AGNICO-EAGLE
MEADOWBANK DIVISION

January 13, 2011

Via Email and Xpresspost

Mr. Richard Dwyer
Licensing Administrator
Nunavut Water Board
P.O. Box 119
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Dear Mr. Dwyer:

Re: Water License 2AM-MEA0815 - Submission of Meadowbank Aquatic Effects Management Program, Version 1, May 2010 and Core Receiving Environment Monitoring Program V2, June 2010

Please find enclosed the Meadowbank Aquatic Effects Management Program Version 1, May 2010 and an updated Core Receiving Environmental Monitoring Program V2, June 2010. These documents are submitted in follow-up to meetings held in March and June, 2010. The following letter describes the rationale for the submission of the revised programs and details the next steps for redesigning the Meadowbank Core Receiving Environmental Monitoring Program.

The Aquatic Effects Management Program (AEMP) for Agnico-Eagle Mines Limited's (AEM) Meadowbank Gold Project was included as part of the Environmental Assessment (EA) for the Project in 2005 (AEMP 2005), and has been formally implemented since 2006. Water License 2AM-MEA0815 for the Project issued by the Nunavut Water Board (NWB) in 2008 requires a revised AEMP and specifies some of the requirements for that revision. Most importantly, while the 2005 AEMP was focused on core receiving environment studies at the level of basins and lakes, the revised AEMP is to be broader in scope to comply with the following license requirements (stipulated in Part I-1):

- *A detailed monitoring protocol to verify that the Canadian Council of Ministers of Environment Fresh Water Aquatic Life Guidelines are met thirty (30) metres from the outfall diffusers;*
- *Annual reporting for more immediate adaptive management;*
- *Mechanisms to measure changes to productivity in the lake as a result of the mine adding nutrients;*
- *Sampling and Analysis Plans; and*
- *Monitoring under Fisheries Authorizations, NWB License Compliance Monitoring, Environmental Effects Monitoring, and Groundwater Monitoring.*

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Two AEMP workshops were held in Yellowknife in early March 2010 and in Edmonton in June 2010, with participants representing the Kivalliq Inuit Association (KIA), NWB, Fisheries and Oceans Canada (DFO), Environment Canada (EC), Indian and Northern Affairs Canada (INAC) and AEM. The purpose of the workshops were to review current monitoring programs at Meadowbank and to discuss a path forward that met the stipulated license requirements in an efficient manner that supported sound environmental management practices.

The enclosed AEMP document was restructured from the 2005 version to synthesize the monitoring on-site, evaluate the project activities and respond in advance to identify potentially negative environment effects. As discussed during the workshops and in agreement with the requirements of the license, the AEMP will best function as an umbrella program that will assimilate the findings from the independent monitoring programs and provide the framework for developing triggers or thresholds, management response plans and mitigation for the Meadowbank mine. It was agreed that each monitoring program will remain independent (i.e. Fisheries Authorization Monitoring, NWB Compliance Monitoring, Environmental Effects Monitoring and Ground Water Monitoring) and where suitable, threshold and trigger levels for each monitoring program may need to be developed. The evolution of the AEMP and the development of triggers and thresholds for the independent monitoring programs will be an iterative process that will require follow-up meetings and consultation to ensure agreement with the NWB.

The Core Receiving Environment Program (CREMP, which was previously referred to as the Aquatic Ecosystem Monitoring Program, 2005) is a central program for evaluating the potential mine effects on the broad receiving environment. As part of the AEMP revision the AEMP (2005) was replaced by the updated CREMP. You will find the CREMP 2010 plan update enclosed with this letter.

In 2009, AEM acknowledged the importance of this program and began collecting field data in support of the CREMP redesign; this was undertaken in advance of revising the AEMP. To adequately redesign the CREMP, monthly water samples and biological samples needed to be taken over at least 1 year to evaluate both the seasonal and spatial variation of the sampling program. Ultimately these samples were collected to evaluate the ability of the CREMP to detect changes in the receiving environment. All of these field data have been collected and are currently under evaluation as part of the CREMP redesign which will guide the establishment of thresholds and triggers using the AEMP framework.

The draft submission of the redesigned CREMP will be submitted in the beginning of the Second Quarter of 2011. Following this submission, a workshop will be held with representatives from EC, DFO, INAC, KIA and NWB to present the CREMP redesign.

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Should you have any questions regarding this submission, please contact me directly at 819-763-0229 or via email at stephane.robert@agnico-eagle.com.

Regards,
Agnico-Eagle Mines Limited – Meadowbank Division

Stéphane Robert
Environment Superintendent

Encl (1)

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Final
Project No. AE - 10 - 01
June 2010

Core Receiving Environment Monitoring Program (CREMP) 2010 Plan Update

Meadowbank Gold Project

Prepared for:

Agnico-Eagle Mines Ltd.
Meadowbank Division

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FINAL

Core Receiving Environment Monitoring Program (CREMP)

2010 Plan Update

Meadowbank Gold Project

Prepared for:

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ACRONYMS

AEMP – Aquatic Effects Monitoring Program

BBD – Baker Lake – barge dock

BPJ – Baker Lake – proposed jetty

BAP – Baker Lake – Akilahaarjuk Point

CREMP – Core Receiving Environment Monitoring Program

DFO – Department of Fisheries and Oceans

DL – Detection limit

DQO – Data Quality Objective

EAS – Effects Assessment Strategy

EEM – Environmental Effects Monitoring

EIA – Environmental Impact Assessment

GPS – Global Positioning System

INUG – Inuggugayualik Lake

ISQG – Interim Sediment Quality Guidelines

NWB – Nunavut Water Board

PAHs – Polycyclic Aromatic Hydrocarbons

PDL – Pipedream Lake

PEL – Probable Effect Level

QA/QC – Quality Assurance / Quality Control

RPD – Relative percent difference

SOP – Standard Operating Procedure

SQG – Sediment Quality Guidelines

SP – Second Portage Lake

TE – Tehek Lake

TEFF – Tehek Lake – Farfield

TPE, TPN, TPS – Third Portage Lake – East, North, and South Basins

UTM – Universal Transverse Mercator

WAL – Wally Lake

1. INTRODUCTION

Agnico-Eagle Mines (AEM) Ltd's Meadowbank Gold Project is situated approximately 75 km north of the hamlet of Baker Lake, Nunavut. The Aquatic Effects Management Program (AEMP, 2005; hereafter referred to as the 2005 AEMP) was developed to monitor issues identified during the environmental impact assessment (EIA) process that could potentially impact the aquatic receiving environments surrounding the development. Building on earlier baseline monitoring (BAER, 2005), the 2005 AEMP described the general monitoring strategy designed to monitor impacts to the aquatic receiving environment. This strategy relied on two primary components: the core monitoring program and targeted studies. Since its inception, the 2005 AEMP strategy has been implemented at the site as follows:

- 2006 and 2007 – The core monitoring program was implemented over two complete cycles (Azimuth, 2008a, b) prior to construction of the mine. These results provided two complete years of baseline data for all original monitoring locations.
- 2008 and 2009 – Mine construction started in 2008, with dike construction activities occurring directly in the receiving environment of Second Portage Lake. Core receiving environment monitoring (Azimuth, 2009a) was complemented by targeted studies on dike construction monitoring (Azimuth, 2009b; 2010a) and effects assessment studies (EAS) for total suspended solids (TSS) (Azimuth, 2009c; 2010b).

"AEMP" Terminology

The term "AEMP" was first used in the 2005 report *Aquatic Effects Management Program*, which described the rationale, framework, strategy, methods, and scope of receiving environment monitoring for the Meadowbank Gold Project. Receiving environment monitoring conducted in 2006 and 2007 use this term in the annual report titles.

The Nunavut Water Board (NWB) A Licence (2AM-MEA0815), issued in 2008, defines "AEMP" as the Aquatic Effects Monitoring Program. Annual report titles for 2008 and 2009 (this report) reflect this change.

AEM has a number of monitoring programs (e.g., effluent monitoring, ground water monitoring, air quality monitoring) relevant to tracking potential changes to the aquatic receiving environment surrounding the Meadowbank Gold Project. One of the requirements of the NWB A Licence is to revise the Aquatic Effects Monitoring Program (AEMP) to consider the results of all these programs; these revisions are currently underway. Previously, the term "AEMP" was essentially synonymous with receiving environment monitoring. However, given the AEMP's broadened scope, more specific terminology is needed to minimize confusion. To that end, we use the following terms in this report:

CREMP – refers to the "core receiving environment monitoring program"; this is synonymous with "core monitoring program".

2005 AEMP – refers to the original AEMP, which is essentially the plan for the CREMP.

AEMP – is used generically when not referring to either of the first two definitions.

Under the 2005 AEMP framework, the core monitoring program consisted of a general strategy to monitor water and sediment quality, phytoplankton, periphyton and benthic invertebrates. The core program was tailored based on our understanding of mine construction, operation and infrastructure (e.g., dikes, effluents, stream crossings, roads, etc.) and has been developed to detect mine-related impacts at temporal and spatial scales that are ecologically relevant. As described in the "AEMP Terminology" textbox on the preceding page, this core program is now referred to as the Core Receiving Environment Monitoring Program (CREMP).

The intent of this *CREMP - 2010 Plan Update* report is to document the current technical details of the CREMP for the NWB. It should be noted that a design review of this program will start in 2010 to ensure that it adequately supports environmental decision making at the site.

This document is organized as follows:

- **Section 1** – Introduction
- **Section 2** – CREMP Overview
- **Section 3** – CREMP Methods
- **Section 4** – 2010 Program Summary

2. CREMP OVERVIEW

2.1. Key Changes to the CREMP

The CREMP monitoring locations for 2010 are shown in **Figures 2-1 through 2-3**. The CREMP initially focused solely on the project lakes during the open water season, but was expanded to Baker Lake in 2008 to ensure that monitoring was also in place to track project-related activities in that area related primarily to barge traffic and shipping. In 2009, as dike construction and mineral exploration continued to expand, adaptive management was initiated in response to TSS release from dike construction. This led to the addition of two new references areas for the CREMP; one far-field reference well downstream of the maximum extent of observed water quality effects within Tehek Lake (Tehek Farfield: TEFF) and another remote external reference in Pipedream Lake (PDL). Additionally in 2009, the frequency of water quality sampling events moved to monthly throughout the year (including through-ice in winter months, where ice conditions permitted). The monthly sampling was a requirement of the NWB water licence (2AM-MEA0815, Type "A", issued June 9, 2008). At the same time, the water sampling program was also modified to better characterize spatial variability (horizontal and vertical) in water quality parameters within each sampling basin; this change was done to support the upcoming CREMP design review. Following from the recommendation in the 2008 CREMP (Azimuth, 2009a) to conclude periphyton sampling, these organisms were not collected in 2009 and are no longer part of the CREMP. This decision was based on having collected several years of baseline periphyton data; enough data with which to compare periphyton growth on habitat compensation features, satisfying the initial reason for including this sampling component. Finally, zooplankton sampling is a planned addition for August 2010 based on discussions at the March 2010 AEMP Workshop in Yellowknife.

