AGNICO EAGLE

November 2nd, 2015

Manager of Licensing, Nunavut Water Board
P.O Box 119
Gjoa Haven, NU X0B 1J0
Phone: (867) 360-6338
Fax: (867) 360-6369

Subject: Management Plans submission for approval in writing

Dear Ms. Beaulieu,

Agnico Eagle Mine Meadowbank Division is required under Part B Item 14 of NWB Type A Water License 2AM-MEA1525, to "*update and revise for submission to the Board for approval in writing, within sixty (60) days of issuance of this Licence, the following management plans:*

a. *Aquatic Effects Management Plan (AEMP);*
b. *Core Receiving Environment Monitoring Program (CREMP) ;*
c. *Water Management Report and Plan;*
d. *Freshet Action Plan;*
e. *Ammonia Management Plan;*
f. *Groundwater Monitoring Plan;*
g. *Tailings Storage Facility: Operation, Maintenance and Surveillance Manual;*
h. *Operation and Maintenance Manual: Sewage Treatment Plan; and*
i. *Spill Contingency Plan"*

Should you have any questions please do not hesitate to contact the undersigned.

Regards,

Manon Turmel
manon.turmel@agnicoeagle.com
819-759-3555 x8025
Senior Environmental Compliance Technician

Version 3
Project No. AEM-15-03
November 2015

AGNICO EAGLE

Aquatic Effects Management Program (AEMP)

Meadowbank Mine

Prepared for:

Agnico-Eagle Mines Ltd.
Meadowbank Division

P.O. Box 540
Baker Lake, Nunavut X0C 0A0

Prepared by:

AZIMUTH

Azimuth Consulting Group Partnership
218-2902 W. Broadway, Vancouver, BC, V6K 2G8
Tel: 604 - 730 - 1220 * Fax: 604 - 739 - 8511

VERSION 3

Aquatic Effects Management Program (AEMP)
Meadowbank Mine

Prepared for

Agnico-Eagle Mines Ltd.
Meadowbank Division
P.O. Box 540
Baker Lake, Nunavut X0C 0A0

November 2015

Azimuth Consulting Group Partnership
218-2902 West Broadway
Vancouver, BC
V6K 2G8

Project No. AEM-15-03

TABLE OF CONTENTS

TABLE OF CONTENTS i

LIST OF TABLES iii

LIST OF FIGURES iv

DOCUMENT CONTROL v

1. INTRODUCTION 1

2. AEMP-RELATED MONITORING PROGRAMS 3

2.1. Core Receiving Environment Monitoring Program 3
2.2. Receiving Environment Effects Assessment Studies 4
2.3. Dike Construction Monitoring 5
2.4. Fisheries Authorizations 7
2.4.1. Fish-Out Programs 7
2.4.2. Habitat Compensation Monitoring 8
2.4.2.1. Mine Site and Western Channel Dike 8
2.4.2.2. All-Weather Private Access Road 9
2.5. Groundwater Monitoring 10
2.6. Dewatering Monitoring 11
2.7. Water Quality and Flow Monitoring 13
2.8. MMER and NWB A License Requirement I-1(a). 14
2.9. AWPAR and Quarry Water Quality 15
2.10. Other Related Monitoring Activities 16
2.10.1. Blasting 16
2.10.2. Air Quality Monitoring 17

3. CROSS-LINKAGES AMONG AEMP-RELATED PROGRAMS 23

3.1. Introduction 23
3.2. Cross-Linkages among Monitoring Programs 24

4. MANAGEMENT RESPONSE PLAN 33

4.1. Introduction and Objective 33
4.2. The MRP at the Program-Specific Level 34
4.2.1. Risk-Based Selection of Key Monitoring Variables 34
4.2.1.1. Potential Stressors and Their Characteristics 35
4.2.1.2. Receptors of Concern 36

4.2.1.3. Exposure Pathways 37
4.2.1.4. Assessment and Measurement Endpoints 38
4.2.2. Experimental Design and Statistical Framework 39
4.2.3. Sampling and Analysis Plans 40
4.2.4. Thresholds and Triggers 41
4.2.4.1. Background 41
4.2.4.2. Meadowbank Approach 41
4.2.5. Data Summary Framework 43
4.3. The MRP at AEMP Level 44
4.3.1. Integrated Data Evaluation 44
4.3.2. Management Actions 45

5. STRUCTURE AND CONTENT OF ANNUAL AEMP REPORTS 58

6. REFERENCES 60

LIST OF TABLES

Table 2-1. AEMP-related monitoring plans. 18

Table 2-2. Concordance between AEMP-related monitoring programs and the Nunavut Water Board A Licence conditions applying to general and aquatic effects monitoring. 19

Table 3-1. Major mine-related activities and potential effects identified in the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (AEIA, 2005) for the construction phase of the Meadowbank Gold Project. 26

Table 3-2. Major mine-related activities and potential effects identified in the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (AEIA, 2005) for the operations phase of the Meadowbank Gold Project..... 27

Table 3-3. Major mine-related activities and potential effects identified in the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (AEIA, 2005) for the closure/post-closure phase of the Meadowbank Gold Project.. 28

Table 4-1. Example template for summarizing results of monitoring under each program. 47

Table 4-2. Example / template summary of exceedances of triggers and thresholds for key AEMP monitoring variables. 49

Table 4-3. Example template for integrated evaluation of monitoring results across all programs for a monitoring variable or group of variables[1].. 50

Table 4-4. Toolbox of some potential receiving environment assessment methods. 51

Table 4-5. Toolbox of some potential mitigation options. 52

LIST OF FIGURES

Figure 3-1. Simple pathway-style conceptual site model showing transport, fate and potential effects relationships for construction-related sedimentation. 29

Figure 3-2. Primary transport pathways, exposure media, and receptors of concern for the Meadowbank Gold Project's Aquatic Effects Management Program. 30

Figure 3-3. Primary transport pathways, exposure media, and receptors of concern for the Meadowbank Gold Project's Aquatic Effects Management Program. 31

Figure 3-4. Example of stressor-specific (zinc in effluent) conceptual site model showing cross-linkages among AEMP-related monitoring programs. 32

Figure 4-1. Generic management response process for the Meadowbank Mine AEMP. 53

Figure 4-2. Management response plan for the Meadowbank Mine AEMP programs. 54

Figure 4-3. Derivation of thresholds and potential triggers for exposure variables. 55

Figure 4-4. Derivation of thresholds and potential triggers for effects variables. 56

Figure 4-5. Example of an issue-specific conceptual site model for the 2008 sedimentation event during East Dike construction. 57

Figure 5-1. AEMP annual reporting process....59

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
0	2005-10	All	All	Cumberland Resources- Meadowbank Gold Project Aquatic Effects Management Program (AEMP)
1	2010-05	All	All	Aquatic Effects Management Program (AEMP) Meadowbank Gold Project
2	2012-12	All	All	Aquatic Effects Management Program (AEMP) Meadowbank Mine
3	2015-11	4.3	43-45; 47-50	Updated Tables 4-1, 4-2, 4-3 and language in text related to those tables to match current CREMP

Version 3:
Reviewed/approved by:

Ryan VanEngen
Environment Superintendent – Nunavut
Permitting and Regulatory Affairs

Approved by:

Kevin Buck
Environment Superintendent – Nunavut

1. INTRODUCTION

The Aquatic Effects Management Program (AEMP) for Agnico-Eagle Mines' (AEM) Meadowbank Gold Mine was included as part of the Environmental Assessment (EA) for the project in 2005 (AEMP 2005), and has been formally implemented since 2006. The water license (2AM-MEA0815) for the project issued by the Nunavut Water Board (NWB) in 2008 required 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 needs to be broader in scope to comply with the following licence 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*[1]*;*
- *Annual reporting for more immediate adaptive management*[2]*;*
- *Mechanisms to measure changes to productivity in the lake as a result of the mine adding nutrients*[3]*;*
- *Sampling and Analysis Plans*[4]*; and*
- *Monitoring under Fisheries Authorizations, NWB Licence Compliance Monitoring, Environmental Effects Monitoring, and Groundwater Monitoring.*

The last requirement diverges from traditional AEMPs (INAC, 2009) and required AEM to propose a new approach, which was presented in draft to the NWB (March 2-3, 2010 in Yellowknife) and necessitated the restructuring of the AEMP. As a result the AEMP was restructured to serve as an overarching 'umbrella' that conceptually provides an opportunity to integrate results of individual, but related, monitoring programs in accordance with the Type A water license requirements. The scope of the 2005 AEMP, which was essentially the core receiving environment monitoring, is now one of the monitoring programs that is integrated under the restructured AEMP and has been renamed the Core Receiving Environment Monitoring Program (CREMP) to minimize confusion.

---

[1] This component is included in quarterly environmental effects monitoring (EEM) receiving environment monitoring under the *Metal Mines Effluent Regulation*.

[2] This applies to most monitoring programs. Some programs, such as the Effects Assessment Studies (EAS) are conducted only when needed.

[3] This is conducted as part of the Core Receiving Environment Monitoring Program (CREMP).

[4] This is part of the CREMP and other programs.

The restructured AEMP is organized as follows. **Section 2** reviews each of the underlying monitoring programs, including the CREMP, the cornerstone broad-level monitoring program. **Section 3** reviews the inter-linkages among the component programs. **Section 4** develops the Management Response Plan for the AEMP that is to be implemented following the integration of results for each component program. Finally, **Section 5** outlines the expected structure and content for the annual AEMP report beginning for the year 2013 (i.e., monitoring in 2012, reported in 2013).

2. AEMP-RELATED MONITORING PROGRAMS

The following subsections summarize the major monitoring programs related to the AEMP. **Table 2-1** lists the programs and provides citations of relevant monitoring plans. **Table 2-2** shows the concordance between the AEMP-related monitoring programs and the NWB A Licence conditions related to general and aquatic effects monitoring.

2.1. Core Receiving Environment Monitoring Program

As discussed in **Section 1**, the CREMP was originally the Aquatic Effects Management Program (AEMP, 2005), which was developed to address issues identified during the environmental assessment (EA) process that could potentially impact the aquatic receiving environments surrounding the development. Building from earlier baseline monitoring (BAER, 2005), the 2005 AEMP described the general monitoring strategy designed to detect impacts to the aquatic environment.

The program was designed to take an integrated, ecosystem-based approach that links mitigation and monitoring of physical/chemical effects on key ecological receptors in the receiving environment. At its core, the report addresses key issues identified in the Meadowbank EA (i.e., mining-related activities with the potential to affect water quality, fish habitat and fish populations). Monitoring results are intended to inform the "adaptive management"[5] process, supporting the early identification of potential problems and development of mitigation options to address them.

The CREMP study design was tailored based on our understanding of mine construction, operation and infrastructure (e.g., dikes, effluents, stream crossings, roads, etc.) and was developed to detect mine-related impacts at temporal and spatial scales that are ecologically relevant (i.e., on a basin spatial scale). The program targets general limnology, water and sediment quality, primary productivity (phytoplankton and periphyton), and benthic community structure. The core program initially focused solely on the project lakes (i.e., those in close proximity to the mine site), 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, two additional references areas were added; 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).

The CREMP has been implemented as follows:

[5] This terminology is refined in **Section 4.1**.

- 2006 and 2007 – Two complete cycles were conducted prior to initiation of mine construction to characterize baseline conditions.
- 2008 through 2010 – Mine construction started in late July 2008, with dike construction activities occurring directly in the receiving environment. CREMP monitoring was complemented by targeted studies on dike construction monitoring and effects assessment studies for total suspended solids (TSS) (see **Sections 2.2 and 2.3**).
- 2010 – 2012 – In addition to continuing dewatering activities, mine operations commenced in this period.

The CREMP consists of the following general elements:

- Sampling Components – limnology, water and sediment chemistry, phytoplankton, and benthic invertebrate community.
- Sampling Areas – 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.
- Timing – annual water sampling (including limnology and phytoplankton) will be conducted in two stages: (1) comprehensive monitoring at all areas will be conducted up to 6 months per year (e.g., April, May, July, August, September and November/December pending safe access or logistical constraints) for full quantitative analysis and (2) basic water quality data (focusing on limnology and opportunistic water chemistry if needed) will be collected at key near-field areas (i.e., TPN, TPE, SP and eventually Wally) at least once mid-winter to reduce uncertainty regarding the potential occurrence of ecologically relevant changes over winter. Sediment chemistry and benthic invertebrate sampling will be conducted in August only, as it has been during baseline data collection.
- Spatial coverage – sampling locations are randomly distributed within each lake basin and samples are collected 3 m below the surface.

2.2. Receiving Environment Effects Assessment Studies

In addition to the core receiving environment monitoring (**Section 2.1**), the 2005 AEMP included complementary "targeted studies" to address activities or issues that required more intensive spatial and/or temporal monitoring and possibly more specialized techniques. AEM commissioned targeted "effects assessment studies" (EAS) in each of the last two years (2008 and 2009) to address concerns regarding the potential impacts of elevated TSS concentrations on the local receiving environment from dike construction. Based on the literature, elevated TSS concentrations can directly or indirectly affect the

entire range of organisms in the aquatic environment, so these studies have addressed a broad array of ecosystem elements.

