. Consequently, while results are presented in absolute terms of density or biomass, the relative composition of the periphyton community is probably the most robust metric to characterize results.

Periphyton density (cells/cm^2; **Table 8**) and biomass (µg/cm^2; **Table 7**) were measured from four sampling areas (5 replicate samples per area) in Second Portage Lake (**Figure 2**):

- SP-ED - the East Dike face (dike construction material sampled)
- SP-BL - a near-field area 200 m east of the East Dike along the north shoreline (natural substrates sampled)
- SP-CREMP - a far-field area 1.9 km from the East Dike, where the previous CREMP sampling was also conducted (natural substrates sampled)
- SP-DT - a reference area in the Drilltrail Arm of Second Portage Lake (natural substrates sampled)

Samples were collected in late August near the height of the growing season. It was anticipated that SP-ED would have a relatively depauparate periphyton community, both in terms of density and biomass, given the age of the East Dike HCF. Furthermore, the proximity of SP-BL to the 2008 construction zone suggested potentially high exposure to suspended and settling sediments. SP-CREMP would have had some exposure to suspended sediments in 2008, but the magnitude would have been much lower than at SP-BL. SP-DT is located in Drilltrail Arm, an area of Second Portage Lake that receives sufficient water inputs from the Drilltrail/Wally Lake watershed and was not subject to elevated TSS concentrations in 2008.

A total of 67 periphyton genera/species were identified across the four sampling areas; a matrix of the periphyton species presence/absence at each sampling area (by replicate) is presented in **Appendix E**.

Overall, the periphyton community was co-dominated by Cyanophytes (12 genera) and Diatoms (44 genera), making up 39.5% and 40% of the total overall biomass, respectively (**Table 7**). The dominant species/genera of Cyanophytes were *Lyngbya*

mucicola Lemmermann, *Pseudoanabaena* sp., *Rivularia dura* Roth and *Gloeothece* having the greatest biomass, and the dominant species of Diatoms were *Achnanthes minutissima (*Kutzing), *Tabellaria flocculosa* (Roth) *Cymbella microcephala (*Grunow), *Fragilaria capucina (*Grunow), *Nitzschia palea* (Kutzing) and *Anomoenies vitrea* (Ross). Green algae (Chlorophytes) made up most of the remaining community biomass at 20% (10 genera), with the genera *Mougeotia*, and *Bulbochaete* contributed the most biomass. In most cases, one or two periphyton species dominated a given sampling area, contributing a majority of the biomass and limiting the contribution of less competitive species. This is not uncommon in harsh Arctic environments. A brief description of some of the dominant periphyton species follows.

- *Lyngbya* is one of the most common Cyanophyte genera, found in periphyton and metaphyton assemblages in a variety of freshwater environments (Anagnostidis and Komárek, 1988). This species was present at all of the sampling areas in 2009 and often dominated or co-dominated the assemblage.
- The Cyanophyte genera *Petalonema* and *Rivularia* were present in all of the samples taken at areas SP-DT and SP-CREMP, but were absent at area SP-ED and only in two samples at area SP-BL. These are species that prefer submerged habitats on calcareous substrata within the splash zone (water surface to 0.7 m). Given that area SP-BL may have been heavily disturbed during construction events of 2008 and that area SP-ED was just constructed, these habitats may have been unfavorable for this species. This species forms large attached colonies that are capable of fixing atmospheric nitrogen. Bergmann and Welch (1990) documented 16% of the annual nitrogen budget of a small lake in the Saqvaqjuac region (Chesterfield Inlet) was via nitrogen fixation by the natural periphyton community. In addition, these species have been documented to occur in extreme environments such as coastal lakes in the eastern Arctic (Komarek et al., 2002) and Antarctica (Vincent, 2000).
- The diatoms *Tabellaria* and *Cyclotella* are cosmopolitan genera that have been documented in northern temperate lakes (Findlay et al., 1999), Arctic lakes (Welch et al., 1989) as well as in several paleolimnological studies covering areas of the Arctic (Lim et al., 2001; Michelutti et al., 2003). Ecologically, *Tabellaria* prefers lakes and ponds that are oligo-mesotrophic, attached to rocks in shallow water (Patrick and Reimer, 1966). However, it does occur in planktonic (free swimming) form. *Cyclotella bodanica* is widely distributed, and generally occurs in oligotrophic lakes with a preference towards circum-neutral environments (pH >7.1).
- The green algae *Mougeotia* sp. is a true benthic genus with numerous species. This organism has a wide ecological distribution, occurring in extreme conditions such as low pH, excessive nutrients and arctic lakes with shortened growing seasons. These species occur in a broad spectrum of lake trophic levels from oligotrophic to eutrophic (Prescott, 1962). This species was not found at SP-ED.

The only other major periphyton group detected in periphyton samples was Chrysophytes, but these were found only in one sample at one area. Interestingly, this area was at the East Dike (SP-ED), the area with the least periphyton density and biomass.

Total periphyton biomass at SP-BL was 201 µg/cm^2, while at SP-CREMP and SP-DT it was 549 µg/cm^2 and 438 µg/cm^2, respectively (**Table 7, Figure 4**). As expected, periphyton biomass and density at SP-ED was very low in comparison to other sampling locations, totaling just 23 µg/cm^2 and 80,207 cells/cm^2. Biomass of Cyanophytes and Chlorophytes at SP-CREMP and SP-DT were considerably higher than at SP-BL while biomass of diatoms was similar among stations. Chlorophytes seemed to be particularly impaired closer to the dike, as mean biomass was at least ten-fold higher at SP-CREMP and SP-DT than at SP-BL (**Figure 4**).

Despite the large differences in periphyton biomass between SP-BL and the other areas, periphyton cell density at SP-BL was similar to that at SP-CREMP and SP-DT (**Table 8**). Differences in biomass were driven primarily by lesser biomass of Chlorophytes and Cyanophytes. When comparing biomass (**Table 7**) and density (**Table 8**) for each major group, it is apparent that there is no relationship between cell density and biomass. This is because although some cells of certain taxa may be very numerous, depending on the taxa, they contribute very little to biomass. Thus, the similarities in cell density between the different locations, despite large biomass differences, are driven by individual taxa within each group, the proportions of which differ between areas (**Appendix E**). This is why biomass is a much more important metric than cell density because ultimately, biomass is a greater contributor to productivity at the base of the food web and ecologically is much more important metric.

Periphyton Text Box

There is an apparent conundrum when comparing mean cell density and biomass, as there is no apparent relationship between these two metrics. This is because certain taxa, although very numerous, may be very small and contribute little to biomass. Conversely, some taxa may be low in abundance but are relatively large and contribute disproportionately to biomass. Specific taxa may be present or absent from particular stations. The taxa responsible for the differences here are being investigated by our taxonomist and results are pending.

The mean biomass recorded at SP-BL was the lowest biomass recorded in Second Portage Lake during previous CREMP (Azimuth, 2008b; 2009) and baseline sampling (Azimuth, 2005b). The mean total periphyton biomass (µg/cm^2) at SP-CREMP was comparable to data from previous CREMP programs (Azimuth, 2009) (**Figure 4**).

Periphyton species richness ranged from 12 (SP-ED) to 20 (SP-CREMP, SP-DT) species per sample, with an overall average of 17 (**Table 7**). Richness was lower at the East Dike (15 species) relative to the other locations (17 – 19), which was not surprising given the

low density and biomass. Species diversity was less variable, with a Simpson's diversity index ranging from 0.62 to 0.86 (both values from samples taken at area SP-ED), with an average of 0.74 (**Table 7**). Simpson's diversity did not differ among locations.

Ultimately, algal growth is driven by nutrient concentrations (carbon, nitrogen and phosphorus) and light. In the case of the Meadowbank project lakes in general, including Second Portage Lake, nutrients are extremely low and one would expect algal growth to be very slow. In nutrient poor lakes of northwestern Ontario, Findlay et al. (2009) used ceramic tiles to assess the effects of an aquaculture cage operation on epilithic growth. Tiles were placed on floating trays in experimental and reference lakes with total phosphorus concentrations approximately 2.5 times higher than typical in Second Portage Lake. Findlay et al. (2009) observed an average growth rate of less than 4.3µg cm/day. In other lakes, following recovery of an acidification event, colonization of rock substrate by periphyton was relatively quick (~ 3 yrs) (Turner et al., 2009). In another study, Turner et al. (2005) discussed the ramifications of lake level draw-down on the epilithic community is a small boreal shield lake. Lake level was allowed to drop by 2-3 m over the winter and allowed to refill during the open-water season for 3 consecutive years. No long-term effect on the epilithic community was observed as periphyton simply re-colonized the new littoral zone.

The periphyton community along the East Dike was reasonably diverse, considering the low biomass and the brief time that the dike material has been in the water. There were differences in dominant species between the East Dike face and the other locations which may be attributable to the rock substrate itself, or to competition for the new habitat by early colonizing species. Based on the literature, epilithic communities in varying locals and nutrient regimes are extremely resilient and it is plausible that the epilithic community could fully colonize (i.e., comparable to baseline in terms of composition, density and biomass) the new barren rock surfaces of the East Dike face HCF in as few as 3 to 5 years.

3.5. Fish Use

3.5.1. Hydroacoustic Assessment

Hydroacoustic surveys in the project lakes consisted of linear transects, focused area transects and random, lake-wide transects. These surveys were designed to detect presence of fish along the East Dike relative to high value habitat elsewhere in Second Portage Lake. Linear hydroacoustic transects were carried out parallel to the East Dike to evaluate relative fish density based on return signals. Reference areas targeted high value habitats in Second Portage Lake near high value habitats HVH2, HVH4, HVH5 and HVH6 (**Figure 3**).

Results of the linear transects (**Table 9**) detected only two small fish during September 9 and 10 – one over the East Dike and another at HVH5. The total effort was marginally higher at reference areas than along the East Dike. However, too few fish were detected to make any statement regarding habitat utilization from linear transects. This speaks more to the paucity of fish in the lakes than the extent of habitat utilization. As discussed earlier a drawback to hydroacoustic surveys is that it is difficult to detect fish in shallow water that may stick close to the bottom or leave the area or hide due to boat noise or shadows.

Focused area surveys supplemented transect data and were conducted in the same areas by randomly motoring for 15 minute blocks later in the month (September 21 and 22). These surveys were also conducted at a slower speed and over a wider depth range (than the linear transects) to determine presence of fish in the vicinity of high value habitats. Using this method we detected more fish and had catch-per-unit-effort results. Five fish were detected along the face of the East Dike (**Table 10**) compared to one fish from HVH6, 10 fish from HVH5, four from HVH4 and 10 fish from HVH2 (**Figure 3**). All of the fish detected at the East Dike were near the dike face, indicating that there may some use of the dike face. However, the vast majority of fish detected using this method were found in deeper water, typically greater than 10 m and away from hard substrates. Again, it may be easier to detect fish in deeper water than in shallow water near hard, rocky surfaces where it is difficult to distinguish fish if they are staying close to the bottom. Although CPUE data are presented, given that most fish were detected away from high value habitat in deeper water, there is no correlation between this statistic and proximity or association with HVH habitats or utilization of the East Dike by fish.

Relatively few fish were detected using a fish-finding depth sounder during linear and focused surveys and suggested that this method of detection may not be useful for long-term monitoring because of the ‘snapshot’ in time the survey necessarily has, difficulty in detecting fish in shallow water, possible disturbance of fish by boat noise and shadow and the general paucity of fish in the project lakes.

In an attempt to determine the relative abundance of fish in Second Portage Lake the depth sounder was used over several one hour random or non-directional lake-wide surveys. Although no firm records were kept, approximately 40 fish were detected with no apparent spatial pattern with two exceptions – a group of about 10 small fish was detected near the outlet to Tehek Lake (near the bottom, in 2 to 3 m of water), and a group of about 5 medium-sized fish was detected just south of the HVH-2/4 area (at about 8 m depth. Small and large fish were also detected near the East Dike.

During both the focused area and random lake-wide surveys, we noticed that most fish detected were in deeper waters rather than the 3-6m range we expected to find them in and targeted by transects. This may reflect true fish distribution (i.e., preferential use of

deeper water, and innate differences between the East Dike face and other parts of the lake) and/or it may be a result of disturbance by fish in shallow water by boat noise. True fish density is unlikely to be captured by hydroacoustic surveys in relatively shallow water, for at least two reasons. First, the sound of the engine or the shadow created by the boat may cause fish to flee before they are detected. Second, noise in the data output (associated with engine vibration) makes it difficult to detect fish in shallow water, near to boulder substrate where fish may hide and be undetected.

Overall, results of all three methods indicate that fish are found along the East Dike face, and that fish density was not less than in reference, high value habitat areas elsewhere in Second Portage Lake.

3.5.2. Gill Netting and Minnow Traps

Minnow traps (n=34) set at various locations (**Figure 3**) and depths along the East Dike and HVH locations between August 25 – 31 and September 3 – 10, respectively did not capture any fish, despite baiting of most traps. This result was not unexpected given that CPUE of minnow traps during historic fisheries surveys was virtually nil. The absence of fish captured by minnow traps along the East Dike and elsewhere in the lake says nothing about habitat utilization. This result is also consistent with unsuccessful attempts to minnow trap at other areas such as Diavik (McEachern et al., unpublished).

Gill nets were much more effective than other methods used in 2009 to quantitatively assess presence and relative abundance of fish in the immediate vicinity of the East Dike relative to habitat elsewhere in Second Portage Lake. Gill nets are very effective at capturing fish because they can be left in the water for an extended period of time and over time are a better reflection of fish presence and habitat utilization over time. Nets set perpendicular to and horizontal with shallow rocky habitats between August 14 and 23 along the East Dike and HVH locations (**Figure 3**) were effective at capturing fish (**Table 11**).

There were several inherent difficulties however. Because the East Dike is situated in relatively shallow water with very steep sides, the surface area of the dike is relatively small, making it difficult to situate nets directly over the new habitat. Gill nets set perpendicular to the dike extended into deeper, natural substrates. Nets set parallel to the dike had to be set near the middle of the dike where water depth was deeper than 3 or 4 m so that the nets were fully submerged along their length; while this fully targets dike face habitat, this set configuration is not typically conducive to catching fish moving parallel to shore, which is a common pattern of fish movement. We also noticed a difference in the effectiveness of mesh size. One-half inch and ¾ inch mesh was not as effective at capturing fish in 1.5 or three inch mesh (**Table 11**). Although we set nets primarily during the daytime, a few nighttime sets were made to verify presence of fish. Previous

gill netting efforts have always showed that catch is greater at night because fish can see and avoid the nets in the daytime.

Gill netting along the East Dike and near HVH 3 on August 14 using small mesh (½ and ¾ inch) net set for short durations (<4 hours) was unsuccessful. Gill nets were set again on August 17 during both daytime and overnight and included 1.5 inch and 3 inch panels to verify that fish whether fish were present in both areas. Seventeen fish were captured, only three in the ½ and ¾ panels while the remainder were captured in the larger mesh nets, possibly because this mesh size is more difficult to see. Only two fish were captured from the reference area with 15 captured on the East Dike consisting of four Arctic char and 11 lake trout of moderate size (~450 mm).

CPUE was considerably higher at the East Dike (CPUE = 28.5; n=15) than at the HVH locations (CPUE = 4.6; n=9) (**Table 11**). This result was unexpected given that the East Dike is a relatively new feature that has not likely yet been colonized by insects and there might be little to motivate fish to utilize the area. Given the reconnaissance nature of this effort, these results should be interpreted with some caution as the number of gill net sets was relatively small and occurred over short duration of a few days. Nevertheless, results of the gill netting effort clearly showed that fish were certainly not avoiding the dike area as they were captured along the dike face, especially near the middle and south ends of the dike, which is situated in deeper water than the north end. Furthermore, lake trout (6), Arctic char (9) and round whitefish (14) were captured along the East Dike, while only 4 lake trout were captured elsewhere in HVH locations. All of the fish captured were relatively large with no char under 166 mm or trout smaller than 323 mm captured, despite the use of small mesh sizes (**Table 12**).

3.5.3. Visual Observations

Despite numerous attempts to observe fish in the water column along the East Dike and adjacent to other high value habitats, either by standing or lying still on shore, while drifting or slow motoring from a boat using polarized glasses or viewing through a partially submerged Plexiglas box, no fish were observed. After several attempts to detect fish in this manner this method was abandoned.

4. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

As specified by DFO's *Fisheries Act* Authorization (NU-03-0191), long-term monitoring following the HCMP (Azimuth, 2008a) is required to document the functionality of habitat compensation features (HCFs) constructed to offset habitat losses associated with development of the Meadowbank Gold Project. The HCMP describes the physical and ecological monitoring requirements, the schedule for monitoring implementation (**Table 1**) and decision criteria for evaluating the success of HCF functionality. This report documents results of ecological monitoring of the East Dike HCF[2] during year C+1 monitoring.

The monitoring strategy of the HCMP (Azimuth, 2008a) follows a tiered framework consisting of quantitative and qualitative tools (**Figure 1**). The first tier focuses on identifying constraints to HCF functionality; higher tiers involve more specialized tools and are only triggered if the success criteria specified in the HCMP are not met. Tier 1 results for the East Dike HCF are briefly summarized below, along with key conclusions and recommendations.

Interstitial (Pore) Dike Water Quality

To address the issue of potential metal leaching from dike construction material as identified in the environmental assessment process, a suite of water quality parameters was analyzed in water collected from interstitial spaces between rocks along the East Dike face. Despite care during sampling some sediment was re-suspended from rock surfaces and entrained into the water sampler, resulting in elevated TSS concentrations. Several nutrients appeared to be associated with TSS (nitrate, TKN, total phosphorus), but only total phosphorus was elevated relative to a CCME trigger (n.b., there is no CCME guideline for total phosphorus) for ultra-oligotrophic waters. This is likely not an ecologically relevant issue given that rocks are an important source of phosphorus and that orthophosphate, the bioavailable form of phosphorus, was less than the detection limit. Follow-up monitoring in 2010 will confirm these results.

Consistent with the results of other programs (e.g., dike construction monitoring) for water samples with elevated TSS, total concentrations of some metals were also associated with TSS. Dissolved metals were rarely found to exceed detection limits or CCME guidelines. The only case was dissolved aluminum, which exceeded the CCME guideline for the protection of aquatic life at one location, primarily due to a marginally low pH (6.42) in that sample. The CCME guideline for aluminum is pH dependent and

[2] Monitoring under the HCMP was supposed to have started in the year of construction (i.e., year C) with an initial round of Tier 1 pore water sampling. This was attempted in 2008, but was unsuccessful due to thick ice along the East Dike face.

increases considerably from 0.005 mg/L to 0.1 mg/L at pH 6.5 (i.e., at higher pH values the higher aluminum guideline is used). Given that pH ranged from 6.85 to 6.92 in the other samples, this value may be anomalous.

The decision whether to escalate monitoring to Tier 2 will be made after reviewing the results of follow-up monitoring in 2010.

Periphyton Community

To verify that periphyton growth is not impaired by metals leaching from dike construction material, the HCMP includes periphyton community as a qualitative Tier 1 monitoring tool. Given the young age of the HCF, we do not expect a well developed periphyton community, but hoped to see the initial stages of colonization.

Periphyton community monitoring was conducted using different tools depending on whether dike face substrates were directly accessible. In deeper areas underwater video was used to qualitatively compare rock surfaces from the East Dike HCF with hard substrate at high-value habitats in Second and Third Portage lakes. In shallow zones were periphyton can be quantitatively sampled a specialized sampler was used to sample individual rocks for abundance (cells/cm^2) and biomass ($\mu g/cm^2$). East Dike results were compared to periphyton communities on natural substrates at three other areas in Second Portage Lake and to historical CREMP results.

Interpretation of the video footage on the dike face was confounded to some degree by the presence of settled sediment. Notwithstanding, no obvious signs of community development could be identified from video footage. Video from natural HVH areas revealed useful information regarding the community in those areas.

Quantitative periphyton sampling along the dike face on new material on the other hand, identified the presence of an early stage periphyton community. While community biomass at the East Dike HCF was low relative to other sampling areas, diversity was fairly high. There were some differences in community composition based on major taxa groups, with the newly colonized communities on the East Dike comprised primarily of diatoms. At this stage these differences are related to ecological succession and that over time the community should become similar to communities found on natural substrates. The pattern of change observed in subsequent monitoring events will determine how this is occurring or if any substrate-related impairment by colonizing periphyton.

Fish Use

HCFs were designed to provide habitat for spawning, egg incubation and nursery areas for lake trout, round whitefish and Arctic char. Recognizing the nutrient-limited status of the project lakes, the HCMP monitoring strategy for evaluating HCF function focuses on capability rather than actual use. Nevertheless, monitoring of fish use is a Tier 1 qualitative tool that provides information that is complementary to the other Tier 1 tools.

Due to the relatively low fish abundance in the project lakes, a variety of methods were used to monitor fish use of the East Dike HCF relative to other high-value habitats in Second Portage Lake. Furthermore, because some of these methods had never been used at the site before, an adaptive approach was used to test and assess a variety of ways in which they might yield useful data. Key results were:

- Hydroacoustic Surveys – Linear, focused area and random, lake-wide hydroacoustic surveys were used. Linear transects did not identify meaningful numbers of fish, regardless of where they were conducted. Focused area surveys were more effective and identified fish in close proximity to the East Dike, as well as in other HVH areas. Random surveys were meant simply to provide the monitoring team with information regarding fish use of Second Portage Lake in general. Unfortunately, this tool has limited capability to demonstrate fish use, especially in shallow waters because engine noise, shadow and the mere presence of the boat is likely to scare fish away from the sonar cone or into the rocks beneath the cone where they avoid detection.
- Minnow Traps and Gill Netting – Minnow traps (n=34) set at various locations and depths along the East Dike and HVH locations did not capture any fish. This result is consistent with previous attempts to capture fish using minnow traps and this technique should be abandoned. Gill nets were much more effective than other methods and provided better quantitative measures of fish utilization than hydroacoustics. Gill net catch-per-unit-effort (CPUE) was generally higher at the East Dike than at other HVH areas in Second Portage Lake.
- Visual Observations - Visual observations of fish presence along the East Dike and at various parts of Second Portage Lake were attempted both from shore and from a boat. No fish could be observed and this method too should be abandoned.

Overall, the hydroacoustic survey (focused area surveys) and gill netting results indicate that fish were present in and around the vicinity of the East Dike at densities or frequencies that were not lower than HVH habitats elsewhere in Second Portage Lake.

The following refinements are recommended for the next scheduled (i.e., year C+3 in 2011) monitoring event:

- Snorkel Surveys – the shallow, linear nature of the East Dike HCF make it a good candidate area for snorkeling.
- Electrofishing – this method was part of the HCMP, but was not conducted due to concerns regarding its lethality in water with very low conductivity. A SOP for similar lakes was developed for another northern mine (Dave Balint, pers. comm. 2010); this will be tested in 2010.

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TABLES

Table 1. Schedule for ecological monitoring of habitat compensation features, Meadowbank Gold Project (from HCMP, Azimuth 2008a).

HCF Types	Quantitative Tools			Qualitative Tools	
	Interstitial Water Quality (Tier 1)	Toxicity Testing (Tier 2)	*In situ* Biological Studies (Tier 3)	Periphyton Community (Tier 1)	Fish Use (Tier 1)
Dike Faces	C, C+1,+3,+5,+10	*	*	C+1,+3,+5,+10	C+1,+3,+5,+10
Finger Dikes	C, C+1,+3,+5,+10	*	*	C+1,+3,+5,+10	C+1,+3,+5,+10
Habitat Mounts	C,C+1,+3,+5,+10	*	*	C,C+1,+3,+5,+10	C,C+1,+3,+5,+10
Shoals/Reefs/Boulder Gardens	B, B+1,+3,+5,+10	*	*	B+1,+3,+5,+10	B+1,+3,+5,+10

Notes: * Tier 2 and 3 quantitative tools only conducted if warranted (see text).
B = breaching; C = construction (which may take several years for certain HCFs).

Table 2. Date, sample ID, and UTM coordinates for sampling locations, Habitat Compensation Monitoring, 2009.

Fish Sampling			
Sample Type	**Date**	**Sample ID**	**UTM (NAD 83)**
Hydroacustic Transects	9-Sep-09	C1	14 W 0640284 7213269
	9-Sep-09	C2	14 W 0640432 7213018
	9-Sep-09	C3	14 W 0640291 7213260
	10-Sep-09	C4	14 W 0640443 7212983
	10-Sep-09	C5	14 W 0640397 7213009
	9-Sep-09	B1	14 W 0640844 7213392
	9-Sep-09	B2	14 W 0640731 7213099
	10-Sep-09	B3	14 W 0640729 7213120
	10-Sep-09	B4	14 W 0640704 7213134
	9-Sep-09	A1	14 W 0640351 7213697
	10-Sep-09	A2	14 W 0640375 7213658
	10-Sep-09	A3	14 W 0640126 7213747
	9-Sep-09	ED1	14 W 0639408 7214236
	9-Sep-09	ED2	14 W 0639385 7213785
	9-Sep-09	ED3	14 W 0639454 7214352
	10-Sep-09	ED4	14 W 0639403 7214264
	10-Sep-09	ED5	14 W 0639402 7213772
	10-Sep-09	ED6	14 W 0639471 7214258
Gill Nets	14-Aug-09	net-trial	14 W 0639415 7214022
	14-Aug-09	net-trial	14 W 0639412 7213920
	14-Aug-09	net-trial	14 W 0639764 7213366
	17-Aug-09	Net-a	14 W 0639427 7213972
	17-Aug-09	Net-b	14 W 0639406 7214040
	17-Aug-09	Net-c	14 W 0639414 7213904
	17-Aug-09	Net-d	14 W 0639817 7213304
	17-Aug-09	Net-e	14 W 0639779 7213366
	21-Aug-09	Net-1	14 W 0640406 7213229
	21-Aug-09	Net-2	14 W 0640408 7213207
	21-Aug-09	Net-3	14 W 0640372 7213266
	21-Aug-09	Net-4	14 W 0639390 7214176
	21-Aug-09	Net-5	14 W 0639404 7214126
	21-Aug-09	Net-6	14 W 0639390 7213845
	21-Aug-09	Net-7	14 W 0639422 7213937
	21-Aug-09	Net-8	14 W 0639409 7213875
	21-Aug-09	Net-9	14 W 0639422 7213959
	22-Aug-09	Net-10	14 W 0639372 7213810
	22-Aug-09	Net-11	14 W 0639375 7213832
	22-Aug-09	Net-12	14 W 0639389 7213852
	22-Aug-09	Net-13	14 W 0639403 7214056
	22-Aug-09	Net-14	14 W 0639405 7214018
	22-Aug-09	Net-15	14 W 0639400 7214087
	22-Aug-09	Net-16	14 W 0640333 7213200
	22-Aug-09	Net-17	14 W 0640402 7213177
	22-Aug-09	Net-18	14 W 0640340 7213162
	23-Aug-09	Net-19	14 W 0640804 7213300
	23-Aug-09	Net-20	14 W 0640802 7213269
	23-Aug-09	Net-21	14 W 0640780 7213333
	23-Aug-09	Net-22	14 W 0640251 7213801
	23-Aug-09	Net-23	14 W 0640211 7213812
	23-Aug-09	Net-24	14 W 0640268 7213798
	23-Aug-09	Net-25	14 W 0639408 7214010
	23-Aug-09	Net-26	14 W 0639414 7213990
	23-Aug-09	Net-27	14 W 0639406 7214030
Minnow Traps	25-31-Aug-09	Trap1	14 W 0639392 7213856
	25-31-Aug-09	Trap2	14 W 0639407 7214057
	25-31-Aug-09	Trap3	14 W 0639402 7214362
	3,4,7,9,10-Sep-09	Trap4	14 W 0640201 7212948
	3,4,7-Sep-09	Trap5	14 W 0640293 7213751
	3,4,7,9,10-Sep-09	Trap6	14 W 0640463 7213295

Water and Periphyton Sampling			
Sample Type	**Date**	**Sample ID**	**UTM Location**
Interstitial Dike Water	10-Aug-09	PW-1	14 W 0639367 7214394
	6-Aug-09	PW-2	14 W 0639391 7214130
	6-Aug-09	PW-3	14 W 0639401 7214068
	6-Aug-09	PW-4	14 W 0639419 7213963
	10-Aug-09	PW-5	14 W 0639379 7213834
Qualitative Periphyton	27-Jul-09	2PL-HVH-1	14 W 0639641 7214006
	27-Jul-09	2PL-HVH-2	14 W 0640055 7213799
	27-Jul-09	2PL-HVH-3	14 W 0639747 7213400
	27-Jul-09	2PL-HVH-4	14 W 0640269 7213786
	27-Jul-09	2PL-HVH-5	14 W 0640825 7213350
	28-Jul-09	2PL-HVH-6	14 W 0640414 7213102
	28-Jul-09	3PL-HVH-1	14 W 0638672 7211817
	28-Jul-09	3PL-HVH-2	14 W 0638854 7212120
	28-Jul-09	3PL-HVH-3	14 W 0639749 7211954
	28-Jul-09	3PL-HVH-4	14 W 0639610 7212516
	28-Jul-09	3PL-HVH-5	14 W 0639052 7211093
	28-Jul-09	3PL-HVH-6	14 W 0639454 7213341
	30-Jul-09	2PL-ED-1	14 W 0639402 7214362
	30-Jul-09	2PL-ED-2	14 W 0639388 7214250
	30-Jul-09	2PL-ED-3	14 W 0639407 7214057
	30-Jul-09	2PL-ED-4	14 W 0639417 7213937
	30-Jul-09	2PL-ED-5	14 W 0639391 7213856
Quantitative Periphyton	30-Aug-09	SP-DT	14 W 0638444 7213723
	28-Aug-09	SP-CREMP	14 W 0641003 7213264
	27-Aug-09	SP-BL	14 W 0639484 7214585
	25-Aug-09	SP-ED-1	14 W 0639369 7214350
	25-Aug-09	SP-ED-2	14 W 0639381 7214252
	25-Aug-09	SP-ED-3	14 W 0639399 7214048
	25-Aug-09	SP-ED-4	14 W 0639414 7213940
	25-Aug-09	SP-ED-5	14 W 0639389 7213865

Table 3. QA/QC data for interstitial dike water sampling, Habitat Compensation Monitoring, 2009.