2.2. Sampling Areas and Study Design

The study design is based on a control-impact approach but has also incorporated the concept of gradients in exposure. To this end, the program consists of 12 areas, each categorized into one of the three main types described below:

Near-field (NF) areas – Areas are situated in close proximity to the development, in particular near dikes and effluent sources. These areas provide the first line of early-warning for introductions of stressors into the receiving environment. For the project lakes area, these areas include: Third Portage Lake North (TPN), Third Portage Lake East (TPE), Second Portage (SP) and Wally Lake (WAL) and Tehek Lake (TE). The TE location was affected by sediment released during construction of the East Dike in

Second Portage Lake, just upstream. For Baker Lake, there are two NF areas, one targeting the hamlet's barge landing area (Baker Barge Dock [BBD]) and the other AEM's fuel storage facility (Baker Proposed Jetty [BPJ]).

Far-field (FF) area – The intent of this area is to monitor downstream of project infrastructure to provide insights into the spatial extent of any effects observed at the near-field areas. The Tehek Farfield (TEFF) area is a key location that will ultimately determine whether or not contaminants are detectable downstream of the entire mine development. Lake waters from Second and Third Portage Lakes and the Vault Lakes (Vault, Wally, Drilltrail) meet at the southern end of Second Portage Lake and discharge via a single channel into Tehek Lake. Monitoring the water and sediment quality and the health of the benthic invertebrate community in the basin adjoining the discharge point from Second Portage Lake will help determine if any effects identified at NF areas are extending into Tehek Lake beyond the first basin located just downstream of the outlet from Second Portage Lake.

Reference (Ref) areas – By definition, reference areas are sufficiently removed from the mine that they are presumed to be unaffected by any infrastructure (roads, dikes, runways) and point sources (aerial and aquatic) associated with mine development. Internal (Third Portage Lake South [TPS]) and external (Inuggugayualik Lake [INUG], Pipedream Lake [PDL]) reference areas were chosen for the purposes of making comparisons with the project lakes (BAER, 2005). Monitoring of reference areas is important in order to distinguish between possible mine-related changes in water quality or ecological parameters and natural changes, unrelated to the mine. The internal reference area (at the extreme headwaters of Third Portage Lake) is far removed from the mine, upstream of the development area and is removed from the prevailing wind direction. The external reference area (Inuggugayualik Lake) is situated about 16 km west of the mine site. Inuggugayualik Lake is a headwater lake of the Meadowbank River system that flows north to the Arctic Ocean. Despite the different drainage basin, Inuggugayualik Lake satisfies the requirements of an external reference lake from a physical/chemical perspective because it is at the same latitude, has similar geology, relief and climate, does not have any significant inflows and has similar limnological parameters, water chemistry and aquatic biological community structure to the project lakes (BAER, 2005). Pipedream Lake was investigated as a candidate reference area in 1998 (EVS, 1999) from a fisheries perspective. While the fish community of this lake may differ slightly from the other lakes (i.e., there was a preponderance of lake trout, very few Arctic char and no round whitefish captured from the 113 fish caught), its other characteristics were considered similar enough to make it a good addition to the program in 2009. Further examination of the fish community may be required. For Baker Lake, an internal reference area was added several kilometers to the east of the hamlet along the north shore of the lake (Baker Akilahaarjuk Point [BAP]).

2.3. General Monitoring Timing

Open-water field sampling is conducted during three time periods; spring (mid to late July immediately after ice-off), summer (mid to late August) and fall (mid to late September); freeze-up occurs in mid-October. The water monitoring program includes through-ice sampling during winter months: November, December, January, February, March, April, and May, but only at a subset of sampling stations (TPE, TPN, TE, SP, and INUG or TPS depending on travel conditions). Sampling is not conducted in June or October because of unsafe ice conditions. General limnology, water and phytoplankton samples are collected in all four seasons, while sediment, benthos, and zooplankton sampling is conducted in summer only (August).

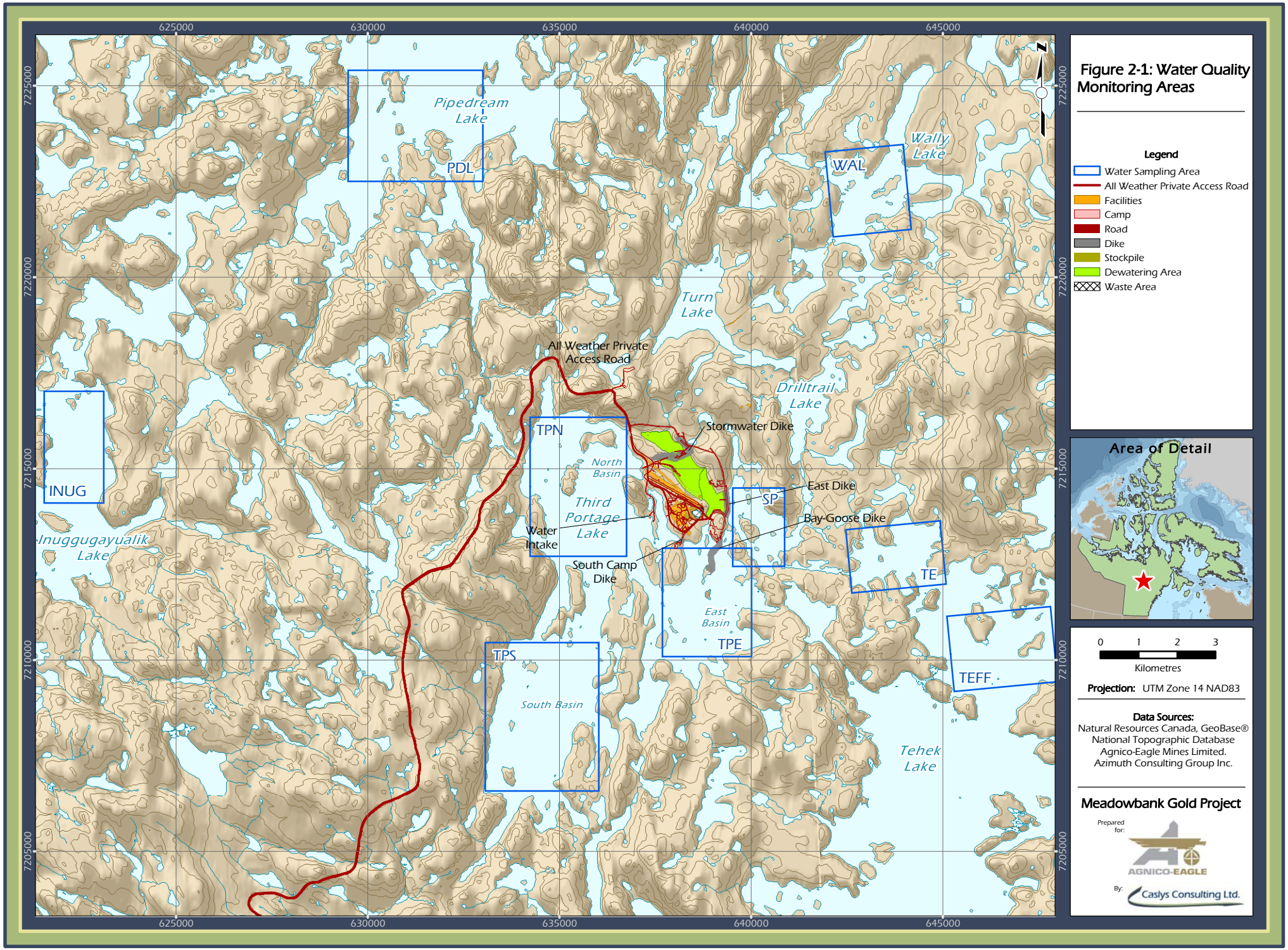

Figure 2-1: Water Quality Monitoring Areas

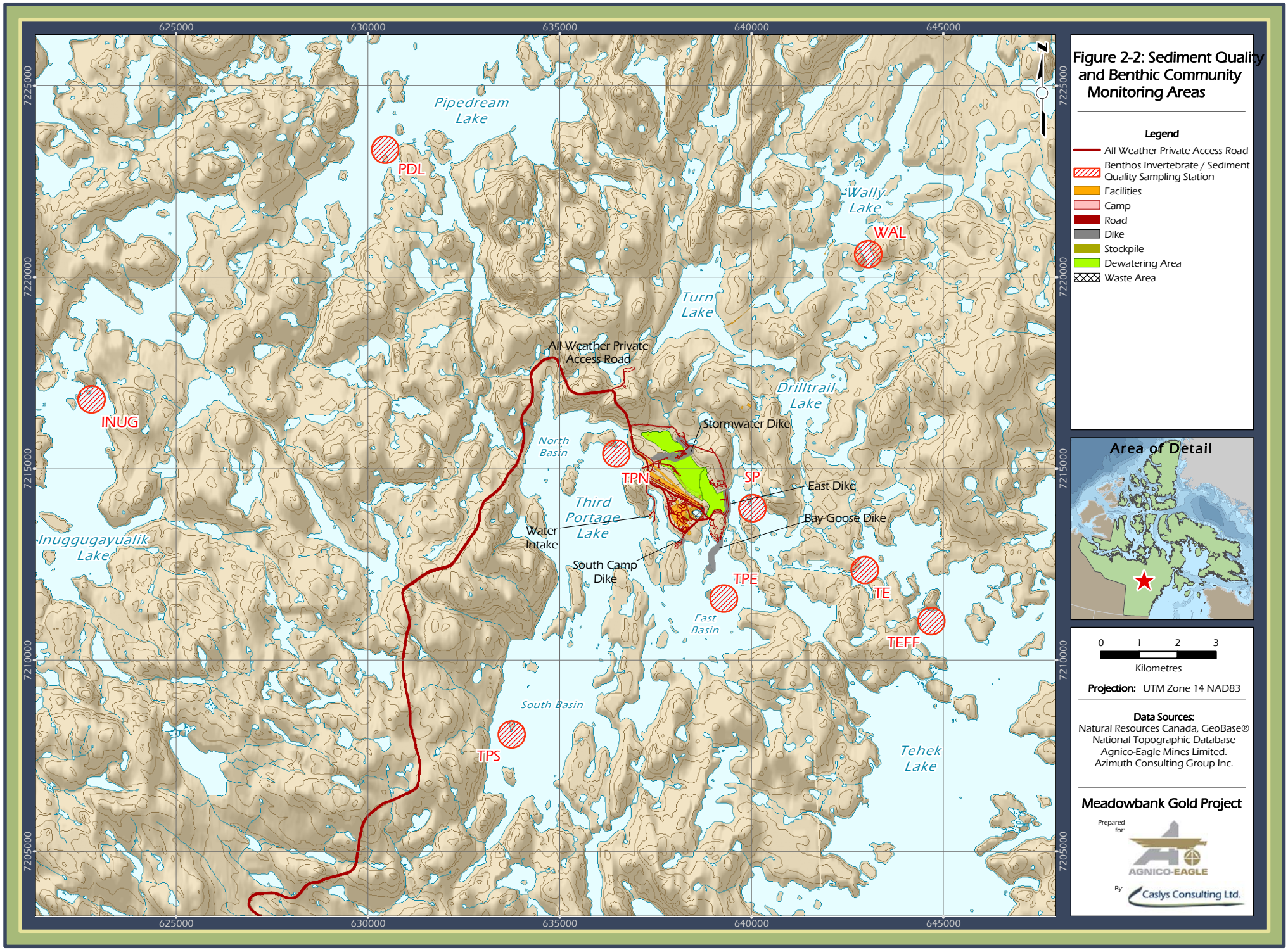

Figure 2-2: Sediment Quality and Benthic Community Monitoring Areas

Legend

- All Weather Private Access Road
- Benthos Invertebrate / Sediment Quality Sampling Station
- Facilities
- Camp
- Road
- Dike
- Stockpile
- Dewatering Area
- Waste Area

0 1 2 3

Kilometres

Projection: UTM Zone 14 NAD83

Data Sources:
Natural Resources Canada, GeoBase® National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.