The East Dike TSS EAS was initiated in 2008 and targets the effects of TSS from East Dike construction, primarily on Second Portage Lake, but also extending into Tehek Lake. This study continued in 2009 to implement some planned components as well as to address some new uncertainties raised by the 2008 results.

The Bay-Goose TSS EAS was initiated in 2009 and targets the effects of TSS from Bay-Goose construction, primarily on the east basin of Third Portage Lake, but also downstream into Second Portage Lake and Tehek Lake. Due to the phased nature of construction of the Bay-Goose Dike (i.e., Phase 1 in 2009; Phase 2 in 2010), the timing of study components is variable, with some conducted in 2009 and others slated for either 2010 and/or 2011.

Given that suspended sediments can directly or indirectly affect the entire range of organisms in the aquatic environment, the strategy developed for the EAS studies addressed a broad array of concerns. The general components included in the TSS EAS are:

- *Water Quality and Limnology* – The most obvious effect of sediment inputs into clear lakes is a noticeable reduction in water clarity and reduced light penetration. There are other possible effects, however, which can be equally significant. These include introduction of metals and nutrients, or other changes to normal conditions (e.g., oxygen reductions or increased temperature).
- *Field Effects Measurements* – Directly measuring key aspects of target aquatic receptors in the field is the best approach to determining the ecological significance of elevated TSS. Water-clarity related changes in productivity could affect primary and secondary productivity of the water column. Potential effects to fish will be most likely manifested through changes to high-value habitat (e.g., sedimentation of spawning areas).
- *Laboratory Effects Measurements* – Taking site water into the laboratory provides a unique opportunity to conduct a suite of tests on sensitive life history stages under controlled conditions. These tests provide insights into how turbid water and/or settled sediment affect zooplankton and fish survival, feeding and growth.

2.3. Dike Construction Monitoring

In addition to the core receiving environment monitoring (**Section 2.1**), the 2005 AEMP included complementary "targeted studies" to address activities or issues that required more intensive spatial and/or temporal monitoring and possibly more specialized techniques. Targeted dike construction monitoring was conducted for the East Dike in 2008 and the first phase of the Bay-Goose Dike in 2009; monitoring is continuing in

2010 for the second phase of the Bay-Goose Dike. Monitoring is being conducted according to the *Water Quality Monitoring and Management Plan for Dike Construction and Dewatering at the Meadowbank Mine* (AEM, 2009a).

Dike construction monitoring focuses primarily on total suspended solids (TSS) as an indicator of environment status; water quality is a secondary focus. In the field, turbidity (easily measured using handheld equipment) profiles over depth are conducted at each monitoring station (see below). An empirical relationship between TSS and turbidity is then used to obtain real-time estimates of TSS concentrations for each profile. Routine monitoring is conducted at least daily (weather dependent) at a network of "routine" (i.e., close to the work area and good indicators of sampling stations (Routine Stations), as well as at stations situated near high-value habitat (HVH Stations). TSS trigger values, developed in the monitoring plan (AEM, 2009a) are as follows:

- *Routine Stations* - 50 mg/L for 24-hr average and 15 mg/L for 30-day average.
- *High-Value Habitat Stations* – same as the routine stations, except after September 1, when 25 mg/L for 24-hr average and 6 mg/L 30-day average are in effect.

Monitoring results are evaluated as follows:

- As routine monitoring continues, a moving 24-hour average TSS concentration is calculated at each monitoring station. If the 24-hour average exceeds the Short Term Maximum, AEM provides a recommended course of action to regulators.
- If the 7-day moving average TSS concentration exceeds the maximum monthly mean, this triggers a series of actions. First, it is determined if the average has been heavily influenced by one or more events that have been addressed. Second, mitigative options are considered, such as re-deployment of silt curtains, deployment of additional silt curtains, and possible adjustments to construction practices.
- If the 30-day moving average Maximum Monthly Mean is exceeded, AEM provides a recommended course of action to regulators.

In addition to monitoring turbidity at routine and high-value habitat stations in the near vicinity of dike construction, broad surveys are conducted. Broad surveys extend further afield to areas downstream and upstream of the dike construction area and are conducted every couple of weeks. Focused turbidity surveys are also conducted in the event of the formation of a TSS plume and to test turbidity curtain effectiveness. In conjunction with TSS sampling, water quality sampling is also conducted at key stations approximately weekly to monitor other parameters (e.g., nutrients, total and dissolved metals).

2.4. Fisheries Authorizations

2.4.1. Fish-Out Programs

AEM officially began construction of the Meadowbank Gold Project in July 2008 under Fisheries and Oceans Canada (DFO) *Authorization for Works or Undertakings Affecting Fish Habitat* NU-03-0191 (hereafter referred to as the "Authorization"). The East Dike was the first dike constructed in the project during the open water season of 2008 and divided Second Portage Lake more or less in half, separating the northwest arm of Second Portage Lake (SP) from the rest of the lake (**Figure 1-1**). Prior to draining the northwest arm as part of mine development, and as stipulated by the Authorization, fish were removed from the entire area during the summer of 2008. A similar program was implemented in 2010 for the portion of Third Portage Lake impounded by the Bay-Goose Dike.

The fish-out program, which was founded on DFO's draft *General Fish-Out Protocol for Lakes to be Lost due to Mining Developments*, was specifically designed (Azimuth, 2008a) and implemented (Azimuth, 2009; North-South Consultants, 2011) to obtain a broad range of scientific information to improve our overall understanding of the ecology of northern lakes.

The fish-out programs generally consists of the following technical elements:

- *General Limnology* – basic data limnological (oxygen and temperature profiles, secchi depth, water samples for nutrients) and biological (zooplankton biomass) data are collected within each basin of the impounded area once per month during the open water season. In addition, benthic invertebrate community productivity and taxonomy were collected once.
- *Mark/Recapture Phase*[6] – The mark-recapture phase involving tagging and releasing fish to obtain population estimates. The phase continues until the 2-day moving average recapture rate of marked and released fish is 10%, or to a maximum duration of 14 days.
- *Catch-Per-Unit-Effort (CPUE) Phase* – Starting at least three days after the mark-recapture phase, the CPUE phase involves collecting detailed catch information in order to derive fish population estimates using both the Leslie and DeLury methods. All captured fish are identified to species, weighed and measured for fork length (total length in the case of burbot, sculpin and stickleback). Each fish is physically "milked" to identify reproducing males or females. Detailed biological information is collected on a subset of fish. The CPUE phase ends

[6] This phase was not conducted for the fish-out of the Bay-Goose impoundment of Third Portage Lake due to its marginal utility for the northwest arm impoundment in Second Portage Lake.

when: (a) there has been a consistent, statistically significant (e.g., $p<0.10$) decline over a 10-day or greater period (for at least one of the two CPUE methods) for gill nets and for trap nets; and (b) overnight sets are catching very few fish regardless of the location of deployment.

- *Final Removal* – Intensive effort is expended to removal all fish. The removal phase is continued until either:
    1. No fish are caught for 48 hours, and then after a 24 hour break, no fish are caught for an additional 48 hours; or
    2. Catch has declined to near zero and the total catch has reached at least 95% of the estimated initial abundance from the CPUE data.
- *Habitat Mapping* –After dewatering is sufficient enough to expose the habitat, and after snowmelt has occurred, low level aerial photographs are taken to document the habitat. Ground surveys are also conducted to verify the habitat interpretations based on the photos. This provides the opportunity to compare and contrast mapping efforts based on through-water aerial photos, through-air aerial photos and ground surveys.

2.4.2. Habitat Compensation Monitoring

2.4.2.1. Mine Site and Western Channel Dike

AEM began construction of the East Dike in July 2008 under Fisheries and Oceans Canada (DFO) *Authorization for Works or Undertakings Affecting Fish Habitat* NU-03-0191. AEM has worked closely with DFO on aspects related to the harmful alteration, disruption or destruction (HADD) of fish habitat. The Authorization was based on the No-Net-Loss Plan (Azimuth, 2006), which was prepared to quantify project-related HADDs and present a habitat compensation strategy for the mine site to comply with DFO's No-Net-Loss of Habitat policy. Habitat compensation features (HCFs) have been designed to serve as productive fish habitat (e.g., Azimuth, 2006; Golder, 2008 for the mine site) for the purpose of compensating for HADD related habitat loss. To determine the HCFs capability to support fish, a long-term tiered monitoring strategy has been undertaken to document water quality, colonization by algae (i.e., the base of the food chain) and ultimately, utilization by fish.

In addition to meeting physical design specifications for fish, acceptable water quality is essential if HCFs (e.g., dike faces) are to function as intended, by providing spawning, nursery and foraging habitat for lake trout, Arctic char and round whitefish. Spawning requirements of each of these species in the project lakes is similar and occurs in relatively shallow water, between 2 and 6 m depth, below the ice scour depth and above the depth where there is a transition to very fine grain sediment (Azimuth, 2006).

A tiered monitoring strategy (Azimuth, has been employed that involves a combination of qualitative and quantitative measures to assess the capability of the HCFs to function as intended. Tiering provides a scientifically-defensible, yet cost-effective means of assessing potential limitations to HCF productivity.

Qualitative tools include visual/functional components including fishing, visual surveys, minnow trapping and measuring periphyton growth. Quantitative measures start with simple tools such as interstitial water quality/chemistry, and can lead to more specialized tools such as toxicity testing and/or *in situ* studies (Tier 3), should Tier 1 or Tier 2 studies fail, respectively. The results of both quantitative and qualitative tools are evaluated using a weight-of-evidence approach to determine whether HCFs are functioning as intended.

While the Western Channel crossing was within the mine site development footprint for the NNLP (Azimuth, 2006), the culverted crossing was constructed in spring 2008 under a different DFO Authorization (NU-08-0013). Monitoring requirements for the associated HCFs are essentially the same as those described for the mine site.

2.4.2.2. All-Weather Private Access Road

The construction of the 105-km All-Weather Private Access Road (AWPAR) between the Hamlet of Baker Lake and Meadowbank Mine Camp was completed in the spring of 2008 under DFO Authorization (NU-03-0190-2). Prior to AWPAR construction, baseline fisheries assessments found Arctic grayling (*Thymallus arcticus*) to be the predominant fish species. Other fish species opportunistically using the AWPAR streams included Lake trout, Arctic char, Round whitefish, slimy sculpin and ninespine stickleback. Many small ephemeral streams were defined as non-fish bearing; 6 of the proposed crossings were considered fish bearing and required follow-up monitoring. Follow-up monitoring in 2006 confirmed the predominance of Arctic grayling in crossings R02, R06, R09, R15 and R19. The decision to construct clear span bridges at these crossings was made to reduce the footprint on these streams and accommodate fish passage.

The three main objectives of the AWPAR fisheries monitoring program, that is designed to meet the Department of Fisheries and Oceans Authorization (NU-03-0190), are to complete:

- An assessment of the fish passage at R02, R06, R09 and R15 (HADD crossings) from the year the road construction began until 2010, inclusive; and every two years after starting in 2012 until 1 year following AWPAR decommissioning. The monitoring is focused on capturing Arctic grayling moving upstream and downstream (upstream of the bridge crossings) using non-invasive hoopnets. By capturing, identifying, enumerating, and collecting biological data of the Arctic grayling, an assessment and evaluation by comparing to baseline data can be made of the Arctic grayling population at each crossing. Furthermore velocity measurements are collected both upstream and downstream of the crossing to

provide a physical measurement and gauge for the ability of fish to move beyond the bridge structures.

- R02 habitat compensation evaluation from the year the road construction began until 2011, inclusive; and every two years after starting in 2013 until 1 year following AWPAR decommissioning. Similar to 2007 and 2008 baseline data collection, larval drift traps that successfully collect Arctic grayling eggs and fry serve as an important tool to evaluate the success of the R02 Habitat Compensation Features. These traps are set in reference areas upstream of the R02 compensation structures and at representative locations downstream and data is compared to historical data. In combination, strategically located hoopnets collect previous and current year recaptured fish (using Floy tagging) provide data to determine the tendencies, patterns and movements of Arctic grayling near the R02 habitat compensation area. Additionally, electro-fishing techniques later in the summer (late July and August) may be used to evaluate Arctic grayling foraging and population recruitment (i.e., year 0-1). Based on the number of fish collected moving upstream near the R02 compensation area, the larval drift data and the recapture *observational* data a weight of evidence approach provides information on whether or not Arctic grayling are successfully using the R02 compensation area as spawning habitat and/or foraging and that young-of-the-year are nursing in its vicinity.

Creel Surveys are to be conducted on an annual basis. These surveys obtain information on the fishing habits in the vicinity of the AWPAR and general fishing patterns of Baker Lake residents.