		Field Duplicate			Laboratory Duplicate			Equipment Blank
		ED-PW-4	ED-PW-DUP	RPD	Original	Duplicate	RPD	ED-PW-Eqmt Blk
	MDLs	10-Aug-09	6-Aug-09	(%)	8-Aug-09		(%)	10-Aug-09
CONVENTIONAL PARAMETERS								
Physical Tests								
Conductivity (µS/cm)	2.0	24.0	24.8	-3.28	-	-	-	<2.0
Hardness (mg/L)	1.1	9.8	9.9	-1.0	-	-	-	<1.1
pH	0.10	6.92	6.89	0.43	-	-	-	5.72
Total Suspended Solids (mg/L)	1.0	18.5	23.9	-25.5	-	-	-	<1.0
Total Dissolved Solids (mg/L)	10	<10	12	N/A	-	-	-	<10
Turbidity (NTU)	0.10	10.4	3.45	100	-	-	-	0.320
Anions & Nutrients (mg/L)								
Alkalinity - Bicarbonate (as $CaCO_3$)	2.0	8.5	8.3	2.4	-	-	-	<2.0
Alkalinity - Carbonate (as $CaCO_3$)	2.0	<2.0	<2.0	0	-	-	-	<2.0
Alkalinity - Hydroxide (as $CaCO_3$)	2.0	<2.0	<2.0	0	-	-	-	<2.0
Alkalinity - Total (as $CaCO_3$)	2.0	8.5	8.3	2.4	-	-	-	<2.0
Ammonia (as N)	0.020	<0.020	<0.020	0	<0.020	<0.020	0	<0.020
Bromide	0.050	<0.050	<0.050	0	-	-	-	<0.050
Chloride	0.50	0.51	0.67	-27.1	-	-	-	<0.50
Fluoride	0.020	0.049	0.049	0.0	-	-	-	<0.020
Nitrate (as N)	0.0050	0.0161	0.0144	11.1	-	-	-	<0.0050
Nitrite (as N)	0.0010	<0.0010	<0.0010	0	-	-	-	<0.0010
Total Kjeldahl Nitrogen	0.050	0.176	0.294	**-50.2**	-	-	-	<0.050
Ortho Phosphate (as P)	0.0010	<0.0010	<0.0010	0	-	-	-	<0.0010
Total Phosphate (as P)	0.0020	0.0095	0.0036	**90.1**	-	-	-	<0.0020
Silicate (as SiO_2)	1.0	<1.0	<1.0	0	-	-	-	<1.0
Sulfate (SO_4)	0.50	2.09	2.17	-3.8	-	-	-	<0.50
ORGANIC / INORGANIC CARBON								
Dissolved Organic Carbon (mg/L)	0.50	1.67	2.2	-27.4	1.65	1.66	-0.60	<0.50
Total Organic Carbon (mg/L)	0.50	1.72	1.6	7.2	1.68	1.77	-5.22	<0.50
TOTAL METALS (mg/L)								
Aluminum	0.010	0.449	0.554	-20.9	-	-	-	<0.0050
Antimony		<0.00050	<0.00050	0	-	-	-	<0.00050
Arsenic		<0.00050	<0.00050	0	-	-	-	<0.00050
Barium	0.0050	<0.020	<0.020	0	-	-	-	<0.020
Beryllium	0.00050	<0.0010	<0.0010	0	-	-	-	<0.0010
Boron	0.00050	<0.10	<0.10	0	-	-	-	<0.10
Cadmium	0.020	<0.000017	<0.000017	0	-	-	-	<0.000017
Calcium	0.0010	2.81	2.7	4.0	-	-	-	<0.10
Chromium	0.10	0.0026	0.0036	-32	-	-	-	<0.0010
Cobalt	0.000017	<0.00030	0.00034	N/A	-	-	-	<0.00030
Copper	0.10	0.0015	0.0015	0	-	-	-	<0.0010
Iron	0.0010	0.641	0.821	-24.6	-	-	-	<0.030
Lead	0.00030	<0.00050	<0.00050	0	-	-	-	<0.00050
Lithium	0.0010	<0.0050	<0.0050	0	-	-	-	<0.0050
Magnesium	0.030	1.04	1.11	-6.5	-	-	-	<0.10
Manganese	0.00050	0.0156	0.0156	0	-	-	-	<0.00030
Mercury	0.0050	<0.000020	<0.000020	0	<0.000020	<0.000020	0	<0.000020
Molybdenum	0.10	<0.0010	<0.0010	0	-	-	-	<0.0010
Nickel	0.00030	0.0016	0.0019	-17	-	-	-	<0.0010
Potassium	0.000020	<2.0	<2.0	0	-	-	-	<2.0
Selenium	0.0010	<0.0010	<0.0010	0	-	-	-	<0.0010
Silver	0.0010	<0.000020	<0.000020	0	-	-	-	<0.000020
Sodium	2.0	<2.0	<2.0	0	-	-	-	<2.0
Thallium	0.0010	<0.00020	<0.00020	0	-	-	-	<0.00020
Tin	0.000020	<0.00050	<0.00050	0	-	-	-	<0.00050
Titanium	2.0	0.020	0.024	-18	-	-	-	<0.010
Uranium	0.00020	<0.00020	0.00024	N/A	-	-	-	<0.00020
Vanadium	0.00050	<0.0010	<0.0010	0	-	-	-	<0.0010
Zinc	0.010	0.0076	0.0065	16	-	-	-	0.0081

Table 3. QA/QC data for interstitial dike water sampling, Habitat Compensation Monitoring, 2009.

		Field Duplicate			Laboratory Duplicate			Equipment Blank
		ED-PW-4	ED-PW-DUP	RPD	Original	Duplicate	RPD	ED-PW-Eqmt Blk
	MDLs	10-Aug-09	6-Aug-09	(%)	8-Aug-09		(%)	10-Aug-09
DISSOLVED METALS (mg/L)								
Aluminum	0.0050	0.0084	0.0086	-2.4	0.0109	0.0106	2.79	<0.0050
Antimony	0.00050	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050
Arsenic	0.00050	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050
Barium	0.020	<0.020	<0.020	0	-	-	-	<0.020
Beryllium	0.0010	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010
Boron	0.10	<0.10	<0.10	0	-	-	-	<0.10
Cadmium	0.000017	<0.000017	<0.000017	0	<0.000017	0.000015	0	<0.000017
Calcium	0.10	2.60	2.60	0	-	-	-	<0.10
Chromium	0.0010	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010
Cobalt	0.00030	<0.00030	<0.00030	0	<0.00030	<0.00030	0	<0.00030
Copper	0.0010	0.0012	0.0016	-29	0.0018	0.0018	0	<0.0010
Iron	0.030	<0.030	<0.030	0	-	-	-	<0.030
Lead	0.00050	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050
Lithium	0.0050	<0.0050	<0.0050	0	<0.0050	<0.0050	0	<0.0050
Magnesium	0.10	0.80	0.82	-2.5	-	-	-	<0.10
Manganese	0.00030	0.00089	0.00113	-23.8	0.00252	0.00252	0	<0.00030
Mercury	0.000020	<0.000020	<0.000020	0	<0.000020	<0.000020	0	<0.000020
Molybdenum	0.0010	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010
Nickel	0.0010	0.0028	<0.0010	N/A	<0.0010	<0.0010	0	<0.0010
Potassium	2.0	<2.0	<2.0	0	-	-	-	<2.0
Selenium	0.0010	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010
Silver	0.000020	<0.000020	<0.000020	0	<0.000020	<0.000020	0	<0.000020
Sodium	2.0	<2.0	<2.0	0	-	-	-	<2.0
Thallium	0.00020	<0.00020	<0.00020	0	<0.00020	<0.00020	0	<0.00020
Tin	0.00050	<0.00050	<0.00050	0	<0.00050	<0.00050	0	<0.00050
Titanium	0.010	<0.010	<0.010	0	-	-	-	<0.010
Uranium	0.00020	<0.00020	<0.00020	0	<0.00020	<0.00020	0	<0.00020
Vanadium	0.0010	<0.0010	<0.0010	0	<0.0010	<0.0010	0	<0.0010
Zinc	0.0050	<0.0050	0.011	N/A	-	-	-	<0.0050

Notes:

RPD = Relative Percent Difference (%) = ((original - duplicate) / (original + duplicate)/2) x 100.

Shaded RPDs exceed 25% (lab duplicates) or 50% (field duplicates), when >10 times MDL.

Bolded RPDs exceed 25% (lab duplicates) or 50% (field duplicates), when <10 times MDL.

Shaded travel and equipment blanks exceed laboratory method detection limits.

Table 4. QA/QC data for periphtyton, Habitat Compensation Monitoring, 2009.

	East Dike			Drilltrail Arm		
	ED-4Q 25-Aug-09	**Lab Duplicate**	**RPD** (%)	**DT-1Q** 30-Aug-09	**Lab Duplicate**	**RPD** (%)
Periphyton Biomass (µg/cm^2)						
Cyanobacteria	0.4	0.2	66.7	478.1	735.2	-42.4
Chlorophyte	0.0	0.1	NA	297.3	76.1	118.5
Diatom	9.9	10.9	-9.6	134.5	227.3	-51.3
Total	**10.3**	**11.2**	**-8.4**	**909.9**	**1038.6**	**-13.2**
Periphyton Density (cells/cm^2)						
Cyanobacteria	15874	13834	13.7	645995	798521	-21.1
Chlorophyte	690	1303	-61.5	71777	26917	90.9
Diatom	28642	28771	-0.4	269165	403747	-40.0
Total	**45206**	**43908**	**2.9**	**986937**	**1229185**	**-21.9**
# Species	15	15	0	17	17	0
Simpson's Diversity	0.86	0.86	-0.4	0.74	0.63	15.9

Notes:

RPD = Relative Percent Difference (%) = (original - duplicate)/((original + duplicate)/2) x 100.

Shaded RPDs exceeded 25% (lab duplicates).

NA = Not applicable for rare taxa.

Table 5. Water chemistry results for interstitial dike water sampling, Habitat Compensation Monitoring, 2009.

Lake & Basin		Second Portage Lake - East Dike					CREMP Reference Station
Station ID		ED-PW-1	ED-PW-2	ED-PW-3	ED-PW-4	ED-PW-5	SP7-S
Depth (m)	**CCME (2007)**	0.5 - 2	1 - 3	2.5 - 4	2 - 4	1 - 3	3
Date	**Guideline[1]**	10-Aug-09	6-Aug-09	6-Aug-09	6-Aug-09	10-Aug-09	12-Aug-09
CONVENTIONAL PARAMETERS							
Physical Tests							
Conductivity (µS/cm)	NG	30.7	24.1	22.9	24.0	24.6	21.8
Hardness (mg/L)	NG	11.8	10.3	9.3	9.8	9.7	9.5
pH	6.5 - 9.0	6.42	6.85	6.88	6.92	6.90	6.82
Total Suspended Solids (mg/L)	NG	56.1	6.5	3.9	18.5	20.5	1.0
Total Dissolved Solids (mg/L)	NG	17	12	13	<10	<10	15
Turbidity (NTU)	NG	29.5	1.36	1.77	10.4	7.77	0.52
Anions & Nutrients (mg/L)							
Alkalinity - Bicarbonate (as $CaCO_3$)	NG	7.1	8.4	7.4	8.5	8.5	6.8
Alkalinity - Carbonate (as $CaCO_3$)	NG	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Alkalinity - Hydroxide (as $CaCO_3$)	NG	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Alkalinity - Total (as $CaCO_3$)	NG	7.1	8.4	7.4	8.5	8.5	6.8
Ammonia (as N)[2]	0.274 - 81.6	<0.020	<0.020	<0.020	<0.020	0.024	<0.020
Bromide	NG	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride	NG	0.77	0.52	<0.50	0.51	0.51	<0.50
Fluoride	NG	0.047	0.047	0.047	0.049	0.049	0.045
Nitrate (as N)	2.9	0.13	0.0112	<0.0050	0.0161	0.0183	<0.0050
Nitrite (as N)	0.06	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	NG	0.331	0.156	0.145	0.176	0.137	0.094
Ortho Phosphate (as P)	NG	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Phosphate (as P)	0.004	0.0108	0.0039	<0.0020	0.0095	0.0028	<0.0020
Silicate (as SiO_2)	NG	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sulfate (SO_4)	NG	4.79	2.26	2.05	2.09	2.13	1.96
ORGANIC / INORGANIC CARBON							
Dissolved Organic Carbon (mg/L)	NG	3.32	1.85	1.78	1.67	1.65	1.61
Total Organic Carbon (mg/L)	NG	1.70	1.85	1.64	1.72	1.68	1.40
TOTAL METALS (mg/L)							
Aluminum[3]	0.005 - 0.100	1.35	0.148	0.0811	0.449	0.241	<0.030
Antimony	NG	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic	0.0050	0.00075	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Barium	NG	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Beryllium	NG	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron	NG	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium*	0.0000043 - 0.0000053	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
Calcium	NG	3.40	2.84	2.42	2.81	2.72	2.28
Chromium[4]	0.0010	0.0057	0.0011	<0.0010	0.0026	0.0019	<0.0010
Cobalt	NG	0.00093	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Copper*	0.002 - 0.004	0.0034	0.0012	0.0010	0.0015	0.0013	<0.0010
Iron	0.300	1.92	0.228	0.130	0.641	0.388	<0.030
Lead*	0.001 - 0.007	0.00141	0.00077	<0.00050	<0.00050	<0.00050	<0.00050
Lithium	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Magnesium	NG	1.61	0.90	0.80	1.04	0.91	0.74
Manganese	NG	0.0337	0.0076	0.0036	0.0156	0.0159	0.00134
Mercury	0.000026	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Molybdenum	0.073	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel*	0.025 - 0.15	0.004	<0.0010	<0.0010	0.0016	0.0013	<0.0010
Potassium	NG	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Selenium	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silver	0.00010	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Sodium	NG	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium	0.00080	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin	NG	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium	NG	0.061	<0.010	<0.010	0.020	<0.010	<0.010
Uranium	NG	0.0004	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Vanadium	NG	0.0023	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc	0.030	0.0151	0.0093	0.0071	0.0076	0.0083	<0.0050

Table 5. Water chemistry results for interstitial dike water sampling, Habitat Compensation Monitoring, 2009.

Lake & Basin		Second Portage Lake - East Dike					CREMP Reference Station
Station ID		ED-PW-1	ED-PW-2	ED-PW-3	ED-PW-4	ED-PW-5	SP7-S
Depth (m)	**CCME (2007)**	0.5 - 2	1 - 3	2.5 - 4	2 - 4	1 - 3	3
Date	**Guideline[1]**	10-Aug-09	6-Aug-09	6-Aug-09	6-Aug-09	10-Aug-09	12-Aug-09
DISSOLVED METALS (mg/L)[5]							
Aluminum[3]	0.005 - 0.100	0.0109	0.0140	0.0070	0.0084	0.0104	<0.0050
Antimony	NG	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic	0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Barium	NG	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Beryllium	NG	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron	NG	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium*	0.0000043 - 0.0000053	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
Calcium	NG	3.27	2.79	2.48	2.60	2.63	2.55
Chromium[4]	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt	NG	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Copper*	0.002 - 0.004	0.0018	<0.0010	<0.0010	0.0012	<0.0010	<0.0010
Iron	0.300	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Lead*	0.001 - 0.007	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Lithium	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Magnesium	NG	0.88	0.82	0.76	0.80	0.77	0.77
Manganese	NG	0.0025	0.0012	0.0007	0.0009	0.0014	0.00033
Mercury	0.000026	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Molybdenum	0.073	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel*	0.025 - 0.15	<0.0010	<0.0010	<0.0010	0.0028	<0.0010	<0.0010
Potassium	NG	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Selenium	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silver	0.00010	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Sodium	NG	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium	0.00080	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin	NG	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium	NG	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium	NG	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Vanadium	NG	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Zinc	0.030	0.0157	0.0087	<0.0050	<0.0050	<0.0050	<0.0050

Notes:

NG = no guideline.

[1]CCME (Canadian Council of Ministers of the Environment) Canadian Water Quality Guidelines for the Protection of Aquatic Life, 1999, updated December 2007.

[2]Ammonia guidelines are for 10°C and are pH dependent (pH <6.5, 25.92, pH <7.0, 8.24)

[3]Aluminum guideline is pH dependent (pH <6.5, 0.005, pH>6.5, 0.10)

[4]Chromium guideline is for Cr VI.

[5]Guidelines have not yet been made for "Dissolved Metals," thus were screened against CCME guidelines for "Total Metals."

*Cadmium, copper, lead and nickel guidelines are hardness dependent.

Shaded concentrations exceed the CCME guideline.

Table 6. Qualitative characteristics of the periphyton community from underwater video analysis, Habitat Compensation Monitoring, 2009.