Meadowbank Gold Project

Prepared for: AGNICO-EAGLE

By: Caslys Consulting Ltd.

Legend

- All-Weather Private Access Road
- Baker Lake Benthic Invertebrate / Sediment Quality Sampling Station

Water Sampling Point

- BAP
- BBD
- BPJ

0 5 10 15
Kilometres

Projection: UTM Zone 14 NAD83

Data Sources:
Natural Resources Canada, GeoBase®
National Topographic Database
Agnico-Eagle Mines Limited.
Azimuth Consulting Group Inc.

Figure 2-3: Baker Lake Water, Sediment and Benthic Invertebrate Monitoring Areas

Meadowbank Gold Project

Prepared for: AGNICO-EAGLE

By: Caslys Consulting Ltd.

3. CREMP METHODS

3.1. Water Quality and Limnology

3.1.1. Within-Area Sampling Locations

As described in **Section 2.1**, replicate sampling has been integrated into the program to better characterize spatial variability (i.e., horizontal and vertical variability). This component was added to support the CREMP design review by providing direct information to evaluate within-area variability. Based on the baseline sampling results and the predominance of key parameters present below analytical detection limits, the program was initially set up with one sample per area per event (AEMP, 2005). The following changes were made to assess the importance of within-area spatial variability:

- Sampling events alternate through the year between "low intensity" (i.e., the traditional approach of one sampling station per area) and "high intensity" (i.e., the modified program).
- Horizontal variability is only assessed during the "high intensity" events, when three stations are randomly selected from within each basin[1]. Locations are selected by generating random coordinates within the sampling areas shown in **Figure 2-1**. Those locations that are situated in > 5 m depth are retained for sampling (note that deeper water is required for assessing vertical variability [see below]. The random coordinates for each station are generated in advance and provided to the field team to upload into their GPS.
- Vertical variability is assessed at INUG and TE at the single "low intensity" station and at two of the three "high intensity" stations. Depth stratified sampling is used to target various depth zones (see **Section 3.1.3** for more details).

While initially only intended to be implemented between May 2009 and May 2010, this aspect has been continued through 2010.The continuation of this within-area variability assessment beyond 2010 will be evaluated during the CREMP design review.

3.1.2. General Limnology

Vertical temperature (^{o}C), dissolved oxygen (mg/L) and conductivity (µS/cm) depth profiles are acquired using the YSI Model 85 temperature – oxygen meter. Profiles are acquired from each station at each sampling event to track changes in oxygen and

[1] During "low intensity" events the single sampling station is also randomly selected using the same approach as described for horizontal variability.

temperature profiles. Secchi depth (m) and pH is measured prior to collection of water and sediment samples.

3.1.3. Water Chemistry

Water samples are collected from all sampling stations in spring, summer and fall and at a selection of stations during winter through-ice sampling. Water is collected from approximately 3 m depth by pumping lake water using weighted flexible (food-grade silicone) tubing, and a diaphragm pump connected to a 12 volt battery. A depth of 3 m is chosen for consistency across all basins and seasons (i.e., sampling at 3 m is still possible in the winter under ice, which is about 2 m thick at its maximum). The lakes are never thermally stratified and are well mixed, thus sampling at a varying depths is not necessary for every sample. An inline filter is connected to the end of the outflow tube when filling bottles for dissolved metals and dissolved organic carbon analyses.

Additional water data is collected during regular sampling (spatial replicates and varying depth) in order to statistically support the CREMP design review. There are three different depths from which water is collected. Routine sampling (where there is no depth-stratified sampling) is from 3 m below the water surface. Where there is depth-stratified sampling, three water samples will be collected from discrete depths (1) Surface: 3 m below surface; (2) Deep: 3 m above the bottom (e.g., if 15 m deep total, water shall be collected from 12 m); and (3) Integrated: integrated from just below surface (0.5 m) to 8 m (or within 1 m from bottom, whichever is nearer). The procedures for collecting the water samples are outlined in greater detail in the Standard Operating Procedure (SOP) for Water and Phytoplankton Sampling (**Appendix A**).

ALS Environmental (Vancouver, BC) provides all of the sampling containers and appropriate preservatives. All samples are stored in the dark and kept on ice immediately following collection and during transport to the laboratory. A completed chain-of-custody form accompanies the samples during transport.

Water samples are analyzed by ALS Environmental for conventional parameters (hardness, conductivity, pH, turbidity, and total dissolved and suspended solids), anions (alkalinity, bromide, chloride, fluoride, silicate and sulfate), nutrients (ammonia, nitrate, nitrite, total Kjeldahl nitrogen, orthophosphate and total phosphate), organic parameters (chlorophyll-α, dissolved and total organic carbon) and total and dissolved metals. A complete list of parameters and their associated detection limits is presented in **Table 2-1**.

Water chemistry concentrations are then tabulated and compared against each other, and, when available, the federal Canadian Council of Ministers of the Environment (CCME, 2007) water quality guidelines for the protection of aquatic life. These guidelines are

intended to provide a conservative level of protection to freshwater aquatic life from anthropogenic contaminants or other physical changes (suspended solids, temperature).

3.1.4. Phytoplankton

Phytoplankton are microscopic, unicellular plant species that are suspended in the water column and, as primary producers, comprise the base of the food web. There are six major groups of phytoplankton present in lakes: cyanophytes (blue green algae), chlorophytes (green algae), chrysophytes (golden-brown algae), diatoms, cryptophytes and dinoflagellates. Seasonal production of phytoplankton can vary widely depending upon water temperature, nutrient concentration, time of year, water clarity and amount of sunlight and predation by zooplankton. Estimates of phytoplankton biomass (mg/m^3) are useful as gross indicators of lake productivity to determine if there have been potential changes due to nutrient additions as a result of blasting (i.e., addition of nitrogen and ammonia from ammonium nitrate).

Unfiltered water is collected at 3 m depth from each sampling station during all seasons and sampling events and a small aliquot is transferred to a 50 mL vial and preserved with Lugol's solution. The procedures for collecting the phytoplankton samples are outlined in detail in greater the SOP for Water and Phytoplankton Sampling (**Appendix A**). Phytoplankton samples are collected at the same time and locations as water sampling.

Preserved samples are transported to Winnipeg, MB for taxonomic identification and analysis by Plankton R Us Inc. For the analysis, 10-mL aliquots of preserved sample are gravity settled for 24 hours. Counts are performed on an inverted microscope at magnifications of 125X, 400X, and 1200X with phase contrast illumination. Cell counts are performed using the Ütermohl technique as modified by Nauwerck (1963). Cell counts are converted to wet weight biomass (mg/m^3) by estimating cell volume. Estimates of cell volume for each species are 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). A specific gravity of 1 was assumed for cellular mass. All biomass (mg/m^3) and density (cells/L) estimates are summed by major taxa, per station.

Simpson's diversity index is calculated for each station to quantify phytoplankton species diversity among stations and sampling events (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 is calculated to measure the species richness among stations and sampling events.

3.2. Sediment Chemistry

Sediment is collected in the summer (August), coincident with the benthic invertebrate sampling program, using proven sample collection and handling techniques (Environment Canada, 1984). The procedures for collecting the sediment samples are outlined in greater detail in the SOP for Benthos and Sediment Sampling (**Appendix B**). Sediment (top 3–5 cm) is collected from all stations using a Petite Ponar grab (sampling area of 0.023 m^2). Three grab samples are composited from each station to reduce the influence of within-station spatial heterogeneity. Sediment chemistry grabs are collected after benthic invertebrate sampling to avoid possible disturbance of biota.

Only those grab samples that meet the following acceptability criteria are retained for analysis: does not contain large foreign objects; has adequate penetration depth (i.e., 10–15 cm); is not overfilled (sediment surface not touching the top of sampler); does not leak (there is overlying water present and no visible leaks); and is undisturbed (sediment surface is relatively flat). Grabs that do not satisfy these conditions are discarded.

Sampling jars are placed in a cooler with ice packs and transported to ALS Environmental (Vancouver, BC) for analysis. A completed chain-of-custody form accompanies the samples during transport. Sediment samples are analyzed for pH, total organic carbon, moisture content, particle size (% gravel, sand, silt and clay), oil and grease, light & heavy extractable petroleum hydrocarbons (LEPHs and HEPHs), PAHs (polycyclic aromatic hydrocarbons) and total metals concentrations. A complete list of parameters and their associated detection limits is presented in **Table 3-1**.

Sediment metals concentrations are compared to sediment quality guideline (SQG) concentrations developed by the CCME (2002) for the protection of aquatic life. There are two levels of SQGs: Interim Sediment Quality Guidelines (ISQG) and Probable Effects Level (PEL) concentrations. ISQGs are conservative values that represent the concentration below which adverse effects are unexpected. The PEL is less conservative and represents a concentration above which adverse effects may be observed, based on laboratory studies. It is important to realize that background concentrations of some metals in sediments routinely exceed both ISQG and PEL concentrations. This is common in many in mineralized areas and this does not mean that adverse effects should be expected. All of the measured sediment chemistry concentrations from the study lakes are then tabulated and compared against each other and, when available, the SQGs.

3.3. Benthic Invertebrate Community

Benthic invertebrates are small animals that live in or on bottom sediments. The most commonly encountered organisms include the aquatic larval stages (i.e., resembling worms) of insects, especially chironomids (i.e., midge larvae). Other common organisms are oligochaete worms, small bivalve clams and amphipods (i.e., crustaceans). Benthic invertebrates form a very important food source for juvenile fish of all species (i.e., lake trout, Arctic char and round whitefish) and adult whitefish and char.