2.5. Groundwater Monitoring

AEM is responsible for completing annual groundwater monitoring as a condition of the Nunavut Impact Review Board (NIRB) Project Certificate (No. 004) and the NWB Water License. Under these conditions groundwater at wells in the groundwater flow path of the tailings storage facility must be monitored for the following parameters: pH, turbidity, alkalinity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphides, total dissolved solids (TDS), total and free cyanide, and a suite of dissolved metals. The Goose Island and Portage pits will be developed within a through talik (unfrozen ground that extends to the base of the permafrost) which is below Third Portage Lake. The tailings storage facility located in the basin of the north arm of Second Portage Lake is also situated over a through talik (Golder, 2004). Groundwater monitoring wells have been installed to provide information on baseline groundwater quality in the taliks and provide information on the movement of unfrozen groundwater. The objective of the groundwater sampling program, initiated in 2003, was two-fold: to measure the salinity of the deep groundwater to calibrate the pit groundwater inflow component of the site water quality

model; and to benchmark pre-mining groundwater quality against which to measure effects of mining on groundwater quality, if any.

Groundwater flow and quality data has been collected from the Portage area since 2003 and have been used as input into the water quality model for the site. Groundwater in the Vault area is not monitored because the talik present under Vault Lake is not anticipated to extend through the permafrost. Four monitoring wells were installed at the site in 2003, three of which subsequently developed internal damage and could no longer be operated. In 2006, the three defective monitoring wells were replaced, but the replacement wells also became inoperable after the first round of sampling in 2006.

To comply with the NIRB project certificate and Water license more robust monitoring well design through permafrost was developed (which included 200-m deep wells, with stainless steel riser pipe heated with trace cables) and 2 of the inoperable wells were replaced in 2008. The installation of the third monitoring well occurred in 2010 and in 2012 only one well was operable. Presently, the installation of groundwater wells, location and monitoring are under review.

Overall, the objectives of the groundwater sampling program remains in line with historical sampling which is to:

- Ensure monitoring well instrumentation is operating effectively,
- Evaluate groundwater quality and flow in second portage and third portage taliks, and
- Ensure the sampling meets QA/QC requirements.

2.6. Dewatering Monitoring

During dewatering of the northwest arm of Second Portage Lake, there is potential for sediments to become suspended as exposed substrates slump. Suspended sediments could then enter the dewatering pipe(s) and be discharged to the receiving environment. In addition, the discharge itself could disturb the bottom sediments in the lakes and lead to increased levels of suspended sediments. The goal of the dewatering and monitoring plan is to mitigate against possible problems with suspended sediments and other key parameters (i.e., pH and aluminum) during dewatering.

To prevent increased re-suspension of sediments, the Intake pipe(s) are located at a sufficient distance from shore and, to the extent possible, in areas with highest water depth. As dewatering progresses, intakes can only be located in deep basins. As well, the discharge points are located in areas of Third Portage Lake where there is deep, low-value habitat discharge area.

Dewatering monitoring is primarily focused at the water intake pumps or at the outlets of the water treatment plant, but will also include the receiving environment. Unlike

monitoring during dike construction, where turbidity was used solely as a real-time surrogate for estimating TSS (see **Section 4**), turbidity measurements will be used two-fold: as a surrogate for TSS (using an established site-specific relationship) and directly as an indicator of water clarity as per the license limits. There are two Water Treatment Plants (WTP) installed to treat discharge water. The water is monitored and then discharged to Third Portage Lake at proper set-back and depth. If the intake water meets the water quality license criteria the WTP is bypassed and water is discharged directly to Third Portage and Second Portage Lakes. Standard operating procedures are followed to ensure that routine monitoring is consistent, conducted by a qualified environmental technician and meets the QA/ QC requirements.

The following describes the mitigative approach to be taken if the respective exceedances occur:

- If parameter levels in a single sample from the WTP outlet or intake pump exceed the STM, this will trigger a series of actions. First, visual inspections will try to identify any obvious source of slumping on the lake edges to determine if the source of sediment is likely to be short-term or more continuous. Second, mitigative measures will be considered, such as movement of the intake pipe(s) and/or putting the WTP in recirculation mode.
- If the moving 24-hour average turbidity value exceeds the STM, then dewatering will shut down or the WTP will be put in recirculation mode while (a) mitigative measures are considered, (b) monitoring continues, (c) weather shifts (if weather is a factor), and (d) AEM provides an appropriate course of action to regulators. Dewatering will resume once the conditions that led to the elevated turbidity levels have been addressed.
- If the 7-day moving average TSS or turbidity concentration at the WTP outlet or intake pump exceeds the MMM, this will trigger a series of actions. First, visual inspections will try to identify any obvious source of slumping on the lake edges to determine if the source of sediment is likely to be short-term or more continuous. Second, mitigative measures will be considered, such as movement of the intake pipe(s) and/or putting the WTP in recirculation mode.
- If the 30-day moving average Maximum Monthly Mean is exceeded, then dewatering will shut down or the WTP will be put in recirculation mode while (a) mitigative measures are considered, (b) monitoring continues, and (c) AEM provides an appropriate course of action to regulators. Dewatering will resume once the conditions that led to the elevated TSS levels have been addressed.

In addition to the monitoring and management of suspended sediments, a hydraulic monitoring plan has been developed to monitor the water levels in Third Portage Lake and Second Portage Lake on a regular basis while dewatering activities are occurring; and outlet erosion inspections to monitor outlet stability, including potential erosion

and/or ice damming within the outlets. Third Portage Lake and Second Potage Lake water levels will be surveyed at a location of sufficient distance from the outlets to limit potential lake level drawdown effects. Lake water levels will be monitored weekly during the freshet and ice-free period, and weekly during the ice-up period, dependent of the ice conditions and worker safety. The outlet will be visually inspected to confirm that no significant erosion of the channel bed or channel banks, or ice damming has occurred. Significant ice damming observed within the outlets will be removed as soon as possible in order to minimize potential reductions in channel capacity. The regular inspection program will occur during the freshet and ice free period at a minimum of once every two weeks.

The objectives of the dewatering monitoring program are to:

- Collect turbidity/ TSS monitoring data on a daily basis,
- At least daily, carry out visual inspections of the intake, WTP and discharge areas,
- Collect water samples for analysis at an accredited laboratory (weekly TSS and turbidity samples),
- Collect water samples in Third Portage Lake receiving environment,
- Ensure the sampling program meets the QA/QC requirements,
- Conduct hydraulic monitoring of the water levels in Third Portage Lake and Second Portage Lake on a regular basis during dewatering activities, and
- Complete outlet erosion inspections to monitor outlet stability, including potential erosion and/or ice damming within the outlets.

2.7. Water Quality and Flow Monitoring

The Water Quality and Flow Monitoring Plan has been prepared in accordance with the requirements of the Nunavut Water Board Type A water license # 2AM-MEA0815.

The Plan summarizes the monitoring locations, sampling frequency, monitored parameters, compliance discharge criteria and an adaptive management plan for water quality at the Meadowbank Gold Project.

The purpose of this Water Quality and Flow Monitoring Plan (the Plan) is to monitor the performance of the waste and water management systems at the Meadowbank Gold Project. The program includes:

- Verifying and validating the predicted water quality values with empirical measurements of the mine site water quality and flows;

- A comparison of measured water quality data to compliance requirements stipulated in the Nunavut Water Board Type A water license # 2AM-MEA0815; and
- A framework for adaptive management that allows the identification and rectification, where necessary, of unexpected trends or non-compliance in water quality and flows.

The Plan provides information on the locations of the monitoring stations at the various stages of mining. These monitoring locations are be used to evaluate the performance of the mine waste and water management system.

The objectives of the monitoring program are:

1) to track the chemistry of the contact and non-contact water prior to and for discharge;
2) to identify if water treatment is required prior to discharge; and
3) to minimize the potential impact of mining activities on the surrounding environment.

2.8. MMER and NWB A License Requirement I-1(a).

In January 2010, AEM's Meadowbank Gold Project became subject to the Metal Mines Effluent Regulations (MMER). AEM has since submitted documentation to MMER authorization officer and registred an environmental monitoring plan which includes the mandatory submission of regulatory data for dewatering discharge characterization, sublethal toxicity testing, water quality monitoring and flow monitoring. Additionally, the biological study design as part of environmental effects monitoring (EEM) will begin development for submission in January 2011. The first interpretive report will be submitted within 30 months of the Meadowbank Gold Project being subject to MMER.

The purpose of the dewatering discharge (effluent) water quality monitoring at the Meadowbank Mine site is to characterize the water quality as per the MMER, ensure that the water quality meets the water license A limits and will provide information for the support of the biological monitoring. Included in the MMER monitoring program at Meadowbank are weekly collections of effluent water quality (*Section 12*) samples from the final dewatering discharge point. Parameters for analysis include: pH, arsenic, copper, cyanide, lead, nickel, zinc, TSS and Radium 226. Monthly volume of discharge is taken (*Section 19*) and once per month effluent toxicity testing (*Section 14*) is completed with rainbow trout and daphnia magna acute lethality as testing endpoints. Under Schedule 5-Section 4 effluent characterization (which includes analysis of aluminum, cadmium, iron, mercury, molybdenum, ammonia and nitrate) is completed at the final dewatering discharge point. Additionally, under Schedule 5- Section 5 AEM completes sublethal

toxicity testing two times per year at the final dewatering discharge point with fish, invertebrate, plant and algae species as endpoints. Lastly, four times per year water quality monitoring is completed in the receiving environment. Water quality is analyzed for: temperature, dissolved oxygen, pH, hardness, alkalinity, aluminum, cadmium, iron, mecury, molybdenum, ammonia, nitrate, arsenic, copper, cyanide, lead, nickel, zinc, TSS and Radium 226, at a dewatering discharge area in Third Portage Lake north basin and a reference station in Third Portage Lake south basin.

The objectives of this program are to meet the MME Regulations and the associated Guidance Documents which can be viewed on Environment Canada's Green Lane at the following addresses:

http://www.ec.gc.ca/nopp/docs/regs/mmer/en/index.cfm

http://www.ec.gc.ca/nopp/docs/regs/mmer/fr/index.cfm

The objectives for biological monitoring as part of the EEM will be established during the study design process. This is an iterative process that will require consultation with the EEM program coordinator and AEM.

In addition to MMER, the NWB A Licence (Part I-1a) stipulates that monitoring is required to show that CCME guidelines are met 30 m from any outfall. This requirement will be either integrated into the MMER program or conducted as part of the CREMP, whichever option does not result in duplication of effort.

2.9. AWPAR and Quarry Water Quality

AEM is responsible to manage erosion, water quality, and the introduction of sediment along the 110-km AWPAR that connects the Hamlet of Baker Lake to the Meadowbank mine site. As part of the water quality management, AEM personnel complete routine and event inspections both pre- and post-freshet for potential or present erosional issues at all stream crossings, complete routine water quality monitoring at all major crossings during the open water season, and collect water samples at representative watercourses and quarries as required.

As per the water quality management plan, a tiered approach is taken during the open water season to evaluate and monitor erosion and turbidity along the AWPAR. To prioritize monitoring at crossings, all crossings were visually inspected for erosion and turbidity on a regular basis, especially during freshet and immediately after freshet. If visual turbidity is observed at a specific location during routine inspections or event inspections (i.e. following freshet or after a rain event), the characteristics of the plume are monitored. Unless turbidity issues are observed, surface water quality sampling is not deemed necessary at non-HADD crossings or contact pools.

Water samples are collected upstream (reference) of the crossings and immediately downstream of the crossings to evaluate the water quality of the AWPAR bridge and abutment construction. Water samples are collected at quarries that contain accumulated water.

The objectives of the annual AWPAR and quarry water quality monitoring program are to:

- Conduct turbidity and erosion monitoring,
- Assess water quality at watercourse crossings,
- Assess quarry water quality, and
- Ensure sampling meets QA/QC requirements.

2.10. Other Related Monitoring Activities

2.10.1. Blasting

AEM has developed a Blasting Monitoring Program for the control of blasting vibrations at Meadowbank (AEM, 2010). The monitoring program complies with the Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters: which is to provide a monitoring and a mitigation plan that is currently in consultation with the DFO, restrict blasting when caribou or sensitive local wildlife may be affected, and minimize the use of ammonium nitrate to reduce effects on water quality.

To ensure that the blast does not impact nearby fish and fish habitat, a blast pressure and vibration threshold has been established. The blast setback distance from fish habitat to the center of detonation of a confined explosion, should not produce an instantaneous pressure change greater than 50 kPa (which affects fish swim bladders) (Wright and Hopky, 1998). Through monitoring and mitigation these levels have been established and are followed at Meadowbank. These setbacks account for the type of substrate (i.e., rock, frozen soil, ice, saturated soil or unsaturated soil) and the weight of explosive charge.

All blasts are monitored to ensure that vibrations generated are less than 13mm/sec and the overpressure is under 50 kPa using an Instantel Minimate Blaster portable unit. The monitoring unit is installed as per the supplier's specifications at two stations: one near the north end of Portage Pit along the shore of Second Portage Lake (north of the East Dike) and the other near the south end of Portage Pit on the shore of Second Portage Lake (south of the East Dike). The data is collected, analyzed and if there are exceedances, changes are made to the blast methodology to ensure compliance. These data are reported annually.