Site Info				Periphyton Description				
Area	Habitat Station	Depth (m)	Substrate	% Cover	Mat Density & Description	Color	Snap Shots (Appendix C)	Ice Scour / Other
East Dike - Second Portage Lake	Natural substrate adjacent to dike	1.8 to 2.1	boulder (~75%), cobble (~25%), fines (~5%)	60-90% (varied), highly smothered in sediment	Good coverage with dense mats apparent on rock sides with good volume though somewhat suppressed by settled sediment. Flat surfaces highly smothered, flattened.	brown, coated with sediment	12:14:50 12:21:05	No evidence of ice scour as clumping, damage and erosion of periphyton likely from heavy sedimentation. Also, foreign gravel debris (snapshot) scattered on flat surfaces.
	Natural substrate near north end of East Dike	3.0 to 3.3	boulder (30-60%), cobble (~20%), fines (20-50%)	30-70% (depending on substrate) moderate cover on boulders, little to no cover on fines and cobble (smothered by sediment).	Sparse mats mainly on boulder and cobble sides, flat surfaces highy impacted. Flattened or distroyed.	brown, coated with thick sediment	12:30:28 12:35:38	No evidence of ice scour. Foreign angular gravel scattered thru out site, randomly strewen on boulder and fines (see snapshot)
	East Dike; middle section	2.2 to 3.6	boulder (~60%), cobble (~40%)	no evidence of periphyton (~0%)	No periphyton visible on dike surface.	n/a	12:51:43	No evidence of ice scour. Angular boulders and cobble hap-hazardly piled. Sheltered areas covered in thick layer of sediment. Exposed areas completely bare (no sediment, no periphyton).
	East Dike; near south end	1.0 to 2.6	HCF material (shallow water): boulder mostly (60%) with some cobble (30%) and boulders (10%) underneath. Natural (in deep water areas): fines (80%) or sediment and cobble (20%).	Only periphyton cover on natural substrate. None on fines, but some on cobble and on boulders (40%). None (0%) on HCF material, although hard to distinguish between sediment and periphyton.	On natural substrate, mats are sparse, flat, and sporadic. Look haggard and unhealthy. Covered in sediment.	brown	13:11:24	No evidence of ice scour.
	East Dike; south end	3.3 to 3.6	Construction material comprised of angular and jagged boulder (70%) and cobble (30%) precariously piled. Natural material in deeper water primarily fines (85%), with some cobble (5%) and few boulders (10%)	Limited (10%) on natural substrate. None (0%) on HCF material.	Mats only on natural cobble and boulder substrate, however matts absent from flat surfaces and are only seen on rock sides but fronds are weighted with sediment and matts appear spars	brown	13:17:30	No evidence of ice scour. Yellow colouring to some heavily sedimented areas.
Second Portage Lake	HVH-2	2.2 to 2.4	50% boulder, 40% cobble, 10% fines	~80-100% coverage	Mats are thick, moderately luxuriant in areas where some sedimentation may be flattening, in others highly luxuriant where protected (rock sides).	green	14:44:27	No ice scour. Some surfaces covered with highly luxuriant periphyton, while adjacent surfaces more sparse due to sediment layer (snapshot 1)
	HVH-1	3.0 to 3.9	20% boulder, 30% cobble, 50% fines	~80%	Denser/more luxuriant periphyton mats in areas of shallower depth.	green	15:08:40	No ice scour. Periphyton coverage on fines is continuous (snapshot)
	HVH-3	1.0 to 3.0	55% boulder, 35% cobble, 5% gravel, 10% fines	~80%	Denser/more luxuriant periphyton mats in areas of shallower depth.	green	15:29:55	Periphyton mat at depth is continuous but not thick, but in shallow water periphyton mat is thick, very luxurious, green, with raised fronds (snapshot)
	HVH-4	1.4 to 2.0	70% boulder, 30% cobble	95%	Patchy in places, very luxuriant in others, but generally all areas had fluffy fronds	green	13:42:24	Periphyton mat may have been damaged by ice scour in the shallowest regions (snapshot) but otherwise healthy looking

Table 6. Qualitative characteristics of the periphyton community from underwater video analysis, Habitat Compensation Monitoring, 2009.

Site Info				Periphyton Description				
Area	Habitat Station	Depth (m)	Substrate	% Cover	Mat Density & Description	Color	Snap Shots (Appendix C)	Ice Scour / Other
Second Portage Lake (con't)	HVH-5	1.6 to 2.0	60% boulder, 35% cobble, 5% fines	90%	Patchy in places, very luxuriant in others, but generally periphyton coverage appears thick and fluffy (raised fronds)	green		Some evidence of ice scour where periphyton is patchy in shallow areas.
	HVH-6	1.4 to 1.5	100% boulder	70%	Mat is thick in places, but not coninuous, highly patchy. In some areas sporadic long fronds are surrounded by bare rock.	green		Ice scour is evident from highly patchy periphyton mat. More patchiness than seen at HVH4 or HVH5.
Third Portage Lake	HVH-2	2.2 to 2.6	40% boulder, 40% cobble, 20% fines	90-100%	Highly dense mat, thick and volumous with well developed, raised fronds. Matt is continuous on all substrates.	green	08:20:28 08:22:25	No ice scour. Mat is completely continuous over all substrates and fronds are large and raised.
	HVH-5	1.7 to 2.3	80% boulder, 20% cobble	70%, but higher at depth	Not as thick or dense as HVH-2 but highly continuous, especially at depth. Looks like peri was ice scoured on shallower surfaces on big boulders. At depth, thick and luxurious periphyton covers all substrate.	green		Ice scour looks to have shorn the periphyton mat in most shallow areas on big boulders.
	HVH-3	1.6 to 2.2	100% boulder	75%	Generally thin-moderate density and thickness of mat. Some protected areas are thick and dense with well raised fronds (sides of rocks and in crevices). Some evidence of ice scour.	green	09:08:58 09:12:55 09:12:57	Generally thin periphyton on tops of boulders in shallow water with some areas bald (shapshot 1). Other areas luxurious peri (snapshot 2). Some clumpy looking periphyton on boulders at depths >2m.
	HVH-4	3.2 to 3.6	65% boulder, 15% cobble, 20% fines	70-90%	Fairly homogeneous characteristics between all reps. Periphyton covers all substrate, matt is mostly continuous, of medium density and thickness. Periphyton on fines is highly textured. No areas of highly luxurious periphyton, even in crevices.	green, grey	9:35:29	No ice scour. Periphyton is continuous on all substrates, and is particularly textured on fines (snapshot).
	HVH-6	1.6 to 2.9	60% boulder, 30% cobble, 10% fines	60-80%	Highly variable periphyton mat. Some areas on boulders and cobble (especially on sides) is very luxurious and dense, while other boulders and cobble have thin or no peri matt. Mat, where present is continuous, especially on fines.	green		Random rocks had no periphyton or very thin mat.
	HVH-1	1.5 to 1.9	100% boulder	75%	Most surfaces covered with mat of high density and luxurious, raised fronds. However, some areas appear to have ice scour where periphyton is absent or very thin.	green, grey	10:22:49	Ice scour evident from patchy areas ((see snapshot).

Note: HCF = Habitat Compensation Feature

Table 7. Biomass (µg/cm^2) and diversity of major periphyton groups, Habitat Compensation Monitoring, 2009.

Station & Rep	Date	Periphyton Biomass (µg/cm^2)					# Species	Simpsons Diversity
		Cyanophyte	Chlorophyte	Chrysophyte	Diatom	Total		
East Dike Face								
ED-1	25-Aug-09	0.3	0	0	17	18	14	0.63
ED-2	25-Aug-09	0.3	0	0	32	33	17	0.74
ED-3	25-Aug-09	0.2	0.1	0.4	40	41	12	0.79
ED-4	25-Aug-09	0.4	0	0	10	10	15	0.86
ED-5	25-Aug-09	0.3	0	0	16	16	16	0.77
	Station Mean	**0.3**	**0**	**0.1**	**23**	**23**	**15**	**0.76**
Boat Launch Area								
SP-BL-1	27-Aug-09	45	13	0	128	185	19	0.79
SP-BL-2	27-Aug-09	63	8	0	233	304	19	0.76
SP-BL-3	27-Aug-09	18	0.2	0	85	104	17	0.77
SP-BL-4	27-Aug-09	5	0	0	172	177	15	0.75
SP-BL-5	27-Aug-09	123	12	0	103	238	16	0.74
	Station Mean	**51**	**6.5**	**0**	**144**	**201**	**17**	**0.76**
CREMP								
SP-CREMP-1	28-Aug-09	212.3	494.7	0	219	926	20	0.66
SP-CREMP-2	28-Aug-09	318.3	71.2	0	213	603	19	0.75
SP-CREMP-3	28-Aug-09	179.6	10.9	0	78	268	15	0.72
SP-CREMP-4	28-Aug-09	160.0	88.3	0	346	594	20	0.74
SP-CREMP-5	28-Aug-09	123.6	84.6	0	149	357	19	0.78
	Station Mean	**199**	**150**	**0**	**201**	**549**	**19**	**0.73**
Drilltrail Arm								
SP-DT-1	30-Aug-09	478.1	297.3	0	135	910	17	0.74
SP-DT-2	30-Aug-09	230.5	6.0	0	116	353	18	0.69
SP-DT-3	30-Aug-09	148.1	72.7	0	79	300	19	0.61
SP-DT-4	30-Aug-09	170.1	70.4	0	63	304	20	0.70
SP-DT-5	30-Aug-09	117.9	0	0	206	324	20	0.74
	Station Mean	**229**	**89**	**0**	**120**	**438**	**19**	**0.70**
Overall Relative Biomass (%):		**39%**	**20%**	**< 0.1%**	**40%**			

Table 8. Cell density (cells/cm^2) of major periphyton groups, Habitat Compensation Monitoring, 2009.

Station & Rep	Date	Periphyton Density (cells/cm^2)				
		Cyanophyte	Chlorophyte	Chrysophyte	Diatom	Total
East Dike Face						
ED-1	25-Aug-09	4102	0	0	84595	88696
ED-2	25-Aug-09	14263	0	0	115488	129751
ED-3	25-Aug-09	2179	897	1794	47552	52423
ED-4	25-Aug-09	15874	690	0	28642	45206
ED-5	25-Aug-09	35156	183	0	49622	84961
	Station Mean	**14315**	**354**	**359**	**65180**	**80207**
Boat Launch Area						
SP-BL-1	27-Aug-09	568236	5981	0	278137	852354
SP-BL-2	27-Aug-09	714781	2991	0	328979	1046751
SP-BL-3	27-Aug-09	634032	5981	0	139567	779580
SP-BL-4	27-Aug-09	46143	0	0	307617	353759
SP-BL-5	27-Aug-09	486739	8972	0	181686	677397
	Station Mean	**489986**	**4785**	**0**	**247197**	**741968**
CREMP						
SP-CREMP-1	28-Aug-09	744689	49347	0	192901	986937
SP-CREMP-2	28-Aug-09	724950	21533	0	154321	900804
SP-CREMP-3	28-Aug-09	610106	29907	0	116638	756651
SP-CREMP-4	28-Aug-09	850560	50244	0	222509	1123313
SP-CREMP-5	28-Aug-09	829027	17944	0	236865	1083836
	Station Mean	**751866**	**33795**	**0**	**184647**	**970308**
Drilltrail Arm						
SP-DT-1	30-Aug-09	645995	71777	0	269165	986937
SP-DT-2	30-Aug-09	628051	2991	0	152527	783568
SP-DT-3	30-Aug-09	520385	38879	0	122619	681883
SP-DT-4	30-Aug-09	658812	35889	0	112793	807494
SP-DT-5	30-Aug-09	476806	0	0	225586	702391
	Station Mean	**586010**	**29907**	**0**	**176538**	**792454**
Overall Mean (%)		**0.71**	**0.03**	**<0.01**	**0.26**	

Table 9. Hydroacoustic fish survey linear transect results, Habitat Compensation Monitoring, 2009.

Area	Date	Transect #	UTM Coordinates (14W, NAD 83)		Start Time	Duration (min.sec)	Fish #
			Survey Start	Survey End			
East Dike	09-Sep-09	1	639408 7214236	639372 7213800	13:57:10	2.40	0
	09-Sep-09	2	639385 7213785	639434 7214204	14:00:35	2.35	0
	09-Sep-09	3	639454 7214352	639411 7213785	14:06:35	2.40	1
	10-Sep-09	4	639403 7214264	639389 7213850	12:22:35	2.25	0
	10-Sep-09	5	639402 7213772	639441 7214204	12:26:30	2.25	0
	10-Sep-09	6	639471 7214258	639413 7213834	12:31:02	2.08	0
HVH-2&4	09-Sep-09	1	640351 7213697	640031 7213810	13:35:30	2.00	0
	10-Sep-09	2	640375 7213658	640128 7213796	12:03:40	1.20	0
	10-Sep-09	3	640126 7213747	640002 7213848	12:07:03	0.57	0
HVH-5	09-Sep-09	1	640844 7213392	640680 7213192	13:23:40	1.25	0
	09-Sep-09	2	640731 7213099	640880 7213514	13:28:30	2.05	0
	10-Sep-09	3	640729 7213120	640876 7213461	11:52:35	1.35	0
	10-Sep-09	4	640704 7213134	640868 7213514	11:58:01	2.04	1
HVH-6	09-Sep-09	1	640284 7213269	640468 7212994	13:10:45	1.00	0
	09-Sep-09	2	640432 7213018	640309 7213240	13:14:46	0.30	0
	09-Sep-09	3	640291 7213260	640412 7212994	13:16:15	2.00	0
	10-Sep-09	4	640443 7212983	640304 7213259	11:42:05	2.00	0
	10-Sep-09	5	640397 7213009	640265 7213279	11:46:00	1.25	0

Total Effort (min.sec)
Reference (HVH) areas: 18.21
East Dike: 14.53

Table 10. Hydroacoustic fish survey results for focused area-based surveys, Habitat Compensation Monitoring, 2009.

Area	Date	Start Time	End Time	Duration	Fish #	Depth of Fish (m)	Depth at Location (m)	CPUE (fish/min)
East Dike	21-Sep	16:00	16:15	15:00	1	4.2	6.0	0.33
					1	3.5	4.5	
					1	4.4	5.9	
					1	4.0	5.8	
					1	3.2	4.8	
HVH-2	22-Sep	15:10	15:25	15:00	4	2.4	6.3	0.67
					1	3.7	6.3	
					1	7.4	10.0	
					1	10.0	12.0	
					1	15.0	17.0	
					1	13.0	13.0	
					1	11.0	13.0	
HVH-4	21-Sep	15:40	15:55	15:00	1	10.0	13.0	0.27
					1	12.0	13.0	
					1	7.3	17.0	
					1	15.0	17.0	
HVH-5	21-Sep	15:35	15:50	15:00	1	3.0	3.2	0.67
					1	2.8	5.8	
					2	23.0	24.0	
					2	28.0	31.0	
					1	13.0	17.0	
					1	10.0	12.0	
					1	21.0	21.0	
					1	9.8	11.0	
HVH-6	22-Sep	15:55	16:10	15:00	1	3.9	7.3	0.07

Table 11. Catch-per-unit-effort (CPUE) for gill net sets, Habitat Compensation Monitoring, 2009.

Date	Set Area[1]	Mesh size (inches)	Duration (hr)	Number Fish Caught	CPUE (#fish/150m/day)
Aug-14	ED-M	0.5 & 0.75	4.0	0	0.0
	ED-S	0.5 & 0.75	4.0	0	0.0
	HVH-3	0.5 & 0.75	3.5	0	0.0
Aug-17 [2]	ED-S	0.5 & 0.75	18.2	2	-
	ED-M	0.5 & 0.75	18.0	0	-
	ED-S	1.5 & 3.0	17.3	13	-
	HVH-3	0.5 & 0.75	16.8	1	-
	HVH-3	1.5 & 3.0	15.9	1	-
Aug-21	ED-N	0.5 & 0.75	4.3	0	0.0
	ED-S	0.5 & 0.75	4.3	0	0.0
	ED-N	0.5 & 0.75	6.3	0	0.0
	ED-S	0.5 & 0.75	6.3	0	0.0
	ED-S	1.5	4.1	2	70.5
	ED-S	1.5	6.5	7	155.1
	ED-S	1.5	5.8	1	25.0
	HVH-6	0.5, 0.75, 1.5	4.4	1	11.0
	HVH-6	0.5, 0.75, 1.5	6.4	0	0.0
Aug-22	ED-S	0.5, 0.75, 1.5	5.0	3	28.6
	ED-M	0.5, 0.75, 1.5	5.1	1	9.4
	ED-S	0.5, 0.75, 1.5	4.4	1	10.9
	ED-M	0.5, 0.75, 1.5	4.4	5	54.4
	HVH-6	0.5, 0.75, 1.5	5.1	2	19.0
	HVH-6	0.5, 0.75, 1.5	4.4	0	0.0
Aug-23	ED-M	0.5, 0.75, 1.5	3.6	6	79.6
	ED-M	0.5, 0.75, 1.5	7.1	3	20.4
	HVH-5	0.5, 0.75, 1.5	4.1	1	11.7
	HVH-4	0.5, 0.75, 1.5	3.9	0	0.0
	HVH-5	0.5, 0.75, 1.5	6.8	0	0.0
	HVH-4	0.5, 0.75, 1.5	6.7	0	0.0

[1] S = south, M = middle, N = north

[2] Nets set overnight, CPUE not calculated.

Table 12. Mean length (mm) and size range of fish captured in gill nets[1], Habitat Compensation Monitoring, 2009.

	Lake Trout			Arctic Char			Round Whitefish		
		Length (mm)			Length (mm)			Length (mm)	
Dike/ Reference	**n**	**mean**	**range**	**n**	**mean**	**range**	**n**	**mean**	**range**
East Dike	6	413	323 - 760	9	321	166 - 455	14	226	170 - 351
HVH	4	368	261 - 438	0			0		

[1] day sets only (night sets excluded)

FIGURES

Figure 1. Ecological monitoring strategy for habitat compensation features (HCFs), Meadowbank Gold Project.