Benthic invertebrates are collected from each sampling station in the summer (August), using a Petite Ponar grab (0.023 m^2) and a 500-µm sieve. Five replicate samples are collected per station. Two independent grabs per replicate are composited to form a single sample to reduce sampling variation within stations and to increase the surface area sampled. A depth of 8 m is targeted but grabs typically range from 6.5 to 9.5 m (with the exception of Wally Lake which has some naturally shallower spots).

Only those grab samples that meet the following acceptability criteria were retained for analysis: does not contain large foreign objects; has adequate penetration depth (i.e., 10–15 cm); is not overfilled (sediment surface not touching the top of sampler); does not leak (there is overlying water present and no visible leaks); and is undisturbed (sediment surface is relatively flat). Grabs that do not satisfy these conditions are discarded.

The procedures for collecting the benthic invertebrate samples are outlined in detail in the SOP for Benthos and Sediment Sampling (**Appendix B**).

Benthos samples are preserved in the field with a 10% buffered formalin solution and sent to Zaranko Environmental Assessment Services (ZEAS) (Nobleton, ON) for taxonomic identification and analysis.

Upon arrival at ZEAS, samples are immediately logged and inspected to ensure adequate preservation to a minimum level of 10% buffered formalin and checked for correct labeling. Benthos samples are sorted at a magnification of between 7 and 10 times with the use of a stereomicroscope. To expedite sorting prior to processing, all samples are stained with a protein dye that is absorbed by aquatic organisms but not by organic material, such as detritus and algae.

Prior to sorting, samples are washed free of formalin in a 500-µm sieve. Benthos are enumerated and sorted into major taxonomic groups, (i.e., order and family), placed in glass bottles and re-preserved in 80% ethanol for more detailed taxonomic analysis by senior staff. Each bottle is labeled internally with the survey name, date, station and replicate number.

Abundance of organisms/m^2 is determined from the total number of organisms enumerated. Nematodes and ostracods are not reported, nor are they included in

abundance and richness calculations because they are too small to be reliably retained on a 500-µm sieve.

The following endpoints are used for assessing benthic community structure, based on sensitivity, objectivity, ease of interpretation and cost-effectiveness:

- Taxa richness (i.e., corresponds to the number of species or taxa per sample and provides a measure of diversity).
- Total abundance (i.e., number of organisms per m^2).
- Abundance and richness of all major taxa (e.g., insects, molluscs, worms).

3.4. Zooplankton

As key primary consumers in the lake food web, these planktonic organisms are important for a number of reasons. From an energy cycling perspective, these herbivorous, omnivorous and carnivorous water column animals are an important food source to key life history stages of certain fish species, especially juvenile round whitefish (*Prosopium cylindraceum*) and Arctic char (*Salvelinus alpinus*) as well as adult Arctic char. The seasonal change in biomass (mg/m^3) of zooplankton is also an important indicator of lake productivity, which ultimately drives the productivity and biomass of fish in the study lakes.

Zooplankton are collected using a 70-µm nitex mesh net with a 30-cm diameter mouth opening and total length of 2.2 m. Five spatial replicate samples are collected at randomly selected locations for each lake/basin. At each of these five locations per basin, one sample is collected for biomass analysis (composite of two vertical tows) and one sample is collected for taxonomic identification (composite of two vertical tows). Tows are taken from depths of 8 m to the surface for all areas. After collection, all samples are placed into uniquely labeled plastic Whirl-Pac bags and are preserved in a 10% buffered formalin solution. All bags are sealed tight to prevent leakage and are sent to North-South Consultants, Winnipeg, MB. Zooplankton samples for biomass are filtered through a pre-dried 45-µm filter, wet weighed and then dried in an oven at 60°C until completely dry. Samples are weighed dry to determine moisture content and dry weight. Dry biomass (mg/m^3) is calculated using the dry sample weight and the volume of water filtered by the net during each vertical tow.

3.5. Quality Assurance / Quality Control

The objective of quality assurance and quality control (QA/QC) is to assure that the 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 is 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.

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 are deemed invalid.

Duplicate results are 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 are:

- Analytical Precision = 25% RPD for concentrations that exceed 10x the detection limit (DL).
- 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. RPDs are not calculated for cases where one of the samples (i.e., either A or B above) is below detection and the other is not.

Field QA/QC: Water Sampling – Field QA/QC standards during water sampling are maintained for every sample. The 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.

One or two field duplicate samples (i.e., independent samples collected at the same location, minutes apart) per sampling event are collected to assess field variability in

chemistry parameters; a RPD of 50% for concentrations that exceed 10x the DL is considered acceptable. One equipment blank is also collected during each sampling event by pumping de-ionized water through the water sampling equipment (pump, tubing and inline filter) and filling the specified sample containers at the site; these samples are used to assess the potential introduction of any contamination accountable to sample handling and sampling techniques. In addition, one travel blank is also included with the sampling containers sent from the laboratory which is never opened by the field crew; these samples are used to assess the potential tampering with samples on route to or from the laboratory. Results from both the equipment and travel blanks are examined for detectable concentrations of any of the parameters measured; no parameter in either blank should exceed detection.

Field QA/QC: Sediment Sampling – Field QA/QC standards during sediment sampling is careful to avoid cross-contamination between sampling areas by rinsing and cleaning the Petite Ponar grab, stainless steel compositing bowls and spoons between stations. This entails rinsing the equipment with site water to remove sediment and organic material, scrubbing with phosphate-free cleaning detergent, and again rinsing with site water. An ashless filter (QA/QC Filter) is swiped over the pre-cleaned bowl at one station to assess the cleaning procedures. The significance of any metal detected on this filter is evaluated by comparing this amount to the measured concentrations in the sediment samples. Where comparison are required, the concentration of metals originating from any equipment is estimated by dividing the amount detected on the filter (weight) by: the surface area of 3 Petite Ponar grabs (assuming a thickness of 3 cm was collected from each), which is multiplied by the density of sediment (assumed to be 2 g/cm^3).

Two field duplicates are collected to assess sampling variability and sample homogeneity; a RPD of 50% for concentrations that exceed 10x the DL is considered acceptable.

Field and Laboratory QA/QC: Biota Sampling – Standard procedures are used to collect biota samples. All sampling gear is thoroughly rinsed between sampling stations to ensure that there is no inadvertent introduction of biota from one station to another.

Field duplicates are collected for phytoplankton during each sampling event in coordination with water sample duplicates and are taken in order to assess sampling variability and sample homogeneity. A RPD of 50% for density and biomass concentrations is considered acceptable. As a measure of QA/QC on the enumeration method replicate counts are preformed on ~10% of the samples. Replicate samples are chosen at random and processed at different times from the original analysis to reduce biases.

Field replicates are collected for benthos to determine natural variability and heterogeneity. Data quality objectives (DQO) for replicates should be within ± 25% of the first count (i.e., the RPD).

ZEAS incorporates the following set of QA/QC procedures in all benthic projects undertaken by the company to ensure the generation of high quality and reliable data:

- Samples are logged upon arrival, inspected, and enumerated;
- Samples are checked for proper preservation;
- Samples are stained to facilitate sorting;
- Taxonomic identifications are based on the most updated and widely used keys;
- 10% of the samples are re-sorted, documenting 90% recovery;
- Precision and accuracy estimates are calculated;
- A voucher is compiled;
- Sorted sediments and debris are re-preserved in 10% formalin and are retained for up to three months. For samples subject to sub-sampling, sorted and unsorted fractions are re-preserved separately.

Table 3-1. Laboratory detection limits (DLs) for water and sediment parameters.

Parameters	Water		Sediment	
	DLs	Units	DLs	Units
Physical Tests				
Conductivity	2	uS/cm	-	-
Hardness (as $CaCO_3$)	1.1	mg/L	-	-
pH	0.1	pH	0.1	
Total Suspended Solids	1	mg/L	-	-
Total Dissolved Solids	10	mg/L	-	-
Turbidity	0.1	NTU	-	-
% Moisture	-	-	0.1	%
Anions and Nutrients				
Alkalinity, Bicarbonate (as $CaCO_3$)	2	mg/L	-	-
Alkalinity, Carbonate (as $CaCO_3$)	2	mg/L	-	-
Alkalinity, Hydroxide (as $CaCO_3$)	2	mg/L	-	-
Alkalinity, Total (as $CaCO_3$)	2	mg/L	-	-
Ammonia as N	0.02	mg/L	-	-
Bromide (Br)	0.05	mg/L	-	-
Chloride (Cl)	0.5	mg/L	-	-
Fluoride (F)	0.02	mg/L	-	-
Nitrate (as N)	0.005	mg/L	-	-
Nitrite (as N)	0.001	mg/L	-	-
Total Kjeldahl Nitrogen	0.05	mg/L	-	-
Ortho Phosphate as P	0.001	mg/L	-	-
Total Phosphate as P	0.002	mg/L	-	-
Silicate (as SIO_2)	1	mg/L	-	-
Sulfate (SO_4)	0.5	mg/L	-	-
Particle Size				
% Gravel (>2mm)	-	-	1	%
% Sand (2.0mm - 0.063mm)	-	-	1	%
% Silt (0.063mm - 4µm)	-	-	1	%
% Clay (<4µm)	-	-	1	%
Organic / Inorganic Carbon				
Dissolved Organic Carbon	0.5	mg/L	-	-
Total Organic Carbon	0.5	mg/L	0.1	%

Table 3-1. Laboratory detection limits (DLs) for water and sediment parameters.

Parameters	Water		Sediment	
	DLs	Units	DLs	Units
Total Metals				
Aluminum (Al)	0.0050	mg/L	50	mg/kg
Antimony (Sb)	0.0005	mg/L	10	mg/kg
Arsenic (As)	0.0005	mg/L	5	mg/kg
Barium (Ba)	0.02	mg/L	1	mg/kg
Beryllium (Be)	0.001	mg/L	0.5	mg/kg
Bismuth (Bi)	-	-	20	mg/kg
Boron (B)	0.1	mg/L	-	-
Cadmium (Cd)	0.000017	mg/L	0.5	mg/kg
Calcium (Ca)	0.1	mg/L	50	mg/kg
Chromium (Cr)	0.001	mg/L	2	mg/kg
Cobalt (Co)	0.0003	mg/L	2	mg/kg
Copper (Cu)	0.001	mg/L	1	mg/kg
Iron (Fe)	0.03	mg/L	50	mg/kg
Lead (Pb)	0.0005	mg/L	30	mg/kg
Lithium (Li)	0.005	mg/L	2	mg/kg
Magnesium (Mg)	0.1	mg/L	50	mg/kg
Manganese (Mn)	0.0003	mg/L	1	mg/kg
Mercury (Hg)	0.00002	mg/L	0.005	mg/kg
Molybdenum (Mo)	0.001	mg/L	4	mg/kg
Nickel (Ni)	0.001	mg/L	5	mg/kg
Phosphorus (P)	-	-	50	mg/kg
Potassium (K)	2	mg/L	200	mg/kg
Selenium (Se)	0.001	mg/L	2	mg/kg
Silver (Ag)	0.00002	mg/L	2	mg/kg
Sodium (Na)	2	mg/L	200	mg/kg
Strontium (Sr)	-	-	0.5	mg/kg
Thallium (Tl)	0.0002	mg/L	1	mg/kg
Tin (Sn)	0.0005	mg/L	5	mg/kg
Titanium (Ti)	0.01	mg/L	1	mg/kg
Uranium (U)	0.0002	mg/L	-	-
Vanadium (V)	0.001	mg/L	2	mg/kg
Zinc (Zn)	0.005	mg/L	1	mg/kg

Table 3-1. Laboratory detection limits (DLs) for water and sediment parameters.