2.10.2. Air Quality Monitoring

The Air Quality Monitoring Plan at Meadowbank addresses the concentration of suspended particulate matter and the deposition rate of particles due to mine operation activities (Golder, 2008). The main components of the air quality monitoring plan include the monitoring of suspended particulate matter (i.e., dust due to wind erosion, vehicles, airstrip activity and incineration), dust fall monitoring, passive NOx monitoring, QA/QC and reporting.

Sampling stations will be adapted to reflect the operations of the site. The best available technology will be used to conduct the passive sampling (at approximately 3 stations) and the dynamic sampling programs (at 2 stations using equipment such as the Ruppercht and Patashnick Partisol Model 2025). Particulate sampling is to be carried out year-round provided safety and weather conditions permit. The sampling program collects information on total dust fall (everything that falls into the collection vessel) and fixed dust fall (non-combustible). These data can be quantified to ascertain dust fall rates and trends. One co-located station to monitor Nitrogen dioxide will also be established. Air quality stations will be installed in 2010.

Table 2-1. AEMP-Related Monitoring Plans.

Plan Title	Plan Citation	Regulator	Authorization / Regulation
Core Receiving Environment Monitoring Program (CREMP) formerly the Aquatic Effects Management Program (AEMP)	Azimuth. 2010. Core Receiving Environment Monitoring Program (CREMP) 2010 Plan Update. Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Agnico-Eagle Mines Ltd., Meadowbank Division, Baker Lake, NU. June 2010. AEMP. 2005. Aquatic Effects Management Program. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Cumberland Resources Ltd (now Agnico-Eagle Mines Ltd.), Vancouver, BC. October 2005.	NWB DFO EC INAC	2AM-MEA0815 Part I, Item 1
MMER Plan	AEMP. 2005. Metal Mining Effluent Regulation. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Cumberland Resources Ltd (now Agnico-Eagle Mines Ltd.), Vancouver, BC. October 2005.	EC	Sec 36 of Fisheries Act
Habitat Compensation Monitoring Plan - Mine Site	Azimuth. 2008. Meadowbank Gold Project Aquatic Effects Management Program Targeted Monitoring - Habitat Compensation Monitoring Plan. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Agnico-Eagle Mines Ltd., Vancouver, BC. May 2008.	DFO	HADD NU-03-0191
Habitat Compensation Monitoring Plan Western Channel	Azimuth. 2008. Meadowbank Gold Project Western Channel Crossing - Habitat Compensation Monitoring Plan. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Agnico-Eagle Mines Ltd., Vancouver, BC. May 2008.	DFO	HADD NU-08-0013
Tier 2 & 3 Habitat Compensation Monitoring Plan	Azimuth. 2009. Detailed Plans for Tier 2 and Tier 3 Habitat Features Compensation Monitoring for the Meadowbank Gold Project. Technical memorandum from Azimuth Consulting Group Inc., Vancouver, BC, to Fisheries and Oceans Canada, Iqaluit, NU. March 2009.	DFO	HADD NU-03-0191
Monitoring Plan for AWPAR HADD Crossings	Azimuth. 2007. Monitoring Plan for Meadowbank Project All-Weather Private Access Road (AWPAR) HADD Crossings for Condition 5 of Authorization NU-03-0190 (2). Technical memorandum from Azimuth Consulting Group Inc., Vancouver, BC, to Fisheries and Oceans Canada, Iqaluit, NU. June 2007.	DFO	HADD NU-03-0190
Water Quality and Flow Monitoring Plan	AEM. 2009 . Meadowbank Gold Project Water Quality and Flow Monitoring Plan In Accordance with Water License 2AM-MEA0815 Version 2 May 2009	NWB	2AM-MEA0815 Part I, Item 2
Groundwater Monitoring Plan	Golder. 2008. Technical Memorandum: 2008 Groundwater Monitoring Plan Meadowbank Gold Project. August 1, 2008	NWB	2AM-MEA0815 Part I, Item 3
Water Quality Monitoring Plan for Dike Construction and Dewatering	AEM. 2009. Meadowbank Gold Project Water Quality and Management Plan for Dike Construction and Dewatering In Accordance with Water License 2AM-MEA0815 Version 4 March 2010	NWB	2AM-MEA0815 Part D, Item 11
QAQC Plan	AEM. 2008. Quality Assurance/ Quality Control Plan: Meadowbank Division, December 2008. Prepared by Agnico-Eagle Mines Limited-Meadowbank Division.	NWB INAC NIRB	2AM-MEA0815 Part I, Item 19 Project Certificate Conditions 6 + 23 Approved by INAC analyst
Fish-Out Program	Azimuth. 2008. Fish-Out Program for the Meadowbank Gold Project. Technical memorandum from Azimuth Consulting Group Inc., Vancouver, BC, to Fisheries and Oceans Canada, Iqaluit, NU. May 2008.	DFO	NU-08-0052
Operational ARD-ML Testing Plan	AEM. 2008. Meadowbank Gold Project Operational ARD/ML Sampling Plan in Accordance with Water License 2AM-MEA0815 Version 1, August 2008	NWB	2AM-MEA0815 Part I, Item 4
Blast Monitoring & Blasting Design Addendum	AEM. 2010 Meadowbank Gold Project Blast Monitoring Program,. Currently in consultation with DFO Version 1 March 2010	NIRB DFO GN	Project Certificate Condition 85
Air Quality Monitoring Plan	Golder. 2008. Addendum Report: Air Quality Monitoring Meadowbank Gold Project Doc 665A May 16, 2008	EC NIRB	Project Certificate Condition 71

Table 2-2. Concordance between AEMP-related monitoring programs and the Nunavut Water Board A Licence conditions applying to general and aquatic effects monitoring. Adapted from Schedule I, Table 2: Monitoring Programs in 2AM MEA0815 License A.

Monitoring Program	Station	Description	Phase	Parameters/ Observations	Frequency
Dike Construction Monitoring	ST-DC-1 to TBD	Monitoring stations during dike construction	Construction	As defined in Water Quality Monitoring Plan for Dike Construction and Dewatering	As defined in Water Quality Monitoring Plan for Dike Construction and Dewatering
	ST-DD-1 to TBD	Monitoring stations during Dike Dewatering	Construction	As defined in Water Quality Monitoring Plan for Dike Construction and Dewatering	As defined in Water Quality Monitoring Plan for Dike Construction and Dewatering
Mine Operations Monitoring	ST-1	Water Intake for Camp and mill	Construction, operation, closure	Volume (m3)	Monthly
	ST-2	Reclaim Water Intake	Construction, operation, closure	Volume (m3)	Monthly
	ST-3	Water Intake for Emulsion Plant	Construction, operation, closure	Volume (m3)	Monthly
	ST-4	Water reclaimed from Tailings Storage	Operation, closure	Volume (m3)	Monthly
	ST-5	Portage Area (east) diversion ditch	Operation, closure	Al, pH, arsenic, copper, cyanide, lead, nickel, zinc, TSS, Radium 226, sulphate and turbidity	Monthly during open water
	ST-6	Portage Area (west) diversion ditch	Operation, closure	Al, pH, arsenic, copper, cyanide, lead, nickel, zinc, TSS, Radium 226, sulphate and turbidity	Monthly during open water
	ST-7	Vault Area diversion ditch	Operation, closure	Al, pH, arsenic, copper, cyanide, lead, nickel, zinc, TSS, Radium 226, sulphate and turbidity	Monthly during open water
	ST-9	Portage Attenuation Pond prior to discharge through Third Portage Lake Outfall diffuser	Early operation	Full Suite	Prior to discharge and weekly during discharge
				Volume (m3)	daily during discharge
				Acute Lethality	Once prior to discharge and monthly thereafter
	ST-10	Vault Attenuation Pond Prior to discharge through Wally Lake Outfall Diffuser	Late Operation	Full Suite	Prior to discharge and weekly during discharge
				Volume (m3)	daily during discharge
				Acute Lethality	Once prior to discharge and monthly thereafter
	ST-11	Tailings Storage Facility	Post Closure	MMER: total cyanide, Ar, Cu, Pb,Ni, Zn, radium 226, TSS, pH, effluent volumes, flow rate, acute tox, Daphnia Magna, Ammonia-Nitrogen, Nitrate-Nitrogen, Nitrite-Nitrogen	Annually during open water
	ST-12	Portage/ Goose Pit Lake	Post Closure	Full Suite	Annually during open water season
	ST-13	Vault Pit Lake	Post Closure	Full Suite	Annually during open water
	ST-15	Vault non-contact diversion ditch	Operation, closure	Al, pH, arsenic, copper, cyanide, lead, nickel, zinc, TSS, Radium 226, sulphate and turbidity	Monthly during open water
	ST-16	Portage Rock Storage Facility	Early operation	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); total	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet
			Late Operation	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
			Closure	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet

Table 2-2. Concordance between AEMP-related monitoring programs and the Nunavut Water Board A Licence conditions applying to general and aquatic effects monitoring. Adapted from Schedule I, Table 2: Monitoring Programs in 2AM MEA0815 License A.

Monitoring Program	Station	Description	Phase	Parameters/ Observations	Frequency
	ST-17	North Portage Pit Sump	Early operation	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); total	Bi-annually during open water
				Volume (m3)	daily during discharge
		Portage Pit Lake	Late Operation	Full Suite	Monthly during open water
			Closure	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
	ST-18	Portage Attenuation Pond	Early operation	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
	ST-19	Third Portage Pit Sump	Early operation	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); total	Bi-annually during open water
				Volume (m3)	daily during discharge
		Third Portage Pit Lake	Late Operation	Full Suite	Monthly during open water
	ST-20	Goose Island Pit Sump	Early operation	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
				Volume (m3)	daily during discharge
		Goose Island Pit Lake	Late Operation	Full Suite	Monthly during open water
			Closure	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
	ST-21	Tailings Reclaim Pond	Early operation (south of central dike)	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); cyanide	Bi-annually during open water
				Volume (m3)	Once Annually immediately following spring freshet
			Late Operation (north of central dike)	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); cyanide	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet

Table 2-2. Concordance between AEMP-related monitoring programs and the Nunavut Water Board A Licence conditions applying to general and aquatic effects monitoring. Adapted from Schedule I, Table 2: Monitoring Programs in 2AM MEA0815 License A.

Monitoring Program	Station	Description	Phase	Parameters/ Observations	Frequency
	ST-22	Tailings Storage Facility	Late operation	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); cyanide	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet
	ST-23	Vault Pit Sump	Late operations	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
				Volume (m3)	daily during discharge
	ST-24	Vault Rock Storage Facility	Late operations	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet
			Closure (east ditch) ST-24-A	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet
			Closure (west ditch) ST-24-B	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
				Total Metals	Once Annually immediately following spring freshet
	ST-25	Vault Attenuation Pond	Late Operation	pH, turbidity, TDS, alkalinity, ammonia, arsenic copper, lead, nickel, zinc	Monthly during open water
				Total Metals	Once Annually immediately following spring freshet
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Bi-annually during open water
	ST-26	Vault Pit Lake	Closure	Full Suite	Monthly during open water (flooding)
				temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Quarterly (fully flooded)
	ST-S1 to TBD	Seeps (to be determined	Construction	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn);	Monthly during open water
			Operation, closure	pH, alkalinity, turbidity, hardness, ammonia Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn;	Monthly or as found
Ground Water Monitoring	ST-GW-1 to TBD	Ground water wells (to be determined)	Construction, operation, closure	temperature, pH, conductivity, redox, DO, alkalinity, turbidity, hardness, ammonia nitrogen, nitrate, nitrite, chloride, fluoride, sulphate, TDS, dissolved metals (Al, As, Ba, Cd, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn); total and free cyanide for wells in ground water flow path of the TSF	Annually
Core Receiving Environmental Monitoring	ST-AEMP-1 to TBD	Receiving AEMP	Construction, operation, closure	Full Suite	Monthly during open water season all AEMP stations. Monthly throughout year at a smaller number of locations (through ice)
MMER	ST-MMER-1 to TBD	Vault and Portage effluent outfall	Early and late Operation	MMER: total cyanide, Ar, Cu, Pb,Ni, Zn, radium 226, TSS, pH, effluent volumes, flow rate, acute tox, Daphnia Magna	Weekly during open water season

Table 2-2. Concordance between AEMP-related monitoring programs and the Nunavut Water Board A Licence conditions applying to general and aquatic effects monitoring. Adapted from Schedule I, Table 2: Monitoring Programs in 2AM MEA0815 License A.