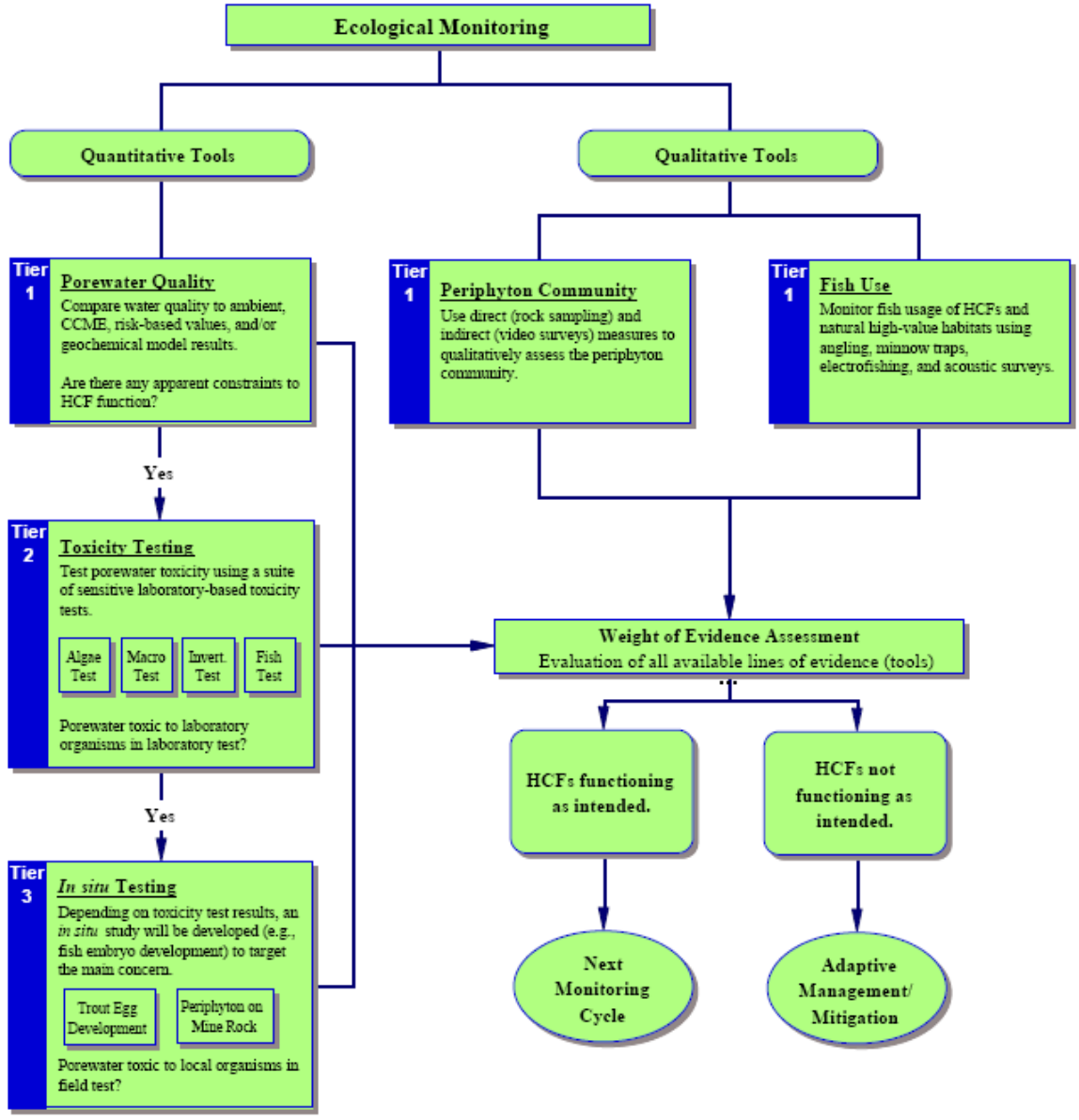


Figure 2. Interstitial dike water and periphyton sampling locations, Habitat Compensation Monitoring 2009.

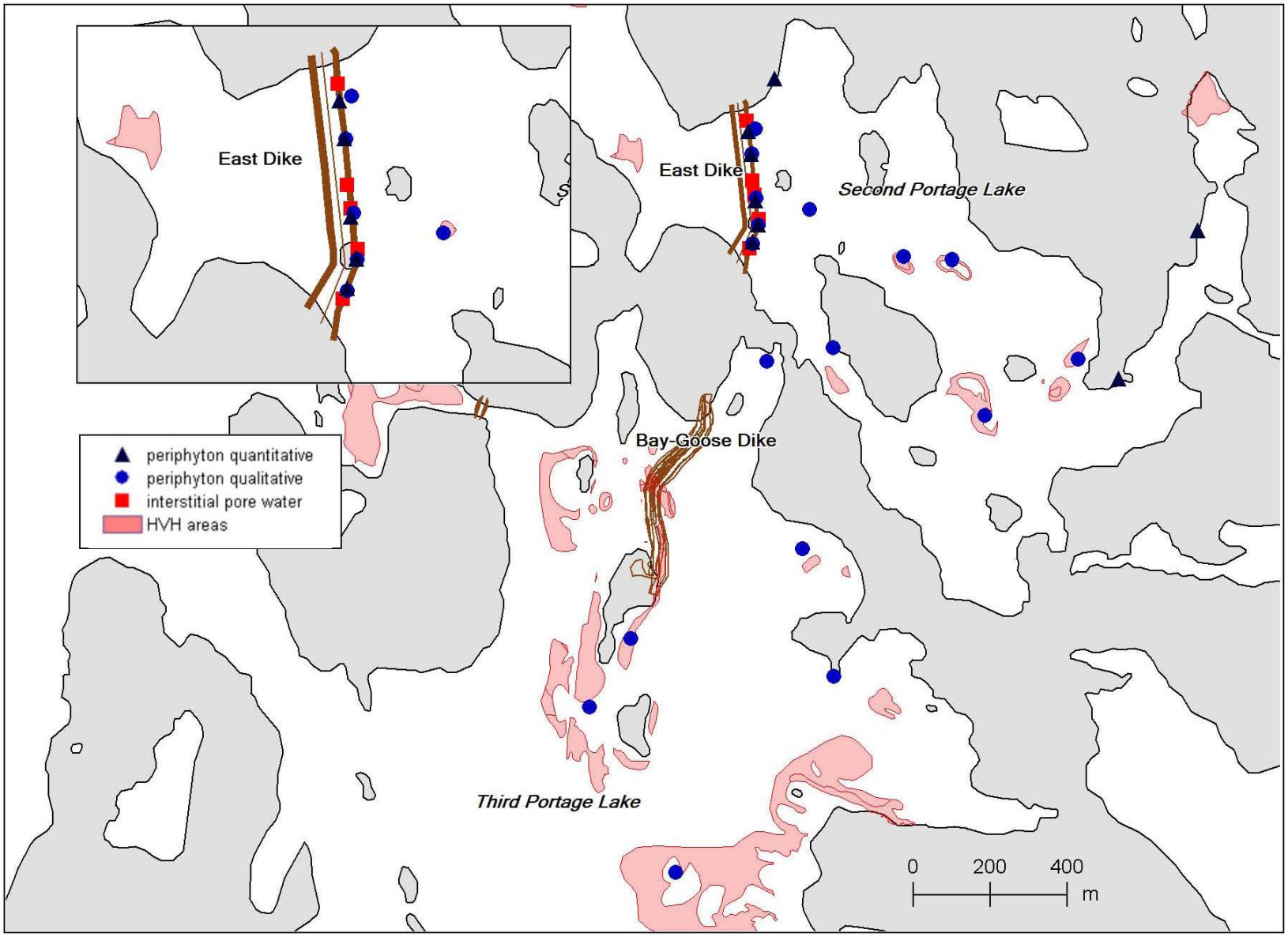


Figure 3. Hydroacoustic surveys, gill netting, and minnow trapping sampling locations, Habitat Compensation Monitoring 2009.

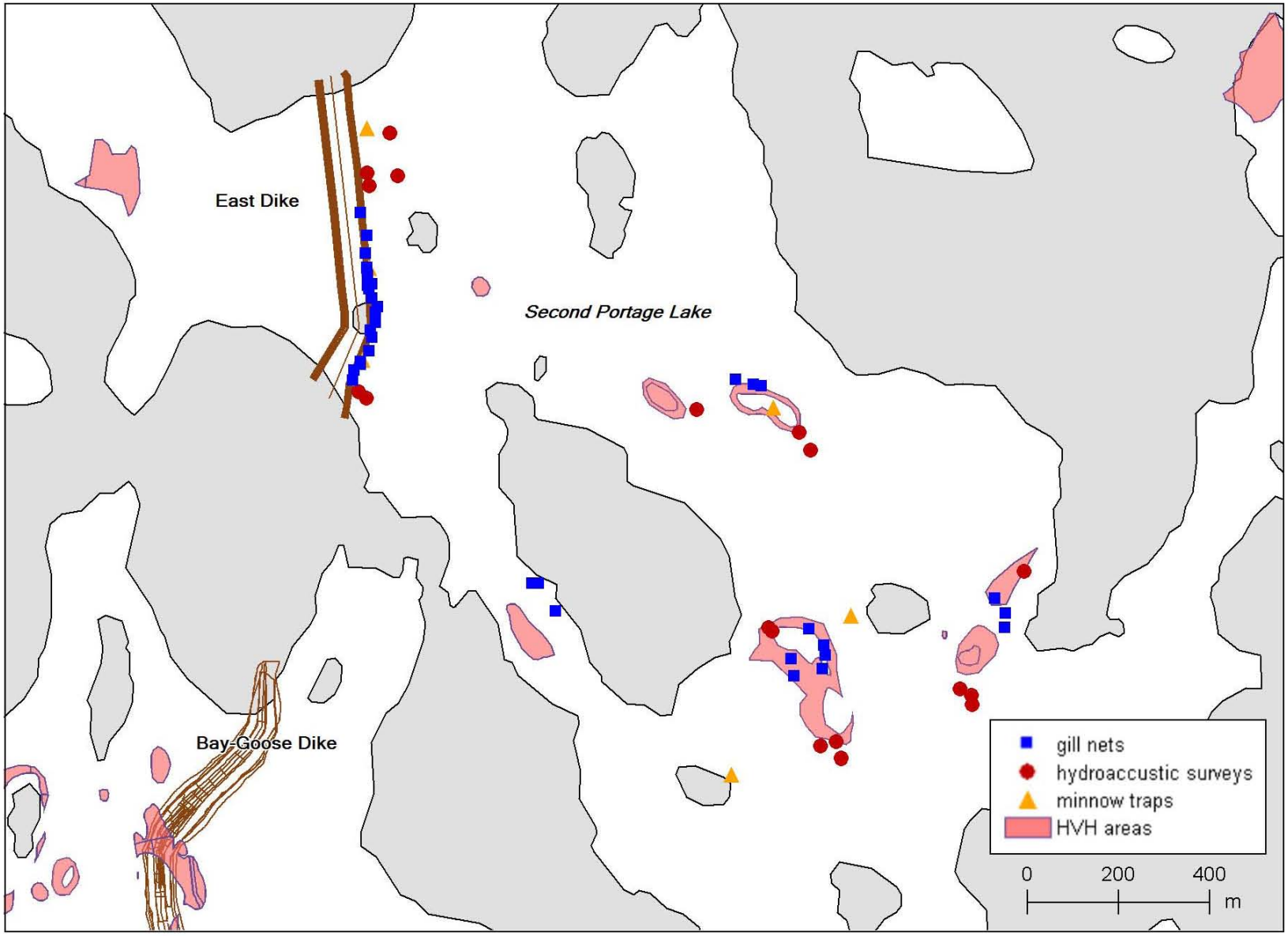
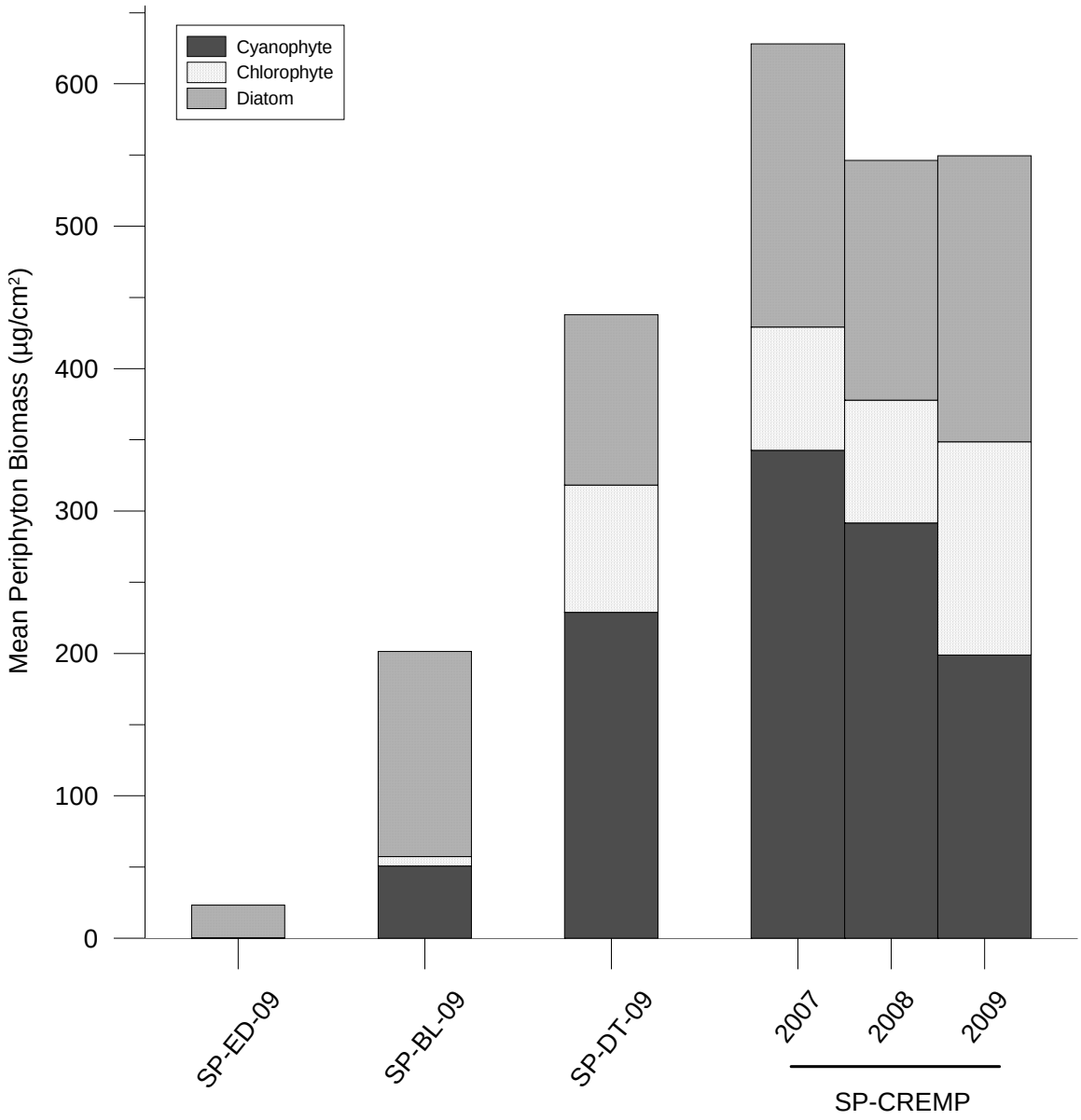


Figure 4. Mean periphyton biomass (ug/cm^2) on the East Dike face (SP-ED) and Second Portage Lake (SP-BL, SP-DT, SP-CREMP).



APPENDICES

APPENDIX A

PHOTOS OF INTERSTITIAL DIKE WATER SAMPLING

Photo A-1. The view of the East Dike face from the boat anchor point.

Photo A-2. Boat anchored to East Dike while placing pole with attached tube into interstitial space between rocks.

Photo A-3. A pole (4 m), with attached tube positioned between rocks of the East Dike, collected interstitial pore water.

Photo A-4. Interstitial pore water collection into a HDSV bucket for subsequent decanting into sampling containers.