Parameters	Water		Sediment	
	DLs	Units	DLs	Units
Dissolved Metals				
Aluminum (Al)	0.005	mg/L	-	-
Antimony (Sb)	0.0005	mg/L	-	-
Arsenic (As)	0.0005	mg/L	-	-
Barium (Ba)	0.02	mg/L	-	-
Beryllium (Be)	0.001	mg/L	-	-
Boron (B)	0.1	mg/L	-	-
Cadmium (Cd)	0.000017	mg/L	-	-
Calcium (Ca)	0.1	mg/L	-	-
Chromium (Cr)	0.001	mg/L	-	-
Cobalt (Co)	0.0003	mg/L	-	-
Copper (Cu)	0.001	mg/L	-	-
Iron (Fe)	0.03	mg/L	-	-
Lead (Pb)	0.0005	mg/L	-	-
Lithium (Li)	0.005	mg/L	-	-
Magnesium (Mg)	0.1	mg/L	-	-
Manganese (Mn)	0.0003	mg/L	-	-
Mercury (Hg)	0.00002	mg/L	-	-
Molybdenum (Mo)	0.001	mg/L	-	-
Nickel (Ni)	0.001	mg/L	-	-
Potassium (K)	2	mg/L	-	-
Selenium (Se)	0.001	mg/L	-	-
Silver (Ag)	0.00002	mg/L	-	-
Sodium (Na)	2	mg/L	-	-
Thallium (Tl)	0.0002	mg/L	-	-
Tin (Sn)	0.0005	mg/L	-	-
Titanium (Ti)	0.01	mg/L	-	-
Uranium (U)	0.0002	mg/L	-	-
Vanadium (V)	0.001	mg/L	-	-
Zinc (Zn)	0.005	mg/L	-	-

Table 3-1. Laboratory detection limits (DLs) for water and sediment parameters.

Parameters	Water		Sediment	
	DLs	Units	DLs	Units
Plant Pigments				
Chlorophyll-α	0.01	ug/L	-	-
Aggregate Organics				
Oil and Grease *	-	-	500	mg/kg
Mineral Oil and Grease *	-	-	500 - 1082	mg/kg
Hydrocarbons				
EPH10-19 *	-	-	200 - 644	mg/kg
EPH19-32 *	-	-	200 - 644	mg/kg
LEPH *	-	-	200 - 644	mg/kg
HEPH *	-	-	200 - 644	mg/kg
Polycyclic Aromatic Hydrocarbons *				
Acenaphthene	-	-	0.005 - 0.125	mg/kg
Acenaphthylene	-	-	0.005 - 0.125	mg/kg
Anthracene	-	-	0.004 - 0.125	mg/kg
Benz(a)anthracene	-	-	0.01 - 0.125	mg/kg
Benzo(a)pyrene	-	-	0.01 - 0.125	mg/kg
Benzo(b)fluoranthene	-	-	0.01 - 0.125	mg/kg
Benzo(g,h,i)perylene	-	-	0.01 - 0.125	mg/kg
Benzo(k)fluoranthene	-	-	0.01 - 0.125	mg/kg
Chrysene	-	-	0.01 - 0.125	mg/kg
Dibenz(a,h)anthracene	-	-	0.005 - 0.125	mg/kg
Fluoranthene	-	-	0.01 - 0.125	mg/kg
Fluorene	-	-	0.01 - 0.125	mg/kg
Indeno(1,2,3-c,d)pyrene	-	-	0.01 - 0.125	mg/kg
2-Methylnaphthalene	-	-	0.01 - 0.125	mg/kg
Naphthalene	-	-	0.01 - 0.125	mg/kg
Phenanthrene	-	-	0.01 - 0.125	mg/kg
Pyrene	-	-	0.01 - 0.125	mg/kg

Notes

* Detection limits vary for these parameters base on the dry weight of the individual sample.

4. MONITORING COMPONENTS FOR 2010

The rationale, framework, strategy, methods, and scope of receiving environment (now referred to as *Core Receiving Environment Monitoring Program* or "CREMP") monitoring for the Meadowbank Gold Project were documented in the 2005 AEMP (AEMP, 2005). The CREMP has been implemented every year since 2006 (see **Section 1**), with some modifications (e.g., station additions, parameter deletions/additions, sampling frequency and intensity; see **Section 2.1**) to improve the program or to comply with regulatory requirements (e.g., the NWB A Licence). The CREMP design will be reviewed in 2010 to ensure that the program is optimally supporting AEM's environmental management needs.

In the interim, the 2010 CREMP will be essentially the same as 2009 (unless noted), as follows, with the major difference being the addition of zooplankton sampling (**Table 4-1**):

- *Sampling Components* – limnology, water and sediment chemistry, phytoplankton, zooplankton, and benthic invertebrate community.

- *Sampling Areas* – sampling areas have been added over the years as needed, but all the original stations have remained. Near-field stations include: TPN, TPE, SP, WAL and Baker Lake stations BBD and BPJ; far-field stations include: TE, TEFF; reference stations include: TPS, INUG, PDL and Baker Lake stations BAP. Review of the reference area at Baker Lake will be undertaken in 2010 because of the large differences in benthic community between exposure and reference stations.

- *Timing* – water sampling (including limnology) and phytoplankton collection will be conducted every month (ice conditions permitting) in 2010. The exception to this will be during periods when ice conditions are not deemed safe (e.g., likely June and October, but may vary). Sampling through-ice will take place in January, February, March, April, May, November and December months. Open-water sampling will take place in July, August and September. Sediment chemistry and benthic invertebrate sampling will be conducted in August only, as it has been in previous years.

- *Spatial coverage* – water sampling within each lake basin area will be randomly distributed and possibly replicated to quantify the horizontal and vertical components of spatial variability (high intensity events only). The intensity (number of samples) of the events alternate between high (all areas, full reps) and low (all areas, no reps) during both open-water and through-ice sampling.

- Changes from 2009 – The only planned change will be the addition of zooplankton sampling at all Meadowbank stations during August of the open-water season (see SOP – **Appendix C**).

Table 4-1. Components planned for 2010 core receiving environment monitoring program (CREMP).

Project Lake	Station ID	TYPE	Through-Ice[1]						Open-Water			Through-Ice		
		MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Third Portage	*TPE*		Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto
	TPN		Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto
	TPS							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe		
Second Portage	*SP*		Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto
Tehek	*TE*		Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto
Tehek	*TEFF*							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe		
Inuggugayualik	*INUG*		Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Limno Water (L) Phyto	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto
Wally	*WAL*							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe		
Pipedream	*PDL*							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos Zoop	Limno Water (H) Phyto	Ice not safe		

Table 4-1. Components planned for 2010 core receiving environment monitoring program (CREMP).

Project Lake	Station ID	TYPE	Through-Ice[1]						Open-Water			Through-Ice		
		MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baker Lake	BBD							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos	Limno Water (H) Phyto	Ice not safe		
	BPJ							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos	Limno Water (H) Phyto	Ice not safe		
	BAP							Ice not safe	Limno Water (H) Phyto	Limno Water (L) Phyto Sed Benthos	Limno Water (H) Phyto	Ice not safe		

Notes:

Limno: 1 profile; parameters includes vertical temperature (°C), oxygen (mg/L), conductivity (µS/cm), and turbidity (NTU) depth profiles; same sampling location & intensity as water.

Water: sample analysis includes conventional parameters (hardness, conductivity, pH, total dissolved & suspended solids, turbidity), anions (alkalinity, chloride, sulfate), nutrients (ammonia, nitrate, nitrite, total kjeldahl nitrogen, orthophosphate, total phosphate), organics (total & dissolved organic carbon, chlorophyll-a) and total & dissolved metals. intensity (number of samples) for each event alternates between high (H) [spatial and vertical reps], and low (L) [no spatial reps, 1 vertical rep].

Phyto: analysis includes identification of species, biomass (mg/m ^{3}) and density (cells/L) for each major taxa from a 50ml sample; same sampling location & intensity as water.

Sed: 3 samples (2-3 grab composite/sample); analysis includes pH, total organic carbon (TOC), moisture content, particle size, PAHs, oil & grease, LEPHs & HEPHs and total metals concentrations.

Benthos: 5 replicate samples (2 grabs/sample); analysis includes identification of species, abundance (#/m ^{2}) and richness (# taxa) (total & for each major taxa group);

Zoop: 5 replicate samples (2 tows/sample) for biomass and 5 replicate samples for taxonomy (2 tows/sample); vertical from 8m to surface; random spatial sample locations within basins.

[1] Through-ice sampling targets the stations shown above; however, samples from INUG may be replaced with TPS if winter tundra travelling conditions are unfavorable.

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APPENDICES

APPENDIX A

STANDARD OPERATING PROCEDURES FOR WATER AND PHYTOPLANKTON SAMPLING.

APPENDIX A
Standard Operating Procedure
Meadowbank Study Lakes & Baker Lake
CREMP Water & Phytoplankton Sampling

GENERAL:

Project Coordinator:
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Email: mmcconnell@azimuthgroup.ca

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

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Up to Twelve sampling stations have been chosen for water quality monitoring in the Meadowbank study lakes and Baker Lake. Water samples are collected monthly during open water and during ice-cover, except for November and June, when ice conditions are unsafe for sampling The 12 stations (with their corresponding abbreviation) are:

- Third Portage Lake – North Basin (TPN)
- Third Portage Lake – East Basin (TPE)
- Third Portage Lake – South Basin (TPS)
- Second Portage Lake (SP)
- Tehek Lake (TE)
- Tehek far-field (TEFF)
- Wally Lake (WAL)
- Inuggugayualik Lake (INUG)
- Pipedream Lake (PDL)
- Baker Lake – Barge Dock (BBD)
- Baker Lake – Proposed Jetty (BPJ)
- Baker Lake – Akilahaarjuk Point (BAP)

There are four levels of sampling intensity over the course of the year, depending on whether under ice or in open water; and whether multiple depths or single depths are sampled. High and Low Intensity. The intensity of water sampling depends on whether open water or under ice, and further, by month. Check the monthly water sampling schedule to confirm the lakes, locations and water depths from which water samples are to be collected BEFORE going into the field.