Monitoring Program	Station	Description	Phase	Parameters/ Observations	Frequency
			8BC-TEH0809		
Mine Operations Monitoring	ST-27 and ST-28	Water Intake for camp and concrete batch plant purposes	Pre-development, Construction	Volume for each purpose (m3)	Monthly
	ST-29 and 30	Water, if any, accumulated in north and south pre-development zones	Pre-development	pH, Turbidity	Weekly
				Metals using ICP-Metals 36 element scan, Total Ammonia, Nitrate, Sulphate	Monthly
	ST-32 and ST-32	Water pumped from north and south pre-development zones to Contact Water	Pre-development	pH, Turbidity	Daily during pumping periods
	ST-33 and ST-34	Contact Water Collection System Lakes #1 and #2	Pre-development	Metals using ICP-Metals 36 element scan, Total Ammonia, Nitrate, Sulphate	Monthly
	ST-35	Discharge from Lake #1 of Contact Water Collection System (Stormwater Management Pond) to Second Portage Lake	Pre-development, construction	ph, TSS, BOD, Fecal Coliforms, Total Metals (Al, As, Cu, CN, Pb, Ni, Zn) and Radium 226	Once prior to discharge and Weekly during periods of discharge
				Acute Lethality	Once prior to discharge and monthly thereafter
				Volume (m3)	Daily during periods of discharge
	ST-36	Discharge from Lake #2 of Contact Water Collection System (Stormwater Management Pond) to Second Portage Lake	Pre-development, construction	ph, TSS, Total Metals (Al, As, Cu, CN, Pb, Ni, Zn) and Radium 226	Once prior to discharge and Weekly during periods of discharge
				Acute Lethality	Once prior to discharge and monthly thereafter
				Volume (m3)	Daily during periods of discharge
			8BC-MEA0709		
Mine Operations Monitoring	ST-37 (MEA-1)	Water sample location at Baker Lake in close proximity to the construction facility	Pre-development, Construction, operations, closure	pH, TSS, Cond, Total Ammonia, Total Arsenic, Total Metals thru ICP Scan, Oil and Grease, TPH, BTEX	Annually
	ST-38 (MEA-2)	East Contact water pond located in the south-east corner of the lay-down area	Pre-development, Construction, operations, closure	pH, TSS, Cond, Total Ammonia, Total Arsenic, Total Metals thru ICP Scan, Oil and Grease, TPH, BTEX	Prior to discharge or transfer of Effluent
				Total Metals (Ar, Cu, Pb, Ni), TSS, Ammonia, Cyanide, Benzene, Toluene, Ethlybenzene, Oil and Grease, pH	
				Volume (m3)	Monthly
	ST-39 (MEA-3)	West Contact Collection Pond located in the south-west corner of the lay-down area	Pre-development, Construction, operations, closure	pH, TSS, Cond, Total Ammonia, Total Arsenic, Total Metals thru ICP Scan, Oil and Grease, TPH, BTEX	Prior to discharge or transfer of Effluent
				Total Metals (Ar, Cu, Pb, Ni), TSS, Ammonia, Cyanide, Benzene, Toluene, Ethlybenzene, Oil and Grease, pH	
				Volume (m3)	Monthly
	ST-41 (MEA-5)	Water sample location at the ammonium nitrate storage area	Pre-development, Construction, operations, closure	Total Metals (Ar, Cu, Pb, Ni), TSS, Ammonia, Cyanide, Benzene, Toluene, Ethlybenzene, Oil and Grease, pH	Prior to discharge or transfer of Effluent
	ST-42 (MEA-6)	Water sample location at the explosive storage area	Pre-development, Construction, operations, closure	Total Metals (Ar, Cu, Pb, Ni), TSS, Ammonia, Cyanide, Benzene, Toluene, Ethlybenzene, Oil and Grease, pH	Prior to discharge or transfer of Effluent

3. CROSS-LINKAGES AMONG AEMP-RELATED PROGRAMS

As described in **Section 2**, AEM is responsible for implementing numerous monitoring programs related to the local aquatic receiving environment. This section presents a framework that highlights cross-linkages among monitoring programs and conceptually shows how it can be used to make more informed environmental management decisions (note that the latter element is presented in detail in **Section 4**).

3.1. Introduction

The framework is founded on the *conceptual site model*, which is used in ecological risk assessment to help understand potential relationships between site activities and the environment (e.g., water quality or certain ecological receptors). Conceptual site models (CSM) typically consist of the following elements:

- *Stressor Sources* – These are the sources of chemical (e.g., metals) or physical (e.g., total suspended solids) stressors that can potentially impact the environment.
- *Stressors* – These are the actual agents that have the potential to cause adverse effects to the receiving environment.
- *Transport Pathways* – These are the ways in which a stressor is released from the source to the receiving environment.
- *Exposure Media* – These are the media where a stressor occurs in the receiving environment. A single stressor might actually end up in multiple exposure media, with different ones being most important at different times. For example, if an effluent contained mercury, it would initially be found to the water column, then most would settle to sediments where it would then enter the food chain (i.e., biota tissue).
- *Receptors of Concern* – These are ecological entities selected for a variety of reasons, usually including sensitivity to relevant stressors and perceived ecological importance. These entities are often called *valued ecosystem components* in environmental impact assessments (see **Section 4.2.1.2** for more details).

These components are depicted in a variety of ways in ecological risk assessment. An example of a simple pathway-style CSM focusing on a single stressor (total suspended solids [TSS] from dike construction) is presented in **Figure 3-1**. Sediment enters the water column by direct discharge (i.e., fine particulates associated with dike construction material) or by resuspension (i.e., disturbance of fine bottom sediments by deposition of construction material). Once in the water column, TSS can affect pelagic receptors

through a variety of mechanisms (e.g., reduced light penetration for phytoplankton). TSS can also settle out of the water column to the lake bottom, where it can affect benthic organisms through (for example) smothering of the benthic community.

3.2. Cross-Linkages among Monitoring Programs

Strategic monitoring of various nodes of the CSM helps to build our overall understanding of the situation to make informed management decisions. Independently, the information provided by monitoring a single node of the CSM is just one piece of the puzzle. Integrated into the CSM framework they provide a much better sense of the "big picture." Ultimately, our ability to mitigate stressors that could potentially affect the receiving environment (e.g., unacceptably high nutrient concentrations) requires identification of the stressor (e.g., nitrate) and its site-related source (e.g., blasting residue). Conceptually and practically, this places an emphasis on the CREMP program results which seek to evaluate potential effects from inputs from all mine related sources (including blasting, effluent, dust, etc.).

The generic principles of the CSM can be applied to any situation, provided that sufficient effort has been expended to adequately characterize each of the key elements. For this project, we relied on the wealth of information generated as part of the environmental impact assessment process for the Meadowbank Gold Project.

- *Sources* – The *Aquatic Ecosystem/Fish Habitat Impact Assessment* (AEIA, 2005) provides a comprehensive overview of the Meadowbank Gold Project and its potential effects to the aquatic environment. The AEIA used "linkage matrices" to describe how each mine-related activity could affect water quantity, water quality, fish, or fish habitat for each major development phase (i.e., construction, operations and closure/post-closure). Collectively, these matrices identify all major activities and their potential effects to the receiving environment; compiled lists for each development phase are provided in **Tables 3-1 to 3-3**.
- *Transport Pathways* – These are listed in **Figure 3-2**. Effluent has been included as its own transport pathway to distinguish it from other pathways (i.e., increases resolution among pathways).
- *Exposure Media* – These are listed in **Figure 3-2**. Tissue is included to cover potential exposure to contaminants via the food chain.
- *Receptors of Concern* – The receptor groups are listed in **Figure 3-2** and include metrics for primary productivity and secondary productivity for both the benthic and pelagic zones of the receiving environment. "Fish habitat" represents critical biological or physical aspects of high-value fish habitat.

Each of the monitoring programs undertaken for the Meadowbank Gold Mine (**Section 2**) provides data for one or more of the transport pathways, exposure media, and/or

receptors of concern. Collectively, as shown in **Figure 3-3**, they represent a comprehensive monitoring network that addresses the nodes of the CSM. Their inter-linkages are highlighted for any given stressor through the development of a stressor-specific CSM (e.g., **Figure 3-4**). In the example shown in **Figure 3-4**, zinc has been identified as an effluent-related stressor (through effluent monitoring). Several other monitoring programs (e.g., CREMP water) may provide insights relevant to assessing the significance of the elevated effluent zinc concentrations in the receiving environment.

Table 3-1. Major mine-related activities and potential effects identified in the Aquatic Ecosystem/Fish Habitat Impact Assessment (AEIA, 2005) for the construction phase of the Meadowbank Gold Project.

Activity	Potential Effects		
	Water Quality	Water Quantity	Fish/Fish Habitat
General Construction	Sedimentation	58% volume of SPL impounded; 0.2% volume of TPL impounded	Barge noise
Dike construction	Emissions (hydrocarbons, incinerated waste)	Pump SPL water to TPL -> 5% volume increase in 3PL	Reduced fish passage: culvert at Turn Lake crossing, SPL/TPL channel closure
Dewatering	Dust (blasting, overburden, stripping, excavation)	TPL water level rise - shoreline erosion	Sedimentation
Pit development	Blasting residues (nitrogen spp.)	Closure of SPL/TPL connecting channel - alternate channel erosion	Construction footprint
Rock storage facilities (Portage and Vault)	Spills (fuel/diesel/explosives/loads on ice)	Vault Lake isolated, no natural outflow	
Main site roads & traffic	Sediment resuspension / increased TSS	Pump water from Vault Lake to Wally/Drilltrail (4.6% volume increase)	
Airstrip & air traffic	Release of soluble dike material	Culvert placement (seasonal increased water levels)	
Mine plant and facilities	Dewatering Effluent (entrained TSS and pore water metals)	Decreased storage capacity in ponds and wetlands	
Freshwater intake and pipeline	Waste rock seepage (metals, acid, TSS)	Change in lakes circulation patterns	
Discharge facilities and pipeline	Release of sediment, metals, and contaminants from surface water runoff	Surface drainage pattern disruption	
Non-contact diversion facilities	Sediment losses via permafrost degradation (mainly in bogs)		
Turn Lake road crossing	Leaching incineration ashes		
Plant site storage	Sewage/waste water discharged to tailings pond		
AN/Explosives storage and emulsion plant	Fires or explosions at the explosives magazine		
Site accomodations			
Sewage and waste disposal			
Access road and traffic			
Barge landing facility			
Barge traffic			
Explosive magazine			
Tank farm			

Note:
Some of the specific details have changed from the AEIA phase; those changes are not necessarily reflected in this table, so some details may be inaccurate.
AN - ammonium nitrate
SPL - Second Portage Lake
TPS - Third Portage Lake
TSS - total suspended solids

Table 3-2. Major mine-related activities and potential effects identified in the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (AEIA, 2005) for the operations phase of the Meadowbank Gold Project.

Activity	Potential Effects		
	Water Quality	Water Quantity	Fish/Fish Habitat
General Construction	Release of soluble dike material	Potentially high seepage rates (from lakes into pits)	Fish larvae entrainment into TPL intake pipe
Dikes	Dust (terrain, tailings dessicate)	Lost natural storage capacity in small ponds and wetlands	Sedimentation
Dewatering	Blasting residues	Water circulation pattern change in Wally Lake	Blasting (physical effect)
Pits	Increased TSS	Lost natural surface drainage (project lakes)	Attenuation pond effluent discharge
Rock storage facilities (Portage and Vault)	Emissions (hydrocarbons, incinerated waste)	Decreased water volume (TPL, Phaser Lake)	Reduced fish passage: culvert at Turn Lake crossing, SPL/TPL channel closure
Main site roads & traffic	Runoff from pit walls and tailings (TSS, metals, acid, nitrogen spp., reagent spills)	Increased water volume (Wall/Drilltrail Lake, Turn Lake (1 m))	Noise (Barge)
Airstrip & air traffic	Concentrated pore water release during tailings freeze back	Culvert (seasonal increase in lake water level)	
Mine plant and facilities	Attenuation pond effluent (yr1-5: TSS, metals, acidity, explosives residues; yr 5+: tailings supernatant, cyanide spp.)		
Freshwater intake and pipeline	Sediment losses via permafrost degredation (mainly through bogs)		
Discharge facilities and pipeline	Leaching incineration ashes		
Vault area effluent discharge	Waste water/ sewage discharge to tailings pond		
Non-contact diversion facilities	Sediment loading during drawdown		
Dewatering and draining facility	Release of water from waste rock piles (to attenuation pond)		
Turn Lake road crossing	Spills (fuel, diesel, transferred metals, explosives, tailings, reagents)		
Plant site storage			
AN/Explosives storage and emulsion plant			
Site accomodations			
Sewage and waste disposal			
Access roads and traffic			
Barge landing facility			
Barge traffic			
Explosive magazine			
Tank farm			

Note:

Some of the specific details have changed from the AEIA phase; those changes are not necessarily reflected in this table, so some details may be inaccurate.

AN - ammonium nitrate

SPL - Second Portage Lake

TPS - Third Portage Lake

TSS - total suspended solids

Table 3-3. Major mine-related activities and potential effects identified in the *Aquatic Ecosystem/Fish Habitat Impact Assessment* (AEIA, 2005) for the closure/post-closure phase of the Meadowbank Gold Project.