APPENDIX B

STANDARD OPERATING PROCEDURES FOR INTERSTITIAL DIKE WATER SAMPLING

Standard Operating Procedure
Meadowbank Study Lakes & Baker Lake
Habitat Monitoring Interstitial Dike Water Sampling 2009

GENERAL:

Project Coordinator:
Maggie McConnell/Randy Baker
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Email: mmcconnell@azimuthgroup.ca, rbaker@azimuthgroup.ca

In case of **emergency**, contact Gary Mann (Azimuth telephone number 604-730-1220 or cell phone 604-908-0601).

OBJECTIVE:

In theory, the East Dike face has been designed to optimize its value as fish habitat, including the potential for serving as spawning habitat at depths greater than 2 m. Metals leaching from construction materials and impacting periphyton colonization or fish (largely by affecting incubating eggs) was raised as a potential concern during the environmental impact assessment process. Interstitial water quality, therefore, is included as a primary component of Tier 1 monitoring in the Habitat Compensation Monitoring Plan.

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Five sampling stations have been chosen for interstitial water quality monitoring of the East Dike face in Second Portage Lake, and are named ED-PW-1 through ED-PW-5. The 5 stations are located at regular intervals of (approximately 150 m) along the East Dike face from the north (ED-PW-1) to south shore (ED-PW-5). Water sample collection should occur at water depths of no more than 4 m and sampling should occur in early August or as soon as practicable, in calm weather.

INTERSTITIAL PORE WATER SAMPLING:

Following is the procedure to collect interstitial water for chemical analysis from within dike pore spaces along the East Dike:

1. Prior to leaving camp gather the appropriate type and number of sampling vessels and acid vials for preservation. Prepare appropriate labels for containers and affix them to the appropriate bottle (see below). Put the same information on the lid. Use the following information:
   - Azimuth company name
   - Station abbreviation (e.g. TPE-S, INUG-INT)

- Date of sample collection
- Parameters to be measured from individual bottle (conventionals, total metals, etc.)

2. Gather **field collection materials**:
   In the boat:
   - Field collection data forms, pencils, waterproof markers & clipboard
   - GPS unit, batteries
   - Water pump & 12V battery
   - Tubing & weight (& extra C-clamps and cable ties)
   - YSI meter, batteries
   - Secchi disk
   - Hand held pH meter, batteries
   - Depth meter, batteries
   - Bucket
   - Rope
   - Sampling gloves
   - Field sample bottles & preservatives (per sample):
     - 2 – 1 L plastic (TSS and Conventionals)
     - 1 – 250 mL amber glass (TKN, Ammonia)
     - 2 – 125 ml amber glass (TOC & DOC)
     - 2 – 250 mL plastic (total and dissolved metals)
     - 1 vial sulfuric acid
     - 2 vial hydrochloric acid
     - 2 vial nitric acid
     - 1 syringe & magnesium carbonate slurry

   - Extra sample bottles in case of breakage or loss
   - QA/QC field duplicate sampling containers & preservatives (same as above), at one randomly selected sampling station per sampling event
   - Take one set of Travel Blank bottles into the field and transport and treat as other samples. Note that the Travel Blank bottles are not to be opened and no preservatives added.

   In camp:
   - Hand pump, filters, tweezers, tinfoil and magnesium carbonate for chlorophyll-a
   - Coolers (for storing and shipping samples)
   - Ice packs (for shipping samples to laboratories)
   - Address labels for coolers
   - Chain-of-custody forms
   - Large Ziploc bags (for sending chain-of-custody form in cooler)
   - Packing tape (for affixing labels to sampling containers & sealing cooler)

   The following table lists the specific bottles to be filled, parameters to be measured and preservatives required for each. Affix the labels to the sampling containers and then prior to shipping, wrap packing tape around the labels to ensure a waterproof seal.

Sampling Container	Parameters to be Measured	Preservatives to be Added
3 - 1 L plastic	Conventionals*, TSS and chlorophyll-a (hand filter)**	None
250 mL amber glass	TKN, Ammonia	1 vial of sulfuric acid
250 mL plastic	Total Metals	1 vial of nitric acid
250 mL plastic	Dissolved Metals (FILTER)	1 vial of nitric acid
125 mL amber glass	TOC	1 vial of hydrochloric acid
125 mL amber glass	DOC (FILTER)	1 vial of hydrochloric acid

* includes: hardness, conductivity, pH, TDS, TSS-low, anion scan (nitrate, nitrite, chloride, sulfate) orthophosphate and total phosphate, silicate, alkalinity (speciated).
** **do not use filtrate water** for any sample Use the in-line filters for collecting dissolved metals and dissolved organic carbon samples.

3. Before and during sampling fill in the requested information on the field data form; complete one field data form in its entirety for each sampling station and sampling event. Forms are made of waterproof paper; print all information on the form using a lead pencil or a write-in-the-rain pen.

4. With the aid of a GPS unit, navigate the boat to the sampling station using the UTM coordinates (in NAD 83) provided. Approach the station from downstream of the wind direction. Within a 5 m radius of the prescribed area, anchor the boat along the shore from two or three points to stabilize the boat during water sampling as much as possible. Choose a calm day. Record the exact **UTM coordinates** on the field data form.

5. Water is to be sampled from 1 – 4 m depth and from within the pore spaces of the dike face. If needed, use the plexiglass box to view the bottom.

6. Place the hose attached to the 4 m long metal pole in the water. Note that the pole extends about 5 cm beyond the end of the hose to minimize entrainment of sediment off of the rock surfaces. During water collection pinch the incurrent end of the hose to minimize and control flow. It is critical that the intake speed of the water sample is quite slow so that true dike pore water is withdrawn, not overlying surface water by drawing water in at too high a rate.

7. Test the flow rate before sucking water from between dike rocks. Attach the alligator clips of the water pump to the battery and begin withdrawing surface water – allow to flush for at least 30 seconds. Turn off.

8. Stick the incurrent end of the hose between the rocks and into the pore space, being careful not to embed the tubing into the bottom and suck up any fine sediment that may be present. Try to keep the pole steady so that any sediment draped on the rocks is not disturbed and drawn into the water sample.

9. Once you have seated the pole and tubing into a dike pore space, turn pump on and allow pore water to flush through the tubing, displacing the surface water that is there. This will take about 15 seconds. Disconnect the battery and then place the excurrent hose into the bucket and then re-connect. Discharge water into a clean HDPE bucket at a rate of

approximately 0.5 L per minute or slower. Pump water for 10 – 15 seconds at this location. Disconnect the battery to stop the flow. Relocate the pole/tubing to a different spot and re-connect. Pump a further 10 – 15 seconds. REPEAT this procedure about 20 times or so, spotting the tubing around within reach of the anchored boat to composite pore water from a small radius and from 1 – 3 m depth. Don't forget to turn off the pump when you re-locate the tubing to avoid sucking in surface water.

10. Once about 5 L has been collected, turn off the pump and withdraw the pole. There should be very little sediment in the sample. Be careful not to disturb or suck up sediment that may be sitting in the pore spaces. If the water is cloudy, pour it out and start again.

11. Using a small hose place it into the bucket and from the bucket, pump water to the collecting vessels as listed in the table on p. 3.

12. Discharge water to all unfiltered sample bottles first; then, attach an inline groundwater filter and fill the dissolved metals and DOC bottles.

13. Consult the water collection SOP for further details if necessary.

14. Repeat this procedure at all five locations; place all sample bottles on ice in a cooler and ship the day following collection.

15. For **QAQC** purposes, a single field duplicate and an equipment blank will be collected during this event. In addition, a travel blank will be taken into the field during sampling and kept for the rest of the program. All parameters measured in the original sample are measured in the field duplicate that is randomly chosen from one of the five locations and labeled as station DUP-1. Record in the field log book the UTM coordinates, water depth and any other field observations of the water sampling exercise. Following the field collection, take an equipment blank using distilled water (excluding TSS).

PACKAGING & SHIPPING SAMPLES:

1. Ensure all **water samples** are **sealed** securely. Prior to shipping, it is advisable to wrap the label of each sample bottle with clear tape to make sure that the label does not come off during shipping and handling. Dry the water bottle and wrap with tape. **Pack** water sampling containers upright in coolers with ice packs, and packing material, to ensure samples do not spill or break during transport. (Ideal storage and transport temperature is 4°C).

2. Ensure the COC form is enclosed and then seal the cooler(s). **Label the cooler**(s) with the following address:

    ALS Environmental
    Suite 100, 8081 Lougheed Highway
    Burnaby BC Canada V5A 1W9
    Attention: Natasha Marcovic-Mirovic

3. **Ship** the water **samples** to ALS Environmental as quickly as possible.

4. Send completed **COC forms** and **field data forms** to **Azimuth** Consulting Group Inc., attention the project coordinator – Maggie McConnell.

APPENDIX C

PHOTOS OF PERIPHYTON COMMUNITY FROM UNDERWATER VIDEO IMAGERY

Photo C-1. (East Dike- midpoint) East Dike construction material primarily made of large jagged boulders.

Photo C-2. (East Dike, south end) Boulders piled upon one another, covered in a layer of sediment.

Photo C-3. (East Dike, near south end) Thick sedimentation on substrate with flat surface, while angled surface has much less settled sediment.

Photo C-4. (East Dike, near north end) Natural substrate completely coated in a thick layer of sediment.

Photo C-5. (East Dike, near north end) Natural substrate at the East Dike with periphyton coverage visible on rock sides, but not on top where sediment coverage is thick.

Photo C-6. (East Dike, north end) Heavy sedimentation and gravel debris from East Dike construction cover natural boulder substrate. While periphyton mats are evident on rock sides, sediment covers the top surface, giving the periphyton a grey colour.

Photo C-7. (East Dike, north end) Physical damage to periphyton mat likely either from ice scour or construction activities.

Photo C-8. (Second Portage Lake HVH1) Periphyton coverage on fines and cobble. The green colour of the periphyton may be muted due to settled sediment.

Photo C-9. (Second Portage Lake HVH3) Green, luxurious periphyton covering boulders, as a dense continuous mat.

Photo C-10. (Second Portage Lake HVH4) Patchy periphyton mat on boulder in shallow water may indicate ice scour.

Photo C-11. (Second Portage Lake HVH2) Flat surface with periphyton mat that is considerably less green, dense and luxuriant as compared to that on the vertical sides of boulders; this may be due to sediment smothering.

Photo C-12. (Third Portage Lake HVH4) Periphyton on fines are highly textured and form a continuous mat.

Photo C-13. (Third Portage Lake HVH2) A boulder covered with a very dense mat of periphyton with raised fronds.

Photo C-14. (Third Portage Lake HVH3) Boulders in shallow water (<2 m) covered in a continuous mat of green periphyton.

Photo C-15 a & b. (Third Portage Lake HVH3) The raised green fronds of a continuous mat of periphyton, covering the side of a boulder.

Photo C-16. (Third Portage Lake HVH2) Continuous mat of periphyton covering all substrates.

Photo C-17. (Third Portage Lake HVH2) Large boulders with patchy periphyton coverage which may be from ice scour (depth < 2m).

APPENDIX D

PHOTOS OF QUANTITATIVE PERIPHYTON SAMPLING

Dike Substrate

Photo D-1. Some evidence of periphyton colonization (brown colouring) on dike construction material.

Photo D-2. Rock from East Dike face nearly entirely covered in periphyton.

Photo D-3. Close up view of periphyton mat on dike construction substrate.

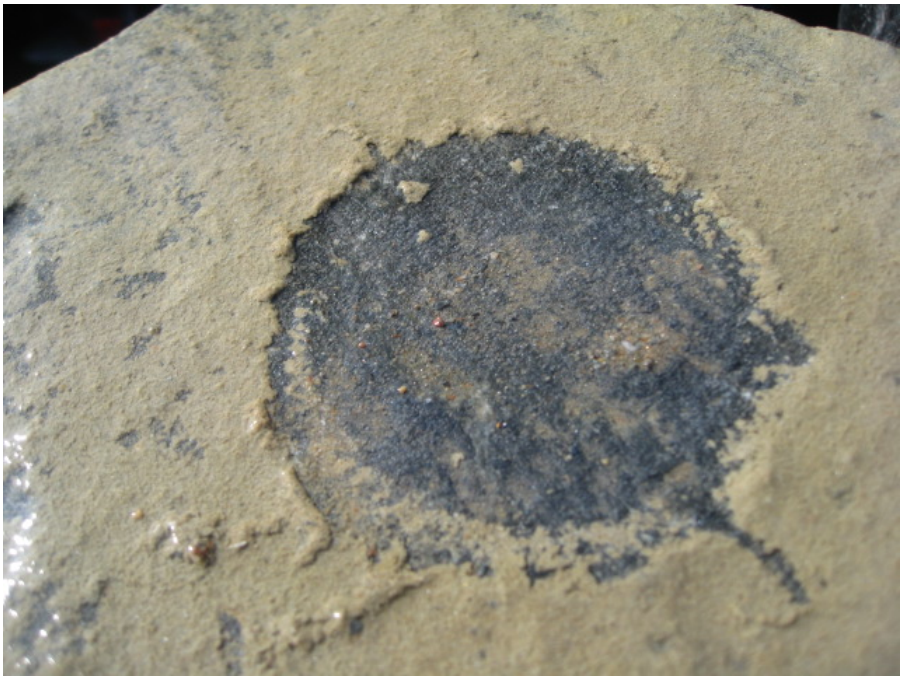

Photo D-4. Close up view of periphyton sampling area on dike construction substrate with some sandy residue remaining.

Natural Substrate

Photo D-5. Preparing the scrubber for removing periphyton from a rock.

Photo D-6. Scrubber in action.

APPENDIX E

PRESENCE (+) / ABSENCE (-) MATRIX OF PERIPHYTON SPECIES

Appendix E. Presence (+) / Absence (-) Matrix of Periphyton Species, Habitat Compensation Monitoring, 2009.