There are up to three different depths from which water will be collected. Routine samples where there is no depth-stratified sampling shall be from **3 m below the water surface**. Where there is depth-stratified sampling, three water samples will be collected from discrete depths (1) Surface (***S***) = **3 m below surface**; (2) Deep (***D***) = **3 m above the bottom** (e.g., if 15 m deep total, water shall be collected from 12 m); and (3) Integrated (***INT***) = **integrated from just below surface (0.5 m) to 8 m** (or to "deep" location). Target locations for each sampling station have been randomly pre-determined and recorded in MapSource and in the hand-held GPS units (NAD 83). Confirm before going into the field.

Field activities are scheduled roughly once a month, including winter ice sampling. Sampling through the ice will take place in January, February, March, April, May, November, and December. Open water sampling will take place in July, August, and September. Sampling will not be conducted in June and November because of thin ice conditions.

MONTHLY CREMP WATER CHEMISTRY & PHYTOPLANKTON SAMPLING:

1. Prior to leaving camp gather the appropriate type and number of sampling vessels and acid vials for preservation. Prepare appropriate labels for containers, affix them to the appropriate bottle (see below), and wrap label with packing tape. 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 (2 – 3 x 8 meter length and 1 meter length) & weight (& extra C-clamps and cable ties). Longer tubing is required in the event that deep samples are being collected.
   - In-line filter and a spare
   - 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 – 50 mL vial for phytoplankton

    - 1 vial sulfuric acid
    - 2 vial hydrochloric acid
    - 2 vial nitric acid
    - 1 syringe & magnesium carbonate slurry
    - 1 syringe & Lugol's solution
- 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 phytoplankton
- De-ionized water for rinsing equipment and collected field equipment blank
- 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**
2 - 1 L plastic	Conventionals*	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	1 vial of nitric acid
125 mL amber glass	TOC	1 vial of hydrochloric acid
125 mL amber glass	DOC	1 vial of hydrochloric acid
50 mL vial	Phytoplankton	**1/4 mL** of Lugol's solution per 50 mL sample

* includes: hardness, conductivity, pH, TDS, TSS-low, turbidity, alkalinity (speciated), orthophosphate and total phosphate, chloride, fluoride, bromide, sulfate, nitrate-nitrogen, nitrite-nitrogen, silicate.

** **do not use filtrate water** for any sample. Use the in-line filters for collecting dissolved metals and dissolved organic carbon samples.

3. For **QAQC** purposes three kinds of samples are required; one set per 10 field samples as follows:

A: One field duplicate is collected for every 10 sample per event (i.e., 10%). All parameters measured in the original sample are measured in the field duplicate. The sampling station is

selected randomly from one of the stations, and labeled as station CREMP [month] DUP-1, -2, -3, -4, etc. Prepare the QAQC labels and affix to the sampling containers, as described in step 2.

B: One set of travel blanks are to be carried into the field and treated like the other sampling vessels except that the bottles are not to be opened or anything added to them.

C: One equipment blank will be acquired per every 10 field samples. To collect an equipment blank set up the water sampling equipment as if a routine sample was to be collected except that the incurrent and excurrent hoses are placed into a 4L container of distilled water (available on site). Pump for 2 minutes (just like in the field) to flush site water from the equipment (also attach the filter to flush for 30 seconds). Using a second 4L jug, flush another approx. 1L (this time excurrent hose is placed in sink) and then use the remaining 2L fill all bottles, except for Turbidity, TSS-low and chlorophyll, preserve and treat as other samples, including filtering where necessary. Label as station CREMP [month] EB-1, -2, -3, -4, etc. Finally, fill a new suite of bottles directly from a third 4L jug to test for any problems with the distilled water itself. Label theses as CREMP [month] DIS-1, -2, -3, -4.

4. 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.

5. 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. In windy conditions, anchor the boat upstream of the station and drift back; it is not necessary to anchor the boat in calm conditions providing the boat remains in the same position. Do not allow the anchor to drag through the sampling station. Record the exact **UTM coordinates** on the field data form.

6. Measure **water depth** at the sampling station using the 'Hawkeye' hand-held depth meter (note: place depth meter in water *before* pushing ON button). Hold the meter in the water, facing the lake bottom, until the meter measures the depth. Record this information on the field data form. If you are in water that is too shallow (i.e., **must have at least 5 m for S stations only or 8 m for D/INT stations**), move to deeper water near the assigned station.

7. Measure the light attenuation at the sampling station using the **Secchi disk**. Lower the disk into the water, on the shady side of the boat, so that you can no longer see it. Slowly raise the disk to the point that you can see it and measure this depth using the markings on the disk rope.

8. Measure the pH of the water at the sampling station using the **pH meter**. Hold the probe portion of the meter in the lake until the meter measures the pH. Record this information on the field data form.

9. Calibrate the YSI probe prior to going into the field; confirm elevation (m) of sampling environment. Lower the **YSI probe** into the lake to just below the water surface level.

Measure the temperature (^{o}C), specific conductance (i.e., temperature corrected) (uS/cm) and dissolved oxygen concentration (mg/L) in the water and record on the field data form. Lower the meter to a depth of 1 m and record the field measurements. Allow the concentrations on the meter to stabilize for 10 to 15 seconds before recording the concentrations. Continue recording the field measurements at 1 m depth intervals until you reach the whole metre mark above the lake bottom (i.e. if the lake depth is 9.3 meters, record field measurements up to a depth of 9 meters). Use the **turbidity probe** in a similar manner to record a turbidity profile.

10. Set up the **water pump** in the boat; attach the tubing to the pump using the C-clamps and attach the 12V battery. Attach the 8 meter length of tubing to the intake valve, and the 1 meter length to the output valve. Attach the plastic coated ball weight to the end of the 8 meter length of tubing. Lower the 8 meter length of tubing into the water to 3 m depth and place the 1 meter length of tubing over the edge of the boat. Run the pump for **2 minutes** to flush the sampling device. If sampling from a deep depth (i.e., 3 m from the bottom), lower the tube to 3 m from the bottom (confirm with hawkeye sounder) and again allow to flush for 2 minutes before taking a sample.

    When collecting an 'integrated' depth sample water is to be discharged into a CLEAN 5 gal HDPE bucket. To collect an integrated sample lower the incurrent hose to 0.5 m below the water surface and allow to rinse for 2 minutes. After flushing, place the excurrent hose into the bucket and slowly lower the hose through the water column to 8 m depth and back again to just below the surface. Repeat. Once sufficient water has been collected, place the incurrent tube into the HDPE bucket and pump water from the bucket into the appropriate collection vessel.

11. For each sampling station, **fill** the required **pre-labeled sampling containers** with water from the 1 meter length of tubing either directly from the lake or from the bucket as appropriate.

12. Dissolved metals and dissolved organic carbon samples are to be collected with an in-line high capacity filter with 0.45 um pore size. After all unfiltered samples have been collected, disconnect the battery from the pump and fix the filter onto the end of the discharge hose. Re-connect the pump and allow the water to discharge and flush through the filter for 15 – 20 seconds. Direct filtered water into the DOC and dissolved metals bottles. Flow from the hose can be controlled by pinching the incurrent end of the tube (not the excurrent). Once filtered samples have been collected remove the filter and place into a plastic or zip-loc bag for re-use. In the Meadowbank environment where the amount of suspended solids is low, filters can be re-used for up to 10 stations. Remember to use the same filter when collecting equipment blank samples, not a new filter.

13. **Add** the **specified preservatives** to the appropriate sampling containers (according to the information on the labels and table in step 2), seal and mix thoroughly by turning upside down and then upright a number of times.

14. To collect a phytoplankton sample, add site water from appropriate depth (i.e., shallow, integrated or deep) into the 50 mL vial provided. Make sure that site information is appropriately labeled on the jar. In the field or the lab, add a few drops of Lugol's solution to the sample so that it has the color of weak tea.

15. Rinse all sections of the water filter apparatus with site water.

16. Back in the office, to process the phytoplankton sample, use the hand-held pump apparatus and filters. Using the tweezers, place an ashless filter paper on the screen in the water filter apparatus, and, prior to filtering, add 1 – 2 drops of magnesium carbonate slurry directly onto the filter, then screw the two sections together and attach the hand-held vacuum pump. **Filter 1 L of water** through the water filter apparatus. Wrap the filter paper in a piece of tinfoil, then place the filter in the pre-labeled ziploc bag. Mark on the COCs and on the field collection data sheet the volume of water filtered. In some cases it is not possible to filter up to 1L. In such cases it is critical to note the actual volume filtered. After filtering remove the filter with clean tweezers, place on a piece of tin foil and double wrap. With a sharpie pen, write the appropriate sampling information on a label and stick to the tin foil. Place the folded tinfoil in a zip loc bag and put into the freezer.

17. Until ready for shipping, the **water samples** are stored **chilled** in a refrigerator in camp, if space is available. The **filter** for chlorophyll-a analysis must be **frozen**; store this bag in a deep freezer in the camp. Bottles should be put in plastic bubble bags prior to storage on ice to protect the labels from water damage. The **phytoplankton samples** are stored at **room temperature**.

18. If this sampling station is selected as the QAQC **field duplicate**, collect a second set of water samples (repeat step 10), fill the pre-labeled sampling containers (repeat step 11) and collect a second filtered chlorophyll-a sample (step 12). Record which sampling station the QAQC samples are collected from on the appropriate field data form.

19. Fill out a **chain-of-custody** form for the water samples and filters being sent to **ALS Environmental**. The COC form must be completed carefully and in its entirety to ensure proper analysis. This includes listing all of the specific conventional parameters (see table in step 2), Azimuth and ALS contact names, and checking off all of the specific boxes for requested analyses. The ALS laboratory quote number must be printed on the COC form to ensure proper billing.

    A **digital COC** form is available; this form can be filled out in advance to ensure accuracy and efficiency and amended in the field as required. Note that using a digital copy of the COC requires printing 2 copies of the document in the field (one for the laboratory, one for Azimuth). Ensure printing services are available in camp prior to using the digital version of the form. Any questions regarding the COC form should be directed to the Azimuth project coordinator – Maggie McConnell. Put the completed COC form in a sealed ziploc plastic bag in a cooler with the water samples.

20. Fill out a **chain-of-custody** form for the phytoplankton samples being sent to **Plankton R Us Inc.**, Winnipeg, MB. Complete all of the required fields and then put the form in a sealed ziploc plastic bag in the cooler with the phytoplankton samples.