Activity	Potential Effects		
	Water Quality	**Water Quantity**	**Fish/Fish Habitat**
Dikes	Release of soluble metals from pit walls (controlled flooding)	Controlled flooding of pits	Leaching/runoff of metals, acid (from waste rock pile, pit walls, dikes)
Pits/ attenuation pond	Release of metals and acid (waste rock pile, dike material)	Portion of TPL recovered	
Dewatering and draining facility	Pit Lake water into groundwater	Drawdown of TPL during flooding	
Rock storage facility	Pit Lake part of receiving environment (ultimately)	SPL area and volume decrease (permanent)	
	Release of nitrogen and metals (tailings dust)	Recontouring to restor drainage patterns	
	Increased TSS (during flooding)	Alteration of lake circulation patterns	
	Release of concentrated pore water (during tailings freeze back)	Continued disruption of surface drainage patterns	
		Deep pits become deposition area for sediment	
		Loss of storage capacity in ponds and wetlands	

Note:

Some of the specific details have changed from the AEIA phase; those changes are not necessarily reflected in this table, so some details may be inaccurate.

SPL - Second Portage Lake

TPS - Third Portage Lake

TSS - total suspended solids

Figure 3-1. Simple pathway-style conceptual site model showing transport, fate and potential effects relationships for construction-related sedimentation.

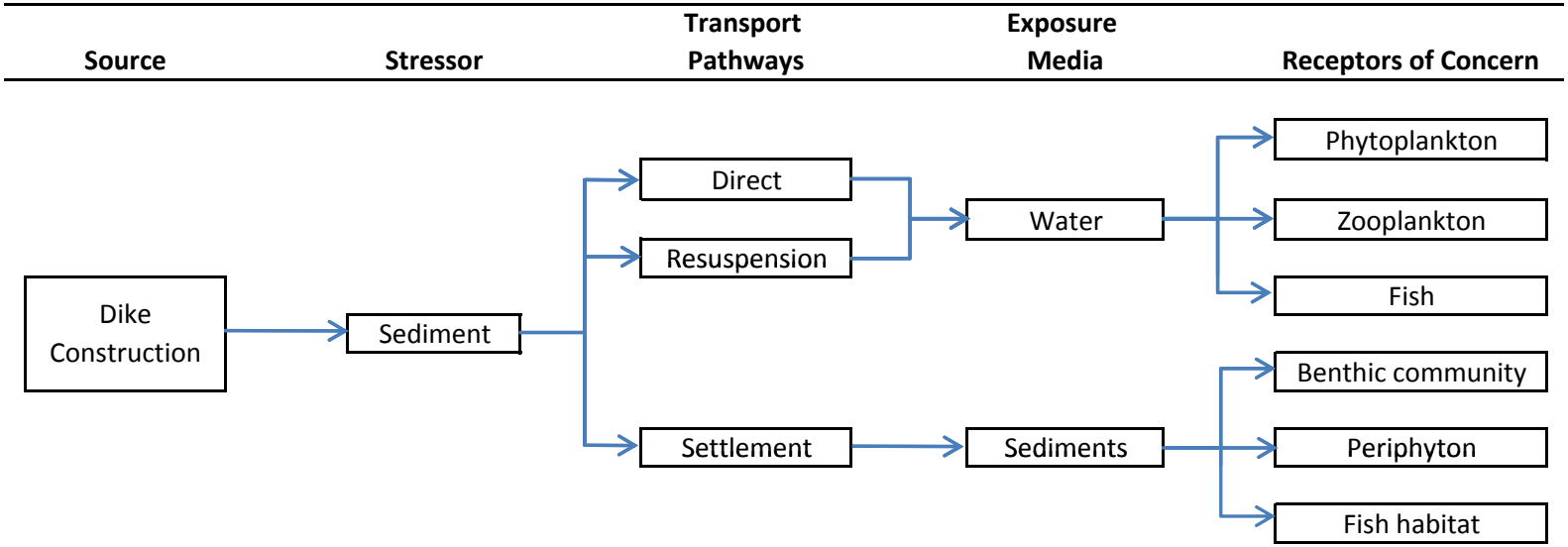


Figure 3-2. Primary transport pathways, exposure media, and receptors of concern for the Meadowbank Gold Project's Aquatic Effects Management Program.

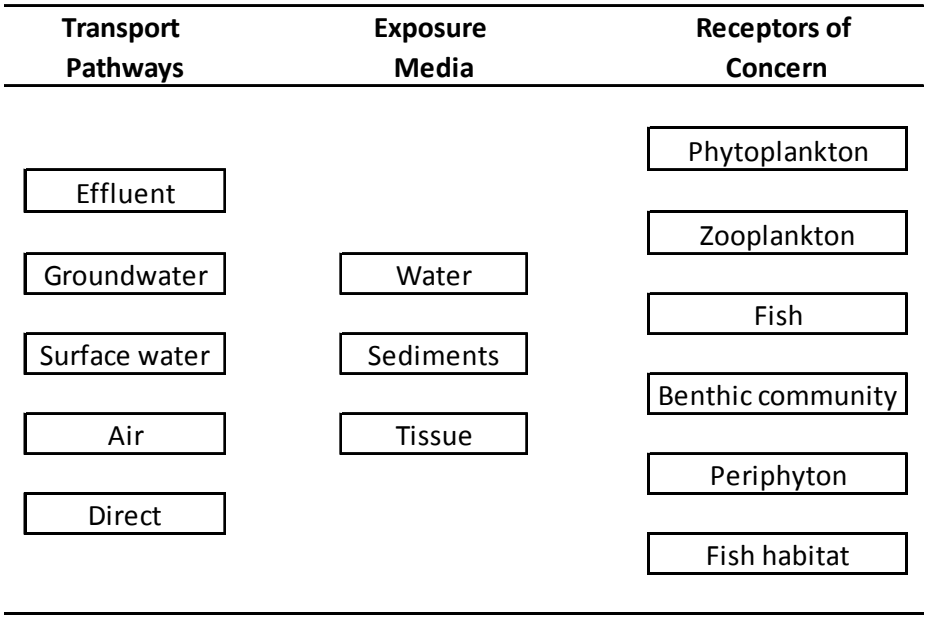
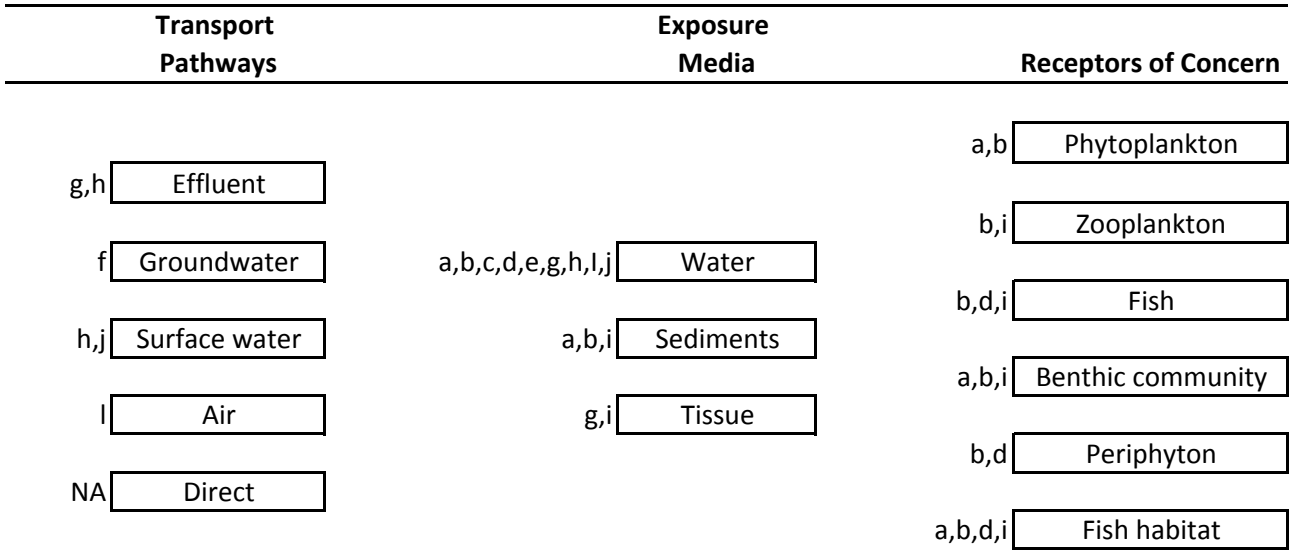


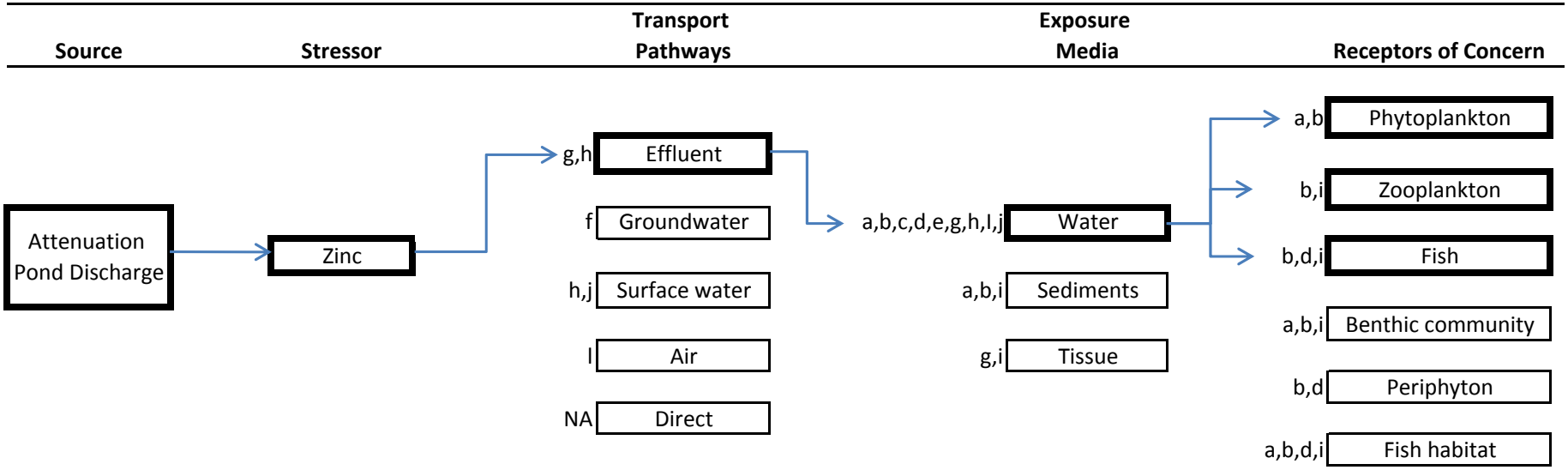
Figure 3-3. Primary transport pathways, exposure media, and receptors of concern for the Meadowbank Gold Project's Aquatic Effects Management Program.



Notes:

a	Core Receiving Environment Monitoring Program
b	Effects Assessment Studies
c	Dike Construction Monitoring
d	Habitat Compensation Monitoring Program
e	Dewatering Monitoring
f	Groundwater Monitoring
g	MMER Monitoring
h	Water Quality and Flow Monitoring
i	Fish-Out Studies
j	AWPAR and Quarry Water Quality Montoring
k	Blasting
l	Air quality monitoring
NA	Direct, so measured in exposure medium.

Figure 3-4. Example of stressor-specific (zinc in effluent) conceptual site model showing cross-linkages among AEMP-related monitoring programs.



Notes:

a	Core Receiving Environment Monitoring Program
b	Effects Assessment Studies
c	Dike Construction Monitoring
d	Habitat Compensation Monitoring Program
e	Dewatering Monitoring
f	Groundwater Monitoring
g	MMER Monitoring
h	Water Quality and Flow Monitoring
i	Fish-Out Studies
j	AWPAR and Quarry Water Quality Montoring
k	Blasting
l	Air quality monitoring
NA	Direct, so measured in exposure medium.

4. MANAGEMENT RESPONSE PLAN

4.1. Introduction and Objective

The management response plan (MRP) aims to fulfill the water license requirement for 'annual reporting for more immediate adaptive management' (see text box below for discussion of terminology). In simple terms, the MRP describes the process of identifying potential risks to the aquatic environment and developing appropriate management responses.

The generic management response process in the context of the Meadowbank mine AEMP is shown in **Figure 4-1**.

Terminology:

The management response plan (MRP) describes the actions that will be taken if potential effects of various magnitudes are predicted or observed (INAC, 2009a). The INAC guidance has replaced the term 'adaptive management plan' with MRP because adaptive management refers strictly to the use of deliberate experimental management to improve understanding and reduce uncertainties (Walters, 1986; Greig et al., 2008). Reviewers of adaptive management plans for other northern mines (e.g., Murray and Nelitz, 2008) have correctly pointed out that the scope of those plans was much broader than adaptive management. The potential role of true adaptive management (i.e., experimental management) is likely to be quite limited, because the impacts of such 'experiments' may not be acceptable or reversible (Greig et al., 2008). Monitoring for impacts from a mine and reacting to results of monitoring is not adaptive management (Murray and Nelitz, 2008). The A-licence for the Meadowbank Mine requires that the AEMP include 'annual reporting for more immediate adaptive management' (H-1(b)). It is assumed that the intent or meaning of that requirement is broad rather than strictly experimental management. Consequently, the term adaptive management is not used in the AEMP.