		ED					SP-BL					SP-AEMP					SP-DT				
	species code	1Q	2Q	3Q	4Q	5Q	001Q	002Q	003Q	004Q	005Q	P1Q	P2Q	P3Q	P4Q	P5Q	P1Q	P2Q	P3Q	P4Q	P5Q
	Cyanophyte																				
1014	*Chroococcus limneticus Lemmermann*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1070	*Anabaenopsis sp.*	+	-	-	-	-	-	+	+	-	-	-	+	-	+	+	-	-	-	+	-
1077	*Pseudoanabaena sp.*	-	+	-	+	+	+	-	+	-	-	+	+	+	-	+	-	-	-	+	-
1081	*Nostoc sp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-
1084	*Gloeocapsa punctata*	-	-	-	-	-	+	+	+	-	+	+	+	+	+	+	+	+	+	+	+
1122	*Phormidium autumnale Agardh*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
1124	*Petalonema alatum Berk*	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	-	-	-
1135	*Anabaena mendotae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
1136	*Lyngbya mucicola Lemmermann*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+
1219	*Stigonema mamillosum Gardner*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	+	+	+
1220	*Rivularia dura Roth*	-	-	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+
1226	*Chlorogloea sp*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chlorophyte																				
2178	*Cosmarium sp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
2193	*Staurodesmus paradoxum Meyen*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2199	*Spondylosium planum (Wolle) W. and G.S. West*	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
2205	*Mougeotia sp.*	-	-	-	-	-	+	-	-	-	+	+	+	-	+	-	-	+	+	+	-
2216	*Zygnema sp.*	-	-	-	-	-	-	-	-	-	-	+	+	-	+	+	+	-	-	-	-
2226	*Ulothrix sp.*	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-
2228	*Oedogonium sp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-
2231	*Bulbochaete sp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
2235	*Ankistrodesmus spiralis Lemmermann*	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2247	*Oocystis gigas Archer*	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-
	Chrysophyte																				
4390	*Dinobryon sociale Ehrenberg*	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Diatom																				
5507	*Cyclotella stelligera Cleve and Grunow*	-	+	+	-	+	+	+	-	-	+	+	-	-	+	+	-	-	-	+	+
5511	*Rhizosolenia eriense H.L. Smith*	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5513	*Tabellaria fenestrata (Lyngbye) Kutzing*	+	+	+	+	+	+	+	-	-	-	-	-	-	+	-	-	+	+	+	+
5514	*Tabellaria flocculsa (Roth) Kutzing*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+
5515	*Fragilaria crotonensis Kitton*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
5518	*Synedra acus Kutzing*	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-
5523	*Synedra ulna (Nitzsch) Ehrenberg*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
5538	*Penate diatoms*	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
5546	*Gyrosigma sp*	-	-	-	-	+	+	-	+	+	-	-	-	-	+	-	-	-	-	+	+
5547	*Frustulia rhomboides (Ehrenberg) de Toni*	-	-	-	-	-	-	-	-	+	-	+	-	-	-	+	+	+	+	-	+
5551	*Cyclotella michiganiana Skvortzow*	+	+	+	+	+	-	+	+	+	-	+	+	+	-	-	+	+	-	-	-
5702	*Achnanthes minutissima Kutzing*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5726	*Eucocconeis sp.*	-	+	-	-	-	-	+	+	-	-	-	+	-	+	+	+	-	-	-	+
5728	*Epithemia argus Kutzing*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-
5733	*Eunotia pectinalis (Kutzing) Rabenhorst*	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
5751	*Navicula incerta Grunow*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
5753	*Navicula sp.*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
5767	*Nitzschia fonticola Grunow*	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5778	*Stauroneis anceps Ehrenberg*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5781	*Eunotia sp.*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
5792	*Neidium iridis (Ehrenberg) Cleve*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
5794	*Pinnularia flexuosa Cleve*	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
5821	*Eunotia exigua (Brebisson) Grunow*	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	+	-
5822	*Tabellaria binalis (Ehrenberg) Grunow*	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5825	*Fragilaria pinata Ehrenberg*	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-
5826	*Cymbella gracilis (Rabhorst) Cleve*	-	-	-	+	-	+	-	-	+	+	+	+	+	-	-	-	-	+	-	-
5833	*Pinnularia biceps Gregory*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
5834	*Cymbella microcephala Grunow*	+	+	-	+	+	+	-	+	+	-	-	-	-	-	+	+	+	-	-	+
5836	*Encyonema silesiacum (Bleisch) D.G. Mann*	+	+	-	-	-	-	-	-	+	+	+	-	-	+	+	-	+	-	-	-
5854	*Pinnularia borealis Ehrenberg*	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-	-	-	-
5857	*Nitzschia filiformis (W. Smith) Hustedt*	-	+	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-
5860	*Diatoma vulgare Bory*	-	-	-	-	+	+	-	-	+	-	-	-	+	-	+	-	-	-	+	-	+
5864	*Neidium gracile Hustedt*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
5865	*Cymbella prostata (Berkeley) Cleve*	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-
5866	*Surirella ovata Kutzing*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
5870	*Navicula radiosa Kutzing*	-	-	-	-	-	-	-	+	-	-	-	-	+	+	-	-	-	+	-	+
5873	*Gomphonema minutum*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	+	-
5874	*Nitzschia palea (Kutzing) W. Smith*	-	+	-	+	+	-	+	-	-	-	-	-	+	+	+	-	+	-	-	+
5875	*Cocconies disculus Schum.*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-
5882	*Anomoenies vitrea Ross*	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5884	*Gomphonema angustum Agardh*	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+
5887	*Navicula pupula Kutzing*	-	-	-	+	-	-	+	+	+	+	-	-	-	-	-	+	-	-	+	-
5908	*Diatoma tenue Agardh*	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
5916	*Fragilaria capucina Grunow*	+	+	+	+	+	+	+	+	+	+	-	+	-	-	-	-	+	+	-	-

APPENDIX F

ALS LABORATORY REPORTS FOR INTERSTITIAL WATER CHEMISTRY

Certificate of Analysis

AZIMUTH CONSULTING GROUP INC.
ATTN: RANDY BAKER
218 - 2902 WEST BROADWAY
VANCOUVER BC V6K 2G8

Report Date: 01-SEP-09 18:39 (MT)
Version: FINAL

Lab Work Order #: **L808869** **Date Received:** **21-AUG-09**

Project P.O. #:
Job Reference: MEADOWBANK MINE HABITAT
Legal Site Desc:
CofC Numbers:
Other Information:

Comments:

Can Dang
Account Manager

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L808869-1	L808869-2	L808869-3	L808869-4	L808869-5
	Description					
	Sampled Date	06-AUG-09	06-AUG-09	06-AUG-09	08-AUG-09	08-AUG-09
	Sampled Time					
	Client ID	ED-PW-1	ED-PW-2	ED-PW-3	ED-PW-4	ED-PW-5
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	30.7	24.1	22.9	24.0	24.6
	Hardness (as CaCO3) (mg/L)	11.8	10.3	9.3	9.8	9.7
	pH (pH)	6.42	6.85	6.88	6.92	6.90
	Total Suspended Solids (mg/L)	56.1	6.5	3.9	18.5	20.5
	Total Dissolved Solids (mg/L)	17	12	13	<10	<10
	Turbidity (NTU)	29.5	1.36	1.77	10.4	7.77
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	7.1	8.4	7.4	8.5	8.5
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Total (as CaCO3) (mg/L)	7.1	8.4	7.4	8.5	8.5
	Ammonia as N (mg/L)	<0.020	<0.020	<0.020	<0.020	0.024
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)	0.77	0.52	<0.50	0.51	0.51
	Fluoride (F) (mg/L)	0.047	0.047	0.047	0.049	0.049
	Nitrate (as N) (mg/L)	0.130	0.0112	<0.0050	0.0161	0.0183
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Total Kjeldahl Nitrogen (mg/L)	0.331	0.156	0.145	0.176	0.137
	Ortho Phosphate as P (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Total Phosphate as P (mg/L)	0.0108	0.0039	<0.0020	0.0095	0.0028
	Silicate (as SIO2) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Sulfate (SO4) (mg/L)	4.79	2.26	2.05	2.09	2.13
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	3.32	1.85	1.78	1.67	1.65
	Total Organic Carbon (mg/L)	1.70	1.85	1.64	1.72	1.68
Total Metals	Aluminum (Al)-Total (mg/L)	1.35	0.148	0.0811	0.449	0.241
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Total (mg/L)	0.00075	<0.00050	<0.00050	<0.00050	<0.00050
	Barium (Ba)-Total (mg/L)	<0.020	<0.020	<0.020	<0.020	<0.020
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
	Calcium (Ca)-Total (mg/L)	3.40	2.84	2.42	2.81	2.72
	Chromium (Cr)-Total (mg/L)	0.0057	0.0011	<0.0010	0.0026	0.0019
	Cobalt (Co)-Total (mg/L)	0.00093	<0.00030	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Total (mg/L)	0.0034	0.0012	0.0010	0.0015	0.0013
	Iron (Fe)-Total (mg/L)	1.92	0.228	0.130	0.641	0.388
	Lead (Pb)-Total (mg/L)	0.00141	0.00077	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Magnesium (Mg)-Total (mg/L)	1.61	0.90	0.80	1.04	0.91
	Manganese (Mn)-Total (mg/L)	0.0337	0.00759	0.00356	0.0156	0.0159
	Mercury (Hg)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L808869-6	L808869-7	L808869-8	L808869-9	L808869-10
	Description					
	Sampled Date	08-AUG-09	08-AUG-09	08-AUG-09	08-AUG-09	08-AUG-09
	Sampled Time					
	Client ID	DC-WQ-SP8	DC-WQ-BGE1	DC-WQ-BGW2	DC-WQ-BGE3	DC-WQ-BGE-5
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)					
	Hardness (as CaCO3) (mg/L)					
	pH (pH)					
	Total Suspended Solids (mg/L)					
	Total Dissolved Solids (mg/L)					
	Turbidity (NTU)					
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)					
	Alkalinity, Carbonate (as CaCO3) (mg/L)					
	Alkalinity, Hydroxide (as CaCO3) (mg/L)					
	Alkalinity, Total (as CaCO3) (mg/L)					
	Ammonia as N (mg/L)					
	Bromide (Br) (mg/L)					
	Chloride (Cl) (mg/L)					
	Fluoride (F) (mg/L)					
	Nitrate (as N) (mg/L)					
	Nitrite (as N) (mg/L)					
	Total Kjeldahl Nitrogen (mg/L)					
	Ortho Phosphate as P (mg/L)					
	Total Phosphate as P (mg/L)					
	Silicate (as SIO2) (mg/L)					
	Sulfate (SO4) (mg/L)					
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)					
	Total Organic Carbon (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)					
	Antimony (Sb)-Total (mg/L)					
	Arsenic (As)-Total (mg/L)					
	Barium (Ba)-Total (mg/L)					
	Beryllium (Be)-Total (mg/L)					
	Boron (B)-Total (mg/L)					
	Cadmium (Cd)-Total (mg/L)					
	Calcium (Ca)-Total (mg/L)					
	Chromium (Cr)-Total (mg/L)					
	Cobalt (Co)-Total (mg/L)					
	Copper (Cu)-Total (mg/L)					
	Iron (Fe)-Total (mg/L)					
	Lead (Pb)-Total (mg/L)					
	Lithium (Li)-Total (mg/L)					
	Magnesium (Mg)-Total (mg/L)					
	Manganese (Mn)-Total (mg/L)					
	Mercury (Hg)-Total (mg/L)					

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L808869-11	L808869-12	L808869-13	L808869-14	L808869-15
	Description					
	Sampled Date	08-AUG-09	08-AUG-09	08-AUG-09	10-AUG-09	10-AUG-09
	Sampled Time					
	Client ID	DC-WQ-HVH-2	DC-WQ-HVH-4	DC-WQ-DUP	ED-PW-DUP	ED-PW-EQUIPMENT BLANK
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)				24.8	<2.0
	Hardness (as CaCO3) (mg/L)				9.9	<1.1
	pH (pH)				6.89	5.72
	Total Suspended Solids (mg/L)				23.9	<1.0
	Total Dissolved Solids (mg/L)				12	<10
	Turbidity (NTU)				3.45	0.32
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)				8.3	<2.0
	Alkalinity, Carbonate (as CaCO3) (mg/L)				<2.0	<2.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)				<2.0	<2.0
	Alkalinity, Total (as CaCO3) (mg/L)				8.3	<2.0
	Ammonia as N (mg/L)				<0.020	<0.020
	Bromide (Br) (mg/L)				<0.050	<0.050
	Chloride (Cl) (mg/L)				0.67	<0.50
	Fluoride (F) (mg/L)				0.049	<0.020
	Nitrate (as N) (mg/L)				0.0144	<0.0050
	Nitrite (as N) (mg/L)				<0.0010	<0.0010
	Total Kjeldahl Nitrogen (mg/L)				0.294	<0.050
	Ortho Phosphate as P (mg/L)				<0.0010	<0.0010
	Total Phosphate as P (mg/L)				0.0036	<0.0020
	Silicate (as SIO2) (mg/L)				<1.0	<1.0
	Sulfate (SO4) (mg/L)				2.17	<0.50
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)				2.20	<0.50
	Total Organic Carbon (mg/L)				1.60	<0.50
Total Metals	Aluminum (Al)-Total (mg/L)				0.554	<0.0050
	Antimony (Sb)-Total (mg/L)				<0.00050	<0.00050
	Arsenic (As)-Total (mg/L)				<0.00050	<0.00050
	Barium (Ba)-Total (mg/L)				<0.020	<0.020
	Beryllium (Be)-Total (mg/L)				<0.0010	<0.0010
	Boron (B)-Total (mg/L)				<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)				<0.000017	<0.000017
	Calcium (Ca)-Total (mg/L)				2.70	<0.10
	Chromium (Cr)-Total (mg/L)				0.0036	<0.0010
	Cobalt (Co)-Total (mg/L)				0.00034	<0.00030
	Copper (Cu)-Total (mg/L)				0.0015	<0.0010
	Iron (Fe)-Total (mg/L)				0.821	<0.030
	Lead (Pb)-Total (mg/L)				<0.00050	<0.00050
	Lithium (Li)-Total (mg/L)				<0.0050	<0.0050
	Magnesium (Mg)-Total (mg/L)				1.11	<0.10
	Manganese (Mn)-Total (mg/L)				0.0156	<0.00030
	Mercury (Hg)-Total (mg/L)				<0.000020	<0.000020

ALS LABORATORY GROUP ANALYTICAL REPORT

		Sample ID	L808869-1	L808869-2	L808869-3	L808869-4	L808869-5
		Description					
		Sampled Date	06-AUG-09	06-AUG-09	06-AUG-09	08-AUG-09	08-AUG-09
		Sampled Time					
		Client ID	ED-PW-1	ED-PW-2	ED-PW-3	ED-PW-4	ED-PW-5
Grouping	**Analyte**						
WATER							
Total Metals	Molybdenum (Mo)-Total (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)		0.0040	<0.0010	<0.0010	0.0016	0.0013
	Potassium (K)-Total (mg/L)		<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Silver (Ag)-Total (mg/L)		<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Total (mg/L)		<2.0	<2.0	<2.0	<2.0	<2.0
	Thallium (Tl)-Total (mg/L)		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Total (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Total (mg/L)		0.061	<0.010	<0.010	0.020	<0.010
	Uranium (U)-Total (mg/L)		0.00040	<0.00020	<0.00020	<0.00020	<0.00020
	Vanadium (V)-Total (mg/L)		0.0023	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)		0.0151	0.0093	0.0071	0.0076	0.0083
Dissolved Metals	Aluminum (Al)-Dissolved (mg/L)		0.0109	0.0140	0.0070	0.0084	0.0104
	Antimony (Sb)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Barium (Ba)-Dissolved (mg/L)		<0.020	<0.020	<0.020	<0.020	<0.020
	Beryllium (Be)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Dissolved (mg/L)		<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)		<0.000017	<0.000017	<0.000017	<0.000017	<0.000017
	Calcium (Ca)-Dissolved (mg/L)		3.27	2.79	2.48	2.60	2.63
	Chromium (Cr)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Dissolved (mg/L)		<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Dissolved (mg/L)		0.0018	<0.0010	<0.0010	0.0012	<0.0010
	Iron (Fe)-Dissolved (mg/L)		<0.030	<0.030	<0.030	<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Magnesium (Mg)-Dissolved (mg/L)		0.88	0.82	0.76	0.80	0.77
	Manganese (Mn)-Dissolved (mg/L)		0.00252	0.00123	0.00070	0.00089	0.00140
	Mercury (Hg)-Dissolved (mg/L)		<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Molybdenum (Mo)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	0.0028	<0.0010
	Potassium (K)-Dissolved (mg/L)		<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Silver (Ag)-Dissolved (mg/L)		<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Dissolved (mg/L)		<2.0	<2.0	<2.0	<2.0	<2.0
	Thallium (Tl)-Dissolved (mg/L)		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Dissolved (mg/L)		<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Vanadium (V)-Dissolved (mg/L)		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Dissolved (mg/L)		0.0157	0.0087	<0.0050	<0.0050	<0.0050

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	Sample ID	L808869-6	L808869-7	L808869-8	L808869-9	L808869-10
	Description					
	Sampled Date	08-AUG-09	08-AUG-09	08-AUG-09	08-AUG-09	08-AUG-09
	Sampled Time					
	Client ID	DC-WQ-SP8	DC-WQ-BGE1	DC-WQ-BGW2	DC-WQ-BGE3	DC-WQ-BGE-5
Grouping	**Analyte**					
WATER						
Total Metals	Molybdenum (Mo)-Total (mg/L)					
	Nickel (Ni)-Total (mg/L)					
	Potassium (K)-Total (mg/L)					
	Selenium (Se)-Total (mg/L)					
	Silver (Ag)-Total (mg/L)					
	Sodium (Na)-Total (mg/L)					
	Thallium (Tl)-Total (mg/L)					
	Tin (Sn)-Total (mg/L)					
	Titanium (Ti)-Total (mg/L)					
	Uranium (U)-Total (mg/L)					
	Vanadium (V)-Total (mg/L)					
	Zinc (Zn)-Total (mg/L)					
Dissolved Metals	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					
	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					
	Manganese (Mn)-Dissolved (mg/L)					
	Mercury (Hg)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					