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
   101-8081 Lougheed Hwy.
   Burnaby, BC, Canada
   V5A 1W9
   Tel: 604-253-4188
   Attention: Natasha Marcovic-Mirovic

3. Ensure **phytoplankton samples** are **sealed** securely and **pack** in a cooler with packing material to ensure samples do not break during transport. It is not necessary to keep samples cool.

4. Ensure the COC form is enclosed and then seal the cooler. **Label the cooler** with the following address:

   Plankton R Us Inc.
   Dave Findlay
   39 Alburg Drive
   Winnipeg, MB
   R2N 1M1
   Tel: 204-254-7952

5. **Ship** the water **samples** to ALS Environmental as quickly as possible. Ship the phytoplankton samples to Dave Findlay at the end of each month or event.

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

APPENDIX B

STANDARD OPERATING PROCEDURES FOR SEDIMENT AND BENTHOS SAMPLING.

APPENDIX B
Standard Operating Procedure
Meadowbank Study Lakes & Baker Lake
CREMP Benthos & Sediment Sampling

GENERAL:

Project Coordinator:
Maggie McConnell
Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, BC, V6K 2G8
Telephone: 604-730-1220
Fax: 604-739-8511
Email: mmcconnell@azimuthgroup.ca

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

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Twelve sampling stations have been chosen for benthos and sediment quality monitoring in the Meadowbank study lakes area. These stations (with their corresponding abbreviation) are:

- Third Portage Lake – North Basin (TPN)
- Third Portage Lake – East Basin (TPE)
- Third Portage Lake – South Basin (TPS)
- Second Portage Lake (SP)
- Tehek Lake (TE)
- Wally Lake (WAL)
- Inuggugayualik Lake (INUG)
- Tehek far-field (TEFF)
- Pipedream Lake (PDL)
- Baker Lake – Barge Dock (BBD)
- Baker Lake – Proposed Jetty (BPJ)
- Baker Lake – Akilahaarjuk Point (BAP)

Field activities are scheduled for once per year, in **mid/late August**. The **target water depth** at each sampling station is approximately **8 meters +/- 1.5 m**; Wally Lake is the exception, with a total water depth of approximately 6 meters (target water depth is 5 to 6 meters).

BENTHOS & SEDIMENT CHEMISTRY SAMPLING:

1. Gather **field collection materials**:
   In the boat:
   - Field collection data forms, waterproof paper, pencils, waterproof markers & clipboard

- GPS unit, batteries
- Depth meter, batteries
- pH meter, batteries
- Rope
- Petite Ponar grab and rope
- 500 micron sieve bag
- 2 stainless steel bowls
- 2 stainless steel spoons
- Liquinox detergent and dish cleaning brush
- Plastic squirt bottle
- Bucket
- Sampling gloves
- Safety glasses
- Field sample jars & preservatives (per sampling station):
  - 3 – 125 mL glass jars (sediment samples)
  - 5 – 500 mL plastic jars (benthos)
- QA/QC field duplicate sediment jars
- Ashless filter paper & tweezers; 1-125 mL glass jar

In camp:

- Formalin (10% Formaldehyde)
- Labels for sampling containers
- Coolers, action packers (for storing and shipping samples)
- Ice packs (for shipping sediment samples to lab)
- Address labels for coolers
- Chain-of-custody forms
- Large Ziploc bags (for sending chain-of-custody form in coolers)
- Electrical tape (for sealing benthos jars)
- Packing tape (for affixing labels to sediment sample containers & sealing coolers)

2. Before going into the field, **label the lids** of all sampling containers using a permanent waterproof marker. After sampling, prepare appropriate labels for containers and affix them when bottles are dry enough to stick to. Use the following information:
   - Azimuth company name
   - Station abbreviation (e.g. TPE-1, INUG-3)
   - Date of sample collection
   - Parameters to be measured from individual jar (2 x 125 mL – total metals, pH, moisture, PAHs, Oil&Grease; 1 x 125 mL – grain size (PSA), TOC)

   Affix the labels to the sediment jars and then wrap packing tape around the labels to ensure a waterproof seal.

   For the **benthos containers**, print the following information directly onto both the jar and jar lid using a permanent waterproof marker:
   - Azimuth company name
   - Station abbreviation (e.g. TPE, INUG) and replicate number (e.g. TPE-1, TPE-2); there are a total of 5 replicates per sampling station
   - Date of sample collection

Prepare **internal labels** for each of the benthos containers. On a small piece of waterproof paper, write, using a lead pencil, the station abbreviation and replicate number (e.g. TPE-1). If no waterproof paper is available, use regular paper. Store the labels in their corresponding sampling container.

3. For **QAQC** purposes, sediment samples are collected in duplicate from one station every sampling event. All parameters measured in the original sample are measured in the field duplicate. The sampling station is selected randomly from one of the ten stations, and labeled as station DUP. Prepare the QAQC labels and affix to the sediment jars, as described in step 2. Label one new 125 mL glass jar with the Azimuth company name, date, QAQC filter and total metals.

4. A 100% formalin solution is equivalent to a solution of 37% formaldehyde. The **target formalin concentration** in each of the sampling containers is 10%. A neutral buffered formalin solution is achieved by adding a sufficient amount of calcium carbonate powder or pellets to render the solution pH neutral (pH = 7.0). Borax powder may be substituted for calcium carbonate powder if necessary.

   Transport Canada allows the free transport of formalin at concentrations less than 25% formaldehyde. Consequently, the formalin transported up to Meadowbank will be diluted in half (18.5% formaldehyde / 50% formalin solution).

   To **prepare** the **neutral buffered formalin**, add a small amount of calcium carbonate powder or pellets to the 50% formalin solution, seal the container and shake until mixed. Check the pH of the solution using the pH pen. Continue adding the powder/pellets until the pH of the solution reaches approximately 7.0. Store at room temperature until ready to use. Only prepare the required volume of neutral buffered formalin for that sampling event. Buffered formalin will not store for long periods of time.

   Follow all **safety precautions** when preparing the formalin solution. Formalin is a carcinogen and irritant. Wear sampling gloves and safety glasses when mixing the solution and prepare the solution in a well ventilated area.

5. Before and during the benthos and sediment 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 write-in-the-rain pen.

6. 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. In windy conditions, anchor the boat upstream of the station and drift back; it is not necessary to anchor the boat in calm conditions providing the boat remains within a 50 meter radius of the position. Do not allow the anchor to drag through the sampling station. Record the exact UTM coordinates on the field data form.

7. Measure the **water depth** at the sampling station using the 'Hawkeye' hand-held depth meter (note: place depth meter in water ***before*** pushing ON button). Hold the meter in the water, facing the lake bottom, until the meter measures the depth. Record this information on the field data form.

8. Begin collecting the benthos samples. Collecting the sediment first would disturb the benthic community.

9. Ensure the rope is securely attached to the **Ponar**. Rinse the Ponar grab, stainless steel bowl and spoon with lake water. **Wash** each of these items with liquinox soap by scrubbing with the dish cleaning brush and then thoroughly rinse with lake water. Put aside the stainless steel bowl and spoon until later (step 18).

10. Lower the **Ponar** to within 1 meter of the bottom of the lake. Lower the Ponar very slowly over the last meter and allow the rope to go slack. Raise the Ponar to the edge of the boat and check the grab for **acceptability**. The grab is acceptable if the sample:
    - does not contain large foreign objects;
    - has adequate penetration depth (i.e., 10-15 centimeters);
    - is not overfilled (sediment surface must not be touching the top of the Ponar);
    - did not leak (there is overlying water present in Ponar); and
    - is undisturbed (sediment surface relatively flat).

    Once the grab is deemed acceptable, open the Ponar jaws and drop the sample into a stainless steel bowl. Rinse the ponar with squirt bottles to make sure all of the material is in the bowl. Gently pour the contents of the bowl into the 500 micron sieve bag.

11. **Sieve the sample** in the lake water until only the benthic organisms and coarse materials remain. Care must be taken to ensure the benthic organisms are not damaged or crushed. Do not disturb the sample to the point that it is splashing out of the sieve. Do not forcibly push materials through the sieve; gently break apart any small clay balls. Rinse off any pieces of larger plant material or rocks in the sample and discard.

12. **Flush** the **remaining sample** in the bottom of the sieve into the pre-labeled plastic sampling container (i.e. station-1 jar). A plastic squirt bottle filled with lake water is useful for this purpose.

13. **Repeat steps 10-12**, flushing the sample into the same pre-labeled plastic sampling container (i.e., station-1 jar). Ensure the sample is collected in an area not previously disturbed by the Ponar. The two independent grabs (per replicate) are composited to increase the surface area sampled.

14. **Rinse the sieve** bag to clear out any debris in the screen. To rinse, hold the sieve upside down and raise and lower the sieve into the water.

15. **Repeat steps 10-14** four more times; there must be a separation of ***20 meters*** or more from other replicate stations. Record the depth and GPS coordinates of each replicate station on the field data form. Put the samples from each replicate in pre-labeled station replicate jars 2

through 5. In total, 10 Ponar grabs will be collected for benthos collection, two grabs per replicate.

16. Ensure internal labels are in each sample container. Shake the formalin to ensure all of the calcium carbonate powder is in solution. **Add** a sufficient volume of **formalin** to each sampling container to make a corresponding formalin solution of approximately 10%. Volumes of formalin are added by 'eye' (for a 10% solution, a ratio of 4 parts water and 1 part 50% formalin solution). Overall, there must be enough liquid in the jar to cover the entire sample. Seal the sample container securely and gently roll the container to mix the sample and formalin solution. Do not shake the sample container; this will crush the benthic organisms inside.

17. Begin collecting the sediment samples. Lower the **Ponar** to within 1 meter of the bottom of the lake, in an area not previously disturbed by the Ponar. Lower the Ponar very slowly over the last meter and allow the rope to go slack. Raise the Ponar to the edge of the boat and check the grab for **acceptability** (see step 10 for criteria).

18. Once the grab is deemed acceptable, open the top of the Ponar and remove any overlying water. Using the pre-cleaned stainless steel spoon, scoop out the **top 3-5 centimeters** of **sediment** and place in the pre-cleaned stainless steel bowl. Empty the remainder of the grab sample into a bucket in the boat, not directly into the lake, to ensure the area is not disturbed.

19. **Repeat steps 17** and **18** one or two more times, placing the sediment into the bowl with the other sediment sample(s).

20. **Homogenize** the sediment samples in the stainless steel bowl (by stirring with the spoon) until the sediment is thoroughly mixed. Scoop the sediment into pre-labeled sediment sampling containers. **Fill the jars** to the top and seal securely.

21. If this station is selected as the QAQC **field duplicate**, using the tweezers and a set of clean sampling gloves, **swipe** the stainless steel bowl and spoon with one piece of ashless **filter paper** and store in the pre-labeled 125 mL glass jar. Collect the duplicate sediment sample from the same sediment collected in steps 17-20. Fill the sampling containers labeled as station DUP. Record that the QAQC samples were collected from this sampling station on the field data form.