The general management response plan for the Meadowbank Mine AEMP is shown in **Figure 4-2**. The development of the MRP is tailored to each program, but response actions are based on the cumulative results of all programs. **Section 4.2** of this document describes the methodology for development and application of the MRP at the program-specific level, while **Section 4.3** describes the methodology and application of the MRP at the AEMP level.

4.2. The MRP at the Program-Specific Level

This section describes the methodology for development and application of the portions of the MRP that occur at program-specific levels. The core receiving environment monitoring program (CREMP) is the program where the most rigour is needed in determining thresholds and early warning triggers for each variable, since the CREMP is the primary program used to detect impacts in the receiving environment, and unlike monitoring under EEM does not have pre-determined decision rules.

The end goal of applying these principles to the existing monitoring programs is to have clear decision criteria with which to evaluate the status of the results of each program. While a fair amount of detail has been provided herein to support the CREMP, the process for other AEMP-related monitoring programs may follow the same principles, but could be implemented in a more simple manner.

The components of the MRP are covered in this section as follows:

- Risk -based approach for determining which variables under each program may be used for establishing decision rules that will lead to management responses (**Section 4.2.1**);
- General experimental design and statistical framework to be applied to monitoring under each program (**Section 4.2.2**);
- Principles for sampling and analysis plans (SAPs) to be applied to each program (**Section 4.2.3**);
- Methodology for determining decision rules (thresholds and early warning triggers) for monitoring variables under each program (**Section 4.2.4**); and
- Process for summarizing data on a program-specific basis (**Section 4.2.5**).

4.2.1. Risk-Based Selection of Key Monitoring Variables

Depending on the program, the variables that are monitored include three types:

- Direct measures of potential effects (e.g., measurement of benthic community abundance and diversity);
- Contaminants or other variables that can cause effects, but that are measures of exposure rather than effects directly; and
- Ancillary variables that modify potential exposure or effects (e.g., water hardness; sediment particle size) or measure general characteristics of a particular environmental medium.

The list of variables that are monitored under each program may be defined in part by legal requirements (e.g., the water license). However where applicable, scientific rationale must be used to determine which subset of variables should be the focus for

development of effects-based benchmarks (i.e., thresholds – explained further in **Section 4.2.4**). This is particularly relevant for the CREMP where some variables, particularly ancillary variables, may not be expected to be affected by the mine. Those variables will still be tracked over time, but their evaluation could be based on statistical triggers rather than effects-based thresholds. This section outlines the process that should be used for selecting variables for which effects-based thresholds should be established – consistent with recommendations in recent guidance for AEMP development (INAC, 2009b), implementation of AEMPs for other northern mines (e.g., Diavik, 2007a; b), and current risk assessment guidance at federal level (Azimuth, 2010a), a risk-based process is outlined with the following components:

- Identify stressors of potential concern (e.g., contaminants) that may impact the aquatic environment, and their characteristics related to (a) transport and fate, and (b) potential effects on aquatic receptors. Of particular importance is the availability of published effects benchmarks representing concentrations above which unacceptable effects might be expected.
- Identify receptors of concern (i.e., species, populations, communities or habitats that need to be protected – equivalent to 'valued ecosystem components')
- Characterize the potential exposure pathways by which sources of stressors may impact the receptors, and depict those linkages using a conceptual site model.
- Select assessment endpoints (specific attributes for receptors that are to be protected) and measurement endpoints (the monitoring variables that are to be used to measure exposure or effects). Measurement endpoints are categorized as primary (those which measure effects, or for which effects-based thresholds are established) and secondary (those that are monitored and evaluated on a statistical basis only, since thresholds are either not warranted or can't be easily developed).

4.2.1.1. Potential Stressors and Their Characteristics

Identification of SOPCs – Metals, suspended solids and other chemical or physical variables that may adversely affect aquatic life are referred to as stressors of potential concern (SOPCs). The list of SOPCs will be program-specific to some degree (e.g., suspended solids are not relevant in groundwater), but there will be a high degree of overlap among the programs. The starting point for identifying SOPCs for each AEMP program will be the variables that are listed in the water license, plus any additional variables that were identified in the Environmental Assessment for the mine as potentially impacting aquatic life. Any variable that can be affected by the mine and could impact aquatic life should be considered.

Potential Effects of SOPCs – The effects of each SOPC will be characterized as part of the CREMP re-design, and most of the information will apply directly to other programs.

The emphasis will be partly on summarizing primary literature but more on summarizing and evaluating the derivation of CCME guidelines and other effects benchmarks (such benchmarks will later be used for derivation of decision rules).

The review of effects characteristics of a SOPC emphasizes the types of organisms that may be affected by the COPC and the relevant mechanisms of action. The concentrations associated with particular effects in particular organisms may be specified, helping to identify the types of effects and receptors that are expected to be most sensitive.

Transport and Fate Characteristics of SOPCs – The transport and fate characteristics of a SOPC determine how the contaminant will move from source(s) and partition into various environmental media such as water, sediment and biota. The transport and fate characteristics help determine which receptors and exposure pathways are relevant for each SOPC. For example, sediment benthic organisms may be the most relevant receptor group for stressors that partition primarily into sediment rather than water. Higher trophic level organisms such as fish may be most relevant for stressors that bioaccumulate or biomagnify up the food chain.

4.2.1.2. Receptors of Concern

For AEMP programs that target the receiving environment, in particular the CREMP, it is important to identify what Receptors of Concern (ROCs)[7] could be affected by stressors. A Receptor of Concern (ROC) is any non-human individual, species, population, community, habitat or ecosystem that is potentially exposed to a SOPC. The level of biological organization at which an ROC is defined varies. In the case of lower levels of biological organization, the community is often identified as the ROC (e.g., zooplankton community, benthic community). In the case of higher trophic levels, the ROC is usually defined at the species level (e.g., mink, eagle). In the latter case, the selection of an individual species may be for direct assessment of the identified organism and/or may be selected as a representative (or surrogate) for similar organisms.

The Environmental Assessment for the mine, specifically the identified Valued Ecosystem Components (VECs), will be the starting point for identification of ROCs in the receiving environment. If it is necessary to identify specific surrogate ROCs to represent particular functional groups, or if gaps are identified based on knowledge gained since completion of the EA, the following criteria (from Azimuth, 2010a) will be used to identify appropriate ROCs:

1. Ecological relevance – An ecologically 'relevant' ROC is an organism that is an appropriate indicator of actual or potential exposures given the environmental conditions

[7] The term Valued Ecosystem Component (VEC) has the same or similar meaning, but ROC is used here for consistency with risk assessment terminology, and to allow for variations from VECs identified during the environmental assessment as appropriate.

germane to the assessment. An ecologically relevant organism should be expected to be found at a site under reasonably foreseeable conditions (e.g., an arctic fox at a site in the arctic). It is usual practice to select ROCs that represent key functional groups that are expected to be exposed to the SOPCs on site. In addition, keystone species that are important to ecosystem stability may be preferentially selected as ROCs.

2. Degree/mechanism of exposure to the SOPCs on site – A number of factors have the potential to affect the degree to which ROCs are exposed to the SOPCs on the site, including:

- The status of the ROC (life stage, migratory versus resident);
- How the ROC uses the site (feeding guild, feeding behaviour);
- How much/often the ROC uses the site (home range size, habitat suitability, off-site habitat characteristics); and
- Number and type of exposure pathways (environmental media, indirect/direct contact/consumption, bioaccumulation and biomagnification processes).

3. Relative sensitivity to the SOPCs – It is customary to include species or other receptor types that are relatively sensitive to the SOPCs. The principle for selection of a sensitive species is that demonstration of lack of harm for a sensitive organism conveys protection for the less sensitive taxa in the same functional group.

4. Relative importance from a conservation perspective – If rare, endangered or threatened species (i.e., listed species) and/or habitats are confirmed to be present, these species must be considered as potential ROCs. They should also be included if they are likely to be present in the future (based on information regarding geographic distribution, habitat preferences and site-specific habitat availability).

5. Relative social, economic and/or cultural importance – Any particular species or group that is of special importance (e.g., species of significance to First Nations, species of commercial or recreational importance) would typically be included as an ROC and may be subjected to more emphasis and more scrutiny than other ROCs.

6. Availability of ecotoxicological and life history data – Where effects data will be literature-based, ROCs for which ecotoxicological data are readily available are preferentially selected; otherwise the ability to assess effects on the ROC may be reduced. The benefit of selecting highly-specific ROCs is offset where data related to toxicity thresholds are limited.

4.2.1.3. Exposure Pathways

Exposure pathways are the routes of exposure from environmental media (e.g., soil, water, air, sediment) to the receptors of concern. Examples of exposure pathways include water and food consumption (for wildlife) and direct contact (for invertebrates). The

identification of pathways links sources of SOPCs to ROCs based on the characteristics of each. For AEMP programs that specifically target sources (e.g., groundwater, effluent discharges) the evaluation of exposure pathways is not relevant; rather, exposure pathways are most relevant for programs that target the receiving environment (e.g., the CREMP).

The starting point for evaluation of exposure pathways will be the Environmental Assessment findings (e.g., linkage matrices) for the project.

4.2.1.4. Assessment and Measurement Endpoints

An assessment endpoint is an explicit expression of the attribute of an ROC that is to be protected. For example, if the ROC is the benthic invertebrate community, an assessment endpoint might be benthic invertebrate abundance and diversity. The assessment endpoint sets the stage for exactly what effects variables will be measured as measurement endpoints.

Measurement endpoints are the specific exposure and effects variables selected to be measured and then used to evaluate risks. For purposes of the MRP for the AEMP, the measurement endpoints are categorized as primary (those which measure effects, or for which effects-based thresholds are established) and secondary (those that are monitored and evaluated on a statistical basis only, since thresholds are either not warranted or can't be easily developed). Criteria for the selection of measurement endpoints and categorization as primary/secondary are:

- Legal requirement for monitoring (e.g., inclusion in the water license);
- Availability of CCME guidelines or other published benchmarks (for exposure variables);
- Availability of toxicological information on effects (for exposure variables);
- Likelihood that mine-related activities would cause changes in the variable (for exposure variables);
- Likelihood that changes in the variable would cause effects on the receptors at the site, given understanding of sources, fate and transport pathways, and sensitivities of receptors (for exposure variables);
- Ability of the specific variable to represent effects on receptors (for effects variables);
- Ability of a variable to simultaneously represent several individual variables. For example, principal components could be used to represent groups of chemistry variables; and

- Duplication with other variables (a program design that targets every parameter has more change of false positives, i.e., type-I errors).

Since the Meadowbank AEMP has been operating for some time, rationale should be provided not only for the inclusion of specific variables as measurement endpoints, but also for the exclusion of variables.

4.2.2. Experimental Design and Statistical Framework

The monitoring programs outlined in **Section 2** vary considerably in terms of focus and content. Some are data rich (e.g., CREMP), allowing for quantitative statistical analyses, and others are constrained by data limitations (e.g., groundwater monitoring) and are assessed without statistical procedures. Some involve explicit comparisons to spatial and temporal reference conditions (e.g., the before-after-control-impact [BACI] design, where data from the 'before' period and for 'control' stations are used to help make inferences from the data about potential impacts of the mine), whereas others rely on tracking trends at individual monitoring stations over time (e.g., the before-after [BA] design, where temporal changes at individual stations are used to make inferences about mine-related changes). Consequently, no single experimental design and analysis framework will apply to all cases. In general, one or more of the following tools will be used for evaluating potential effects in each of the component programs:

- Visual trend analysis – although graphical presentation of data and time trends would be an integral part of all analyses, we specify interpretation of graphical data separately because it may include data that are not used in the formal statistical tools below.
- Time series analysis – This approach refers to any methods of evaluating the data where time is treated as a continuous variable. The methods may range from simple linear models (e.g., linear regression) to more complex and formal time series methods (e.g., autoregressive integrated moving average modeling), if warranted and supported by the data. We distinguish time series regression from BACI-style analyses below only for communication purposes – the general modeling framework is the same, with the only distinction being the treatment of time as a continuous variable. Treatment of time as a continuous variable will become more relevant as the temporal length of the data sets increase.
- BACI-style (including CI) linear and multi-level modeling – This refers to a general modeling framework that evaluates measured variables as functions of time, space and other measured variables. It covers statistical tools such as analysis of variance, analysis of covariance, linear regression, and multiple regression. Depending on what type of data are available and how those data are structured, linear and multi-level models encompasses traditional control-impact, before-after, and BACI-style designs (Hewitt et al., 2001) and related

formulations such as impact level by time, impact trend by time, and exposure gradient analyses (as described by Wiens and Parker, 1995). The reference to 'multi-level' modeling (Gelman and Hill, 2006; Pinheiro and Bates, 2000) refers to model formulations that account for the structured nature of the data (i.e., in cases where data are not independent but rather are grouped by year, month/season, station, or other variables). In this generalized, flexible modeling framework, data may be balanced or unbalanced (e.g., different numbers of replicates per station, missing data for some area / time combinations, etc.), and predictor variables can be treated as continuous or categorical. The levels inherent in any data groupings as well as their interactions are considered. To the extent that the available data support the analyses, model formulations that are relevant from a monitoring viewpoint will be explored. For additional details, the 2009 EAS report (Azimuth, 2010b) is the best example to date of implementation of the statistical modeling framework for the Meadowbank AEMP.