ALS LABORATORY GROUP ANALYTICAL REPORT

		Sample ID	L808869-11	L808869-12	L808869-13	L808869-14	L808869-15
		Description					
		Sampled Date	08-AUG-09	08-AUG-09	08-AUG-09	10-AUG-09	10-AUG-09
		Sampled Time					
		Client ID	DC-WQ-HVH-2	DC-WQ-HVH-4	DC-WQ-DUP	ED-PW-DUP	ED-PW-EQUIPMENT BLANK
Grouping	**Analyte**						
WATER							
Total Metals	Molybdenum (Mo)-Total (mg/L)					<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)					0.0019	<0.0010
	Potassium (K)-Total (mg/L)					<2.0	<2.0
	Selenium (Se)-Total (mg/L)					<0.0010	<0.0010
	Silver (Ag)-Total (mg/L)					<0.000020	<0.000020
	Sodium (Na)-Total (mg/L)					<2.0	<2.0
	Thallium (Tl)-Total (mg/L)					<0.00020	<0.00020
	Tin (Sn)-Total (mg/L)					<0.00050	<0.00050
	Titanium (Ti)-Total (mg/L)					0.024	<0.010
	Uranium (U)-Total (mg/L)					0.00024	<0.00020
	Vanadium (V)-Total (mg/L)					<0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)					0.0065	0.0081
Dissolved Metals	Aluminum (Al)-Dissolved (mg/L)					0.0086	<0.0050
	Antimony (Sb)-Dissolved (mg/L)					<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)					<0.00050	<0.00050
	Barium (Ba)-Dissolved (mg/L)					<0.020	<0.020
	Beryllium (Be)-Dissolved (mg/L)					<0.0010	<0.0010
	Boron (B)-Dissolved (mg/L)					<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)					<0.000017	<0.000017
	Calcium (Ca)-Dissolved (mg/L)					2.60	<0.10
	Chromium (Cr)-Dissolved (mg/L)					<0.0010	<0.0010
	Cobalt (Co)-Dissolved (mg/L)					<0.00030	<0.00030
	Copper (Cu)-Dissolved (mg/L)					0.0016	<0.0010
	Iron (Fe)-Dissolved (mg/L)					<0.030	<0.030
	Lead (Pb)-Dissolved (mg/L)					<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)					<0.0050	<0.0050
	Magnesium (Mg)-Dissolved (mg/L)					0.82	<0.10
	Manganese (Mn)-Dissolved (mg/L)					0.00113	<0.00030
	Mercury (Hg)-Dissolved (mg/L)					<0.000020	<0.000020
	Molybdenum (Mo)-Dissolved (mg/L)					<0.0010	<0.0010
	Nickel (Ni)-Dissolved (mg/L)					<0.0010	<0.0010
	Potassium (K)-Dissolved (mg/L)					<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)					<0.0010	<0.0010
	Silver (Ag)-Dissolved (mg/L)					<0.000020	<0.000020
	Sodium (Na)-Dissolved (mg/L)					<2.0	<2.0
	Thallium (Tl)-Dissolved (mg/L)					<0.00020	<0.00020
	Tin (Sn)-Dissolved (mg/L)					<0.00050	<0.00050
	Titanium (Ti)-Dissolved (mg/L)					<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)					<0.00020	<0.00020
	Vanadium (V)-Dissolved (mg/L)					<0.0010	<0.0010
	Zinc (Zn)-Dissolved (mg/L)					0.0105	<0.0050

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L808869-1	L808869-2	L808869-3	L808869-4	L808869-5
	Description					
	Sampled Date	06-AUG-09	06-AUG-09	06-AUG-09	08-AUG-09	08-AUG-09
	Sampled Time					
	Client ID	ED-PW-1	ED-PW-2	ED-PW-3	ED-PW-4	ED-PW-5
Grouping	**Analyte**					
WATER						
Plant Pigments	Chlorophyll a (ug/L)					

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L808869-6	L808869-7	L808869-8	L808869-9	L808869-10
	Description					
	Sampled Date	08-AUG-09	08-AUG-09	08-AUG-09	08-AUG-09	08-AUG-09
	Sampled Time					
	Client ID	DC-WQ-SP8	DC-WQ-BGE1	DC-WQ-BGW2	DC-WQ-BGE3	DC-WQ-BGE-5
Grouping	**Analyte**					
WATER						
Plant Pigments	Chlorophyll a (ug/L)	0.396	0.343	0.248	0.290	0.499

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L808869-11	L808869-12	L808869-13	L808869-14	L808869-15
	Description					
	Sampled Date	08-AUG-09	08-AUG-09	08-AUG-09	10-AUG-09	10-AUG-09
	Sampled Time					
	Client ID	DC-WQ-HVH-2	DC-WQ-HVH-4	DC-WQ-DUP	ED-PW-DUP	ED-PW-EQUIPMENT BLANK
Grouping	**Analyte**					
WATER						
Plant Pigments	Chlorophyll a (ug/L)	0.481	0.489	0.528		

Reference Information

Additional Comments for Sample Listed:

Samplenum	Matrix	Report Remarks	Sample Comments

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Analytical Method Reference(Based On)
ALK-SCR-VA	Water	Alkalinity by colour or titration	EPA 310.2 OR APHA 2320

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.
OR
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-BR-IC-VA	Water	Bromide by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-F-IC-VA	Water	Fluoride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-NO2-IC-VA	Water	Nitrite by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Specifically, the nitrite detection is by UV absorbance and not conductivity.

ANIONS-NO3-IC-VA	Water	Nitrate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Specifically, the nitrate detection is by UV absorance and not conductivity.

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 "TOTAL ORGANIC CARBON (TOC)"

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 "TOTAL ORGANIC CARBON (TOC)"

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Analytical Method Reference(Based On)
CHLOROA-VA	Water	Chlorophyll a by Fluorometer	EPA 445.0

Chlorophyll and Pheopigments by Fluorometry analysis is carried out using procedures adapted from USEPA Method 445.0. The sample is filtered using either a glass fiber filter or a 0.45 micron Membrane filter. The pigments are extracted from the filter with 90% aqueuos acetone. For chlorophyll-a analysis the extract is read using a fluorometer. For pheopigments the extract is first acidified then read. This method is not subject to interferences from chlorophyll b.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness is calculated from Calcium and Magnesium concentrations, and is expressed as calcium carbonate equivalents.

HG-DIS-CCME-CVAFS-VA	Water	Diss. Mercury in Water by CVAFS (CCME)	EPA 3005A/245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).

HG-TOT-CCME-CVAFS-VA	Water	Total Mercury in Water by CVAFS (CCME)	EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).

MET-DIS-CCME-ICP-VA	Water	Diss. Metals in Water by ICPOES (CCME)	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-DIS-CCME-MS-VA	Water	Diss. Metals in Water by ICPMS (CCME)	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

MET-TOT-CCME-ICP-VA	Water	Total Metals in Water by ICPOES (CCME)	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-TOT-CCME-MS-VA	Water	Total Metals in Water by ICPMS (CCME)	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

NH3-SIE-VA	Water	Ammonia by SIE	APHA 4500 D. - NH3 NITROGEN (AMMONIA)

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Analytical Method Reference(Based On)
		This analysis is carried out, on sulphuric acid preserved samples, using procedures adapted from APHA Method 4500-NH3 "Nitrogen (Ammonia)". Ammonia is determined using an ammonia selective electrode.	
PH-MAN-VA	Water	pH by Manual Meter	APHA 4500-H "pH Value"
		This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.	
PH-MAN-VA	Water	pH by Manual Meter	APHA 4500-H pH Value
		This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.	
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"
		This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode	
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value
		This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode	
PO4-DO-COL-VA	Water	Dissolved ortho Phosphate by Colour	APHA 4500-P "Phosphorous"
		This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". All forms of phosphate are determined by the ascorbic acid colourimetric method. Dissolved ortho-phosphate (dissolved reactive phosphorous) is determined by direct measurement. Total phosphate (total phosphorous) is determined after persulphate digestion of a sample. Total dissolved phosphate (total dissolved phosphorous) is determined by filtering a sample through a 0.45 micron membrane filter followed by persulfate digestion of the filtrate.	
PO4-DO-COL-VA	Water	Dissolved ortho Phosphate by Colour	APHA 4500-P Phosphorous
		This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". All forms of phosphate are determined by the ascorbic acid colourimetric method. Dissolved ortho-phosphate (dissolved reactive phosphorous) is determined by direct measurement. Total phosphate (total phosphorous) is determined after persulphate digestion of a sample. Total dissolved phosphate (total dissolved phosphorous) is determined by filtering a sample through a 0.45 micron membrane filter followed by persulfate digestion of the filtrate.	
PO4-T-COL-VA	Water	Total Phosphate P by Color	APHA 4500-P "Phosphorous"
		This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". All forms of phosphate are determined by the ascorbic acid colourimetric method. Dissolved ortho-phosphate (dissolved reactive phosphorous) is determined by direct measurement. Total phosphate (total phosphorous) is determined after persulphate digestion of a sample. Total dissolved phosphate (total dissolved phosphorous) is determined by filtering a sample through a 0.45 micron membrane filter followed by persulfate digestion of the filtrate.	
PO4-T-COL-VA	Water	Total Phosphate P by Color	APHA 4500-P Phosphorous
		This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". All forms of phosphate are determined by the ascorbic acid colourimetric method. Dissolved ortho-phosphate (dissolved reactive phosphorous) is determined by direct measurement. Total phosphate (total phosphorous) is determined after persulphate digestion of a sample. Total dissolved phosphate (total dissolved phosphorous) is determined by filtering a sample through a 0.45 micron membrane filter followed by persulfate digestion of the filtrate.	
SILICATE-COL-VA	Water	Silicate by Colourimetric analysis	APHA 4500-SIO2 D.
		This analysis is carried out using procedures adapted from APHA Method 4500-SiO2 D. "Silica". Silicate (molybdate-reactive silica) is determined by the molybdosilicate-heteropoly blue colourimetric method.	
TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC
		This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.	
TKN-SIE-VA	Water	Total Kjeldahl Nitrogen by SIE	APHA 4500-Norg (TKN)

Reference Information

Methods Listed (if applicable):

ALS Test Code	Matrix	Test Description	Analytical Method Reference(Based On)
		This analysis is carried out using procedures adapted from APHA Method 4500-Norg "Nitrogen (Organic)". Total kjeldahl nitrogen is determined by sample digestion at 367 celcius with analysis using an ammonia selective electrode.	
TSS-LOW-VA	Water	Total Suspended Solids by Grav. (1 mg/L)	APHA 2540 Gravimetric
		This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.	
TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"
		This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.	
TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity
		This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.	

** Laboratory Methods employed follow in-house procedures, which are generally based on nationally or internationally accepted methodologies.
The last two letters of the above ALS Test Code column indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location	Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA		

GLOSSARY OF REPORT TERMS
Surr - A surrogate is an organic compound that is similar to the target analyte(s) in chemical composition and behavior but not normally detected in enviromental samples. Prior to sample processing, samples are fortified with one or more surrogate compounds.
The reported surrogate recovery value provides a measure of method efficiency.
mg/kg (units) - unit of concentration based on mass, parts per million
mg/L (units) - unit of concentration based on volume, parts per million
N/A - Result not available. Refer to qualifier code and definition for explanation

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Although test results are generated under strict QA/QC protocols, any unsigned test reports, faxes, or emails are considered preliminary.

ALS Laboratory Group has an extensive QA/QC program where all analytical data reported is analyzed using approved referenced procedures followed by checks and reviews by senior managers and quality assurance personnel. However, since the results are obtained from chemical measurements and thus cannot be guaranteed, ALS Laboratory Group assumes no liability for the use or interpretation of the results.

Short Holding Time

Rush Processing Required

ALS Laboratory
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

in of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Page 1 of 2

Report to: Randy Baker	**Report Format / Distribution**	**Service Requested:**
Company: Azimuth Consulting Group Inc.	☑ Standard ☐ Other	☑ Regular Service (Default)
Contact: Randy Baker	☑ PDF ☑ Excel ☐ Fax	☐ Rush Service (2-3 Days)
Address: Vancouver	Email 1: rbaker@azimuthgroup.ca	☐ Priority Service (1 Day or ASAP)
	Email 2: gmann@azimuthgroup.ca , mmcconnell@azimuthgroup.ca	☐ Emergency Service (<1 Day / Wkend) - Contact ALS
Phone: 604-730-1220 Fax:		**Analysis Request**
Invoice To: ☑ Same as Report	Indicate Bottles Filtered / Preserved (F/P) →→	
Company:	**Client / Project Information:**	
Contact:	Job #: Meadowbank Mine HABITAT	
Address:	PO/AFE:	
Sample	Legal Site Description:	
Phone: Fax:	Quote #: ALSEQ09-077	
Lab Work Order # (lab use only): L808869	**ALS Contact:** Natasha MM **Sampler** (Initials)	

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	T-Metals (CCME)	D-Metals (CCME)	TOC, DOC	TKN, Ammonia	TDS, TSS-low	Alk (SPECIATED)	Anion Scan, Si, pH, EC	T-PO4, ortho-PO4	Chlorophyll-a	Turbidity	Hazardous?	Highly Contaminated?	Number of Containers
	ED-PW-1	06-Aug-09		Water	x	x	x	x	x	x	x	x		x			
	ED-PW-2	06-Aug-09		Water	x	x	x	x	x	x	x	x		x			
	ED-PW-3	06-Aug-09		Water	x	x	x	x	x	x	x	x		x			
	ED-PW-4	08-Aug-09		Water	x	x	x	x	x	x	x	x		x			
	ED-PW-5	08-Aug-09		Water	x	x	x	x	x	x	x	x		x			
	DC-WQ-SP8	08-Aug-09		Water									x				
	DC-WQ-BGE1	08-Aug-09		Water									x				
	DC-WQ-BGW2	08-Aug-09		Water									x				
	DC-WQ-BGE3	08-Aug-09		Water									x				
	DC-WQ-BGE-5	08-Aug-09		Water									x				

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	NOTE: Phytoplankton samples are part of Dike Construction program submitted on August 11 COC

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

Relinquished By	Randy Baker	Date & Time	09-Aug-09	Received By.	[illegible]	Date & Time	08/21/09 , 1[illegible] PM
Relinquished By		Date & Time		Received By		Date & Time	

Sample Condition (lab use only)	
Temperature	Samples Received in Good Condition? Y / N (if no provided details)
21°C	

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

Report to: Randy Baker	**Report Format / Distribution**	**Service Requested:**	
Company: Azimuth Consulting Group Inc.	☑ Standard ☐ Other	☑	Regular Service (Default)
Contact: Randy Baker	☑ PDF ☑ Excel ☐ Fax	☐	Rush Service (2-3 Days)
Address: Vancouver	Email 1: rbaker@azimuthgroup.ca	☐	Priority Service (1 Day or ASAP)
	Email 2: gmann@azimuthgroup.ca , mmcconnell@azimuthgroup.ca	☐	Emergency Service (<1 Day / Wkend) - Contact ALS
Phone: 604-730-1220 Fax:		**Analysis Request**	
Invoice To: ☑ Same as Report	Indicate Bottles Filtered / Preserved (F/P) →		
Company:	**Client / Project Information:**		
Contact:	Job #: Meadowbank Mine HABITAT		
Address:	PO/AFE:		
Sample	Legal Site Description:		
Phone: Fax:	Quote #: ALSEQ09-077		

Lab Work Order # (lab use only): L808869 | **ALS Contact:** Natasha MM | **Sampler** (Initials)

Sample #	Sample Identification (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type (Select from drop-down list)	T-Metals (CCME)	D-Metals (CCME)	TOC, DOC	TKN, Ammonia	TDS, TSS-low	Alk (SPECIATED)	Anion Scan, Si, pH, EC	T-PO4, ortho-PO4	Chlorophyll-a	Turbidity	Hazardous?	Highly Contaminated?	Number of Containers
	DC-WQ-HVH-2	08-Aug-09		Water									x				
	DC-WQ-HVH-4	08-Aug-09		Water									x				
	DC-WQ-DUP	08-Aug-09		Water									x				
	ED-PW-DUP	10-Aug-09		Water	x	x	x	x	x	x	x	x		x			
	ED-PW-Equipment Blank	10-Aug-09		Water	x	x	x	x	x	x	x	x		x			

Guidelines / Regulations	**Special Instructions / Hazardous Details**
	NOTE: Phytoplankton samples are part of Dike Construction program submitted on August 11 COC

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the adjacent worksheet.

								Sample Condition (lab use only)	
Relinquished By	Randy Baker	Date & Time	09-Aug-09	Received By.	[illegible]	Date & Time	08/21/09 . 10⁷ PM	Temperature	Samples Received in Good Condition? Y / N (if no provided details)
Relinquished By:		Date & Time		Received By:		Date & Time.		21°C	