22. **Complete** the **field data form**, including a description of the sediment (grain size, consistency, colour, presence of biota, sheen, unusual appearance) and the sampling effort (equipment failure, control of vertical descent of sampler) required to collect the benthos and sediment samples.

23. **Rinse** out the Ponar, stainless steel bowl and spoon with lake water. Dump the sediment and water from the plastic bin into the lake.

24. Until ready for shipping, store the **sediment samples and QAQC filter paper chilled** (on ice) in a cooler or in a refrigerator in camp, if space is available. The sediment sampling

containers may be put in plastic bags prior to storage on ice to further protect the labels from water damage. **Benthos samples** are stored in a cooler or action packer at **room temperature**.

25. Fill out a **chain-of-custody** form for the sediment samples being sent to **ALS Environmental**. The COC form must be completed carefully and in its entirety to ensure proper analysis. This includes listing all of the specific parameters to be analyzed (see step 2), Azimuth and ALS contact names, and checking off all of the specific boxes for requested analyses. The ALS laboratory quote number must be printed on the COC form to ensure proper billing.

    A **digital COC** form is available; this form can be filled out in advance to ensure accuracy and efficiency and amended in the field as required. However, using a digital copy of the COC requires printing 2 copies of the document in the field (one for the laboratory, one for Azimuth). Ensure printing services are available in camp prior to using the digital version of the form. Any questions regarding the COC form should be directed to the Azimuth project coordinator – Maggie McConnell. Put the completed COC form in a sealed ziploc plastic bag in the cooler with the samples.

26. Fill out a **chain-of-custody** form for the benthos samples being sent to **Zaranko Environmental Assessment Services** (ZEAS). Complete all of the required fields and then put the form in a sealed ziploc plastic bag in the cooler with the benthos samples.

PACKAGING & SHIPPING SAMPLES:

1. Ensure all **sediment samples** are **sealed** securely. **Pack** sediment sampling containers upright in a cooler with ice packs, and packing material, to ensure containers do not 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
   101-8081 Lougheed Hwy.
   Burnaby, BC, Canada
   V5A 1W9
   Tel: 604-253-4188
   Attention: Natasha Marcovic-Mirovic

3. Ensure **benthos samples** are **sealed** securely. Wrap electrical tape around the edge of the lids to ensure a tight seal. **Pack** benthos sampling containers upright in a cooler or action packer; ensure the cooler/action packer is well packed so the jars are not able to move around.

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

   Zaranko Environmental Assessment Services
   36 McCutcheon Avenue
   P.O. Box 1045
   Nobleton, ON
   L0G 1N0
   Tel: 905-859-7976

5. **Ship** the sediment **samples** to ALS Environmental as quickly as possible. Ship the benthos samples to ZEAS when convenient. Coordinate shipping with the camp manager.

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

APPENDIX C

STANDARD OPERATING PROCEDURES FOR ZOOPLANKTON SAMPLING.

APPENDIX C
Standard Operating Procedure
Meadowbank Study Lakes
CREMP Zooplankton Sampling

GENERAL:

Project Coordinator:
Maggie McConnell
Azimuth Consulting Group Inc.
218-2902 West Broadway
Vancouver, BC, V6K 2G8
Telephone: 604-730-1220
Fax: 604-739-8511
Email: mmcconnell@azimuthgroup.ca

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

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Nine sampling stations have been chosen for zooplankton monitoring in the Meadowbank study lakes area. These stations (with their corresponding abbreviation) are:

- Third Portage Lake – North Basin (TPN)
- Third Portage Lake – East Basin (TPE)
- Third Portage Lake – South Basin (TPS)
- Second Portage Lake (SP)
- Tehek Lake (TE)
- Wally Lake (WAL)
- Inuggugayualik Lake (INUG)
- Tehek far-field (TEFF)
- Pipedream Lake (PDL)

Field activities are scheduled for once per year, in **mid/late August**. The target **water depth** at each sampling station is 10 meters (at least > 8 m).

ZOOPLANKTON SAMPLING:

1. Gather **field collection materials**:
   In the boat:
   - Field collection data forms, waterproof paper, pencils, waterproof markers & clipboard
   - GPS unit, batteries
   - Depth meter, batteries
   - pH meter, batteries
   - Rope

- 70 micron nitex plankton net (30 cm diameter; 2.2 m long)
- Plastic squirt bottle
- Sampling gloves
- Safety glasses
- Field sample jars (per sampling station):
    - 10 – 500 mL plastic jars

In camp:

- Buffered formalin (10% Formaldehyde)
- Coolers, action packers (for storing and shipping samples)
- Address labels for coolers
- Chain-of-custody forms
- Large Ziploc bags (for sending chain-of-custody form in coolers)
- Electrical tape (for sealing zooplankton jars)
- Packing tape (for sealing coolers)

Before going into the field, **label all the lids and sampling containers** using a permanent waterproof marker. Print the following information directly onto both the jar and jar lid using a permanent waterproof marker:

- Azimuth company name
- Station abbreviation (e.g. TPE-1-B, INUG-3-B)
- Date of sample collection
- Parameters to be measured from individual jar (5 x 500 mL – Taxonomy; 5 x 500 mL – Biomass)

The following table lists the number of jars to be filled per sampling area (i.e., lake basin), naming convention to use, number of tows per replicate, analyses and preservatives required for each.

Sampling Containers / Area	**Sample ID / Rep** e.g.,	**Tows / Rep**	**Analyses**	**Preservatives**
5 x 500 mL plastic wide-mouth jar	**TPE-1-B** through **TPE-5-B**	2 tows	Biomass Analysis	5-10% Formalin
5 x 500 mL plastic wide-mouth jar	**TPE-1-T** through **TPE-5-T**	2 tows	Taxonomic Identification	5-10% Formalin

Prepare **internal labels** for each of the zooplankton containers. On a small piece of waterproof paper, write, using a lead pencil, the station abbreviation and replicate number (e.g. TPE-1). If no waterproof paper is available, use regular paper. Store the labels in their corresponding sampling container.

2. A 100% formalin solution is equivalent to a solution of 37% formaldehyde. The **target formalin concentration** in each of the sampling containers is 10% (i.e., $1/10^{th}$ of the 37% solution). A neutral buffered formalin solution is achieved by adding a sufficient amount of

calcium carbonate powder or pellets to render the solution pH neutral (pH = 7.0). Borax powder may be substituted for calcium carbonate powder if necessary.

Transport Canada allows the free transport of formalin at concentrations less than 25% formaldehyde. Consequently, the formalin transported up to Meadowbank will be diluted in half (18.5% formaldehyde / 50% formalin solution).

Store at room temperature until ready to use. Only prepare the required volume of neutral buffered formalin for that sampling event. Buffered formalin will not store for long periods of time. Do not freeze the formalin solution as this renders it useless.

Follow all **safety precautions** when preparing the formalin solution. Formalin is a carcinogen and irritant. Wear sampling gloves and safety glasses when mixing the solution and prepare the solution in a well ventilated area.

3. Before and during the zooplankton 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 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. In windy conditions, anchor the boat upstream of the station and drift back; it is not necessary to anchor the boat in calm conditions providing the boat remains within a 50 meter radius of the position. Do not allow the anchor to drag through the sampling station. Record the exact UTM coordinates on the field data form.

5. Measure the **water depth** at the sampling station using the 'Hawkeye' hand-held depth meter (note: place depth meter in water ***before*** pushing ON button). Hold the meter in the water, facing the lake bottom, until the meter measures the depth. Record this information on the field data form. Prior to sampling, make sure that the depth below the boat is at least **10 m**, to allow for a standard 8 m sampling depth, plus the length of the net (~2 m).

6. Ensure the rope is securely attached to the **Plankton Net**. Rinse the net with lake water. Lower the **Plankton Net** to 8 meters and wait for 30 seconds. Slowly tow the net towards the surface at a rate of about 0.3 m /second. It should take nearly 30 seconds to raise the net so that the mouth is above the water surface. Rinse the sidewalls of the net well by splashing water onto the outsides of the net to wash any zooplankters down towards the cod end of the net (i.e., the colleting vessel).

7. **Empty** the **sample** from the collecting vessel i**nto the pre**-labeled plastic sampling container (i.e. st**ation-1 jar)**. A plastic squirt bottle filled with lake water is useful for this purpose.

8. **Repeat steps 6-7**, to acquire a second complete sample. Combine the second sample with the first sample into the same pre-labeled plastic sampling container (i.e., station-1 jar). The two tows (per replicate) are composited to increase the water volume sampled (these are for

Biomass Analyses). Collect an additional 2 tows at the same station and composite for Taxonomic ID. Note the tow depth of the water sampled at each station.

9. **Rinse the net** by, holding the net upside down and raise and lower the net and collecting vessel into the water to ensure that there are no zooplankters stuck inside the net.

10. **Repeat steps 6-9** four more times. Navigate to the four pre-determined random sample locations within the entire basin (spatial replicates). Ensure that there is sufficient depth beneath the boat. If not, move to slightly deeper water. Record the depth and GPS coordinates of each replicate station on the field data form. Put the samples from each replicate in pre-labeled station replicate jars 2 through 5. In total, 20 tows will be collected for zooplankton collection, four tows per replicate.

11. Ensure internal labels are placed in each sample container. Shake the formalin to ensure all of the calcium carbonate powder is in solution. **Add** a sufficient volume of **formalin** to each sampling container to make a corresponding formalin solution of approximately 5 - 10%. Volumes of formalin are added by 'eye' (for a 10% solution, a ratio of 4 parts water and 1 part 50% formalin solution). Overall, there must be enough liquid in the jar to cover the entire sample. Seal the sample container securely and gently roll the container to mix the sample and formalin solution. Do not shake the sample container; this will crush the organisms inside.

12. **Complete** the **field data form**, including sampling effort (successful tows, equipment failure, control of vertical ascent of net, tow depth) required to collect the zooplankton samples.

13. Until ready for shipping, store the zooplankton samples in a cooler or action packer at **room temperature**. Dry the zooplankton net before storing away.

14. Fill out a **chain-of-custody** form for the benthos samples being sent to **North South Consultants, Winnipeg**. Complete all of the required fields and then put the form in a sealed ziploc plastic bag in the cooler with the samples.

PACKAGING & SHIPPING SAMPLES:

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

   North South Consultants Inc.
   83 Scurfield Blvd.
   Winnipeg, MB, Canada
   R3Y 1G4
   Tel: 204-284-3366

2. Ensure **samples** are **sealed** securely. Wrap electrical tape around the edge of the lids to ensure a tight seal. **Pack** sampling containers upright in a cooler or action packer; ensure the cooler/action packer is well packed so the jars are not able to move around.

3. **Ship** the samples to North South when convenient. Coordinate shipping with the camp manager.

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