In general, for programs where statistical approaches are appropriate for data analysis, implementation will aim to:

- Use more than one method or model where appropriate.
- Use models that take into account the sources of variability that could affect any measured variable. Key sources of variability likely to be common to all programs are spatial variability, temporal variability (annual or seasonal), subsample variability and measurement error.
- Carefully consider subsampling / replication and the potential impact of pseudoreplication.

4.2.3. Sampling and Analysis Plans

After the monitoring variables are selected, sampling and analysis plans (SAPs) for each program are used to specify how data will be collected and how laboratory analyses will be conducted. Since the programs within the AEMP have been underway for multiple years, the SAPs are already implemented for the various programs (e.g., CREMP). However, these should be updated as needed. A SAP should cover the following elements:

- Field sampling methods;
- Field QA/QC procedures including storage and transport;
- Data quality objectives;
- Lab methods including sample processing, analytical methods and detection limits; and
- Lab QA/QC procedures.

4.2.4. Thresholds and Triggers

4.2.4.1. Background

The need for and nature of management actions can be based on various criteria, but the most important among these are criteria that measure the *magnitude* of a problem, such as the concentration of suspended solids in the water column. The key principle is to establish an approach that allows actions to be triggered before unacceptable adverse effects occur (INAC, 2009a). In addition, there may be more than one type or level of trigger for a given measured variable.

4.2.4.2. Meadowbank Approach

Despite the varied nature of the monitoring programs contributing to the AEMP (**Section 2**), most benefit from having clear decision criteria to help inform the management response plan. That said, there may be some programs (e.g., fish-out programs) where the approach does not make sense or where it may need to be modified. As an example, the remainder of this section focuses on the decision criteria for the CREMP, where a two-tiered approach is being applied, consisting of:

- *Thresholds* are defined as legal requirements, regulatory guidelines, or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which unacceptable adverse effects may occur. If effects-based thresholds do not exist or are not warranted for a particular variable, then early warning triggers will be developed *without* thresholds. In such cases, if triggers are exceeded then the implications of such exceedances can only be understood through the integration of results from other AEMP monitoring programs, or, if important information gaps still exist, through focused studies (e.g., risk assessment).
- *Triggers* are early warning criteria that lead to action. The triggers may be based on absolute numbers (e.g., an increases half-way from baseline to an identified effects threshold) or statistical criteria (e.g., statistically significant trend that predicts exceedances of a threshold within 3 years).

The principles to be used for derivation of thresholds and triggers are as follows:

- For exposure variables, thresholds should be based on available benchmarks that relate the variable to potential effects. CCME guidelines are generally appropriate for use as thresholds because they have a toxicological basis and are relatively conservative, but the applicability of the underlying data to the receptors of concern at the site should be evaluated. Where CCME guidelines do not exist, there may be published guidelines or standards in other jurisdictions that could be considered applicable..

- For effects variables, thresholds should be derived by defining a critical effect size of ecological relevance. Effect sizes of relevance may vary depending on the variable but should be consistent with effect sizes that are (a) used in Canada for derivation of environmental quality guidelines, (b) used in Canada for site-specific risk assessments, (c) specified in the Environmental Assessment.
- More than one type of trigger may be appropriate for either exposure or effects variables. It is expected that triggers will be based on statistical analysis of time series data as well as comparison of data for any particular sampling event to baseline data. Time series triggers are expected to become more relevant as the length of the time series grows.

The types of thresholds and triggers that are developed will be different for exposure variables (e.g., chemical concentrations) and effects variables. The derivation process for thresholds and examples of potential triggers are shown in **Figure 4-3** (for exposure variables) and **Figure 4-4** (for effects variables, such as those in the CREMP). These figures are not detailed or specific to particular variables – the application to each variable (or groups of variables) may be developed as appropriate on a program-specific basis (e.g., for the CREMP [Azimuth, 2012]). It should be noted that for many programs (e.g., EEM) thresholds and triggers are pre-defined and are not subject to revision and for others the methods described above may not be applicable (e.g., AWAR habitat compensation monitoring program).

The difference in the derivation processes for exposure variables and effects variables is most easily understood with examples from the CREMP:

- Exposure Variable Example:
    - Variable: Zinc concentration in bulk sediment.
    - Threshold: CCME sediment quality guideline.
    - Triggers: (a) Mean zinc concentration in an area increases halfway from baseline (in a BACI framework) to the CCME SQG, with a given degree of confidence; (b) Time trend analysis shows zinc concentration likely to exceed the CCME SQG within three years, with a given degree of confidence.
- Effects Variable Example:
    - Variable: Benthic invertebrate community richness measured as total number of taxa.
    - Threshold: *x* % decrease in the total number of taxa relative to baseline (where *x* represents an agree acceptable effect size, and baseline is estimated in a BACI framework).

- Triggers: (a) Mean estimate of total number of taxa in an area decreases by ½ (*x* %) relative to baseline, with a given degree of confidence; (b) Time trend analysis shows that the mean estimate of total number of taxa in an area is expected to decrease by ½ (*x* %) relative to baseline within three years, with a given degree of confidence.

A key concept for derivation of thresholds is effect size. Effect sizes are implicit in CCME environmental quality guidelines (or other published benchmarks) and are unlikely to be questioned in those cases since they are already generally acceptable to regulatory agencies. However, for effects variables, a threshold can only be developed through explicit agreement on a critical effect size (an effect size below which effects would be considered acceptable). If a threshold cannot be developed or agreed, early warning triggers will be based purely on statistical criteria.

A key concept for application of triggers is statistical confidence. As part of the design for the CREMP (and other AEMP programs as appropriate), sample sizes required to ensure that exceedances of triggers can reasonably be detected in a BACI-style framework or time series analysis framework will be determined using *a priori* statistical power analysis for typical modeling scenarios and various time frames. Sample sizes may relate to the number of sampling areas and/or the number of samples in a given area depending on what question is being addressed by a statistical model. The desired power and the trade-offs among type 1 and type 2 errors will be determined for the CREMP (and other programs as appropriate) based on review of available guidance and discussion with regulators.

Once details regarding application of triggers are agreed, the subsequent evaluation of data should be based on the level of confidence in results (e.g., probability that the actual effect size is greater than the critical effect size of interest) (Newman, 2008).

4.2.5. Data Summary Framework

If a trigger or threshold is exceeded, a risk-based, integrated evaluation of key results across AEMP programs will be conducted that evaluates monitoring variables according to criteria commonly used in risk assessment (Hull and Swanson, 2006; Azimuth, 2010a):

- *Magnitude* – the degree to which a variable exceeds early warning triggers or thresholds (as described above in **Section 4.2.4**)
- *Spatial Scale* – the scale at which exceedances of triggers or thresholds occurs.
- *Causation* – the strength of evidence for a mine-related cause.
- *Permanence* – the likelihood and rate of reversal of the effect over time.
- *Uncertainty* – a reflection of confidence (or lack thereof) in the findings regarding magnitude, spatial scale and causation.

Within the annual report for each AEMP-related program, these criteria will be applied to each monitoring variable in each medium, and the results will be summarized using a categorical rating system for magnitude, spatial scale, causation, permanence and uncertainty, as shown in the example in **Table 4-1**.

4.3. The MRP at AEMP Level

The role of the annual AEMP report is more than a summary of the findings of each program. While each program may identify particular issues, evaluation of the findings across all programs is needed in order to understand the linkages between sources of stressors and potential effects, and to best design management actions. For example, if zinc is found to be elevated in sediment in the receiving environment, it will be important to evaluate the zinc data for groundwater, effluents and other discharges in order to determine the mine-related source, if any.

Once data are summarized for each program, the key findings for each program need to be evaluated together at the AEMP level so that any issues can be identified and understood, and management response actions can be developed. This section describes the process of integrated data evaluation (**Section 4.3.1**), and the process of selecting management actions (**Section 4.3.2**).

4.3.1. Integrated Data Evaluation

The integrated evaluation of data across all programs begins with a summary of the data. Since magnitude is the most important criterion for determining the need for management actions, a simple table such as that shown in **Table 4-2** should be used to summarize under which programs there were exceedances of triggers and thresholds. **Table 4-2** is the highest level of summary table. For those variables or groups of variables where there are exceedances of triggers or thresholds, a more thorough summary of the data is warranted including the other criteria related to spatial scale, causation, permanence and uncertainty. An example template for such a summary is provided in **Table 4-3** for a stressor variable.

Once the data summary is complete, the patterns among the programs need to be characterized in mechanistic detail. This should be done using an issue-specific conceptual site model. For each issue identified, available information across AEMP-related programs for source, stressor, transport pathways, exposure media, and effects measures will be evaluated. Each stressor/transport-pathway, stressor/medium and medium/effect measure combination related to the issue would be assessed across programs based on the overall evidence for magnitude, spatial scale, causation permanence and uncertainty. In addition, the strength of available information relating stressors to specific sources and effect measures to specific stressors will be assessed. As shown in **Figure 4-2**, understanding both these linkages (i.e., effect to stressor to source)

are critical to the identification of effective management actions. An example of an issue-specific conceptual site model for the 2008 sedimentation event during East Dike construction is shown in **Figure 4-5**. This summary is based on a range of data collected in 2008 and 2009 across several programs (CREMP, Dike Construction Monitoring, Effects Assessment Studies, Habitat Compensation Monitoring; Azimuth, 2010b,c,d,e), but all related to East Dike construction.

4.3.2. Management Actions

Management actions will be taken in cases where integrated evaluation of results across AEMP programs identifies a potential impact to the receiving environment; the scope of management actions will depend on the nature of the problem, the spatial scale, evidence for causality, permanence and uncertainty. The process that will be used to identify management actions was shown in **Figure 4-2**. Management actions can be divided into those aimed at further assessment and those aimed at mitigation. A toolbox of assessment options is provided in **Table 4-4** and a toolbox of mitigation options is provided in **Table 4-5**.

The specific management action that would be appropriate in a given case depends on the underlying cause. For example, if a metal becomes elevated in receiving water, the identification of options for further assessment and/or mitigation options would be different if the source of the metal is groundwater versus effluent versus dust.

The timing of management actions is also case-specific. In cases where further monitoring and assessment is warranted, that assessment should begin as soon as practically possible. In cases where mitigation is considered, mitigation should begin as soon as the weight of evidence indicates that mitigation is warranted, and the benefits of commencing mitigation immediately outweigh the disadvantages of waiting for further information. Consultation with regulators and stakeholders is important for determining management actions.

Importantly, management actions including assessment and mitigation should be considered on a real-time basis. In fact, the EAS studies that have been implemented in 2008 and 2009 were designed for further assessment in real time as TSS levels became elevated during dike construction. The AEMP process should then consider the results of the EAS in developing any additional management actions that may be appropriate. Furthermore, there will be cases where management actions may be implemented in real time based on results of a single program – for example, if a problem is identified in an effluent discharge, action may be taken without considering findings of other ongoing programs.

Consultation and Communication – Stakeholder involvement is key to the success of the AEMP. Mechanisms for stakeholder involvement are in place. Annual reporting processes generally have a time lag (e.g., results from one year are not distributed until

early the following year). To the extent that data analyses can be completed in advance of finalization of annual reports, any issues that arise should be communicated as soon as they are detected. For some cases (e.g., elevated TSS during dike construction), problems can be detected within a day or two and can be communicated to regulatory agencies immediately.

Table 4-1. Example template for summarizing results of monitoring under each program.

Variable Type & Variable group	Magnitude[1]	Spatial Scale[2]	Causation[3]	Permanence[4]	Uncertainty[5]	Comments	Management Action[6]
Sediment Chemistry – total metals	0	n/a	n/a	Moderate	??		0
Benthic Invertebrates – total abundance	1	Small	Moderate	Moderate	?		1
…							

[1] **Magnitude Ratings:**

0 – no exceedances of early warning triggers or thresholds (or no apparent changes from baseline of concern)

1 – early warning trigger exceeded (or change from baseline warranting concern)

2 – threshold exceeded (or change from baseline exceeding magnitude of concern)

[2] **Spatial Scale Ratings:**

n/a – no magnitude of effect, therefore not evaluated

Small – localized scale

Moderate – sub-basin to basin scale

Large – basin to whole lake scale

[3] **Causation Ratings:**

n/a – no magnitude of effect, therefore not evaluated

Low – no evidence for a mine-related source

Moderate – some likelihood of a mine-related source

High – the source of the problem is very likely to be mine-related

[4] **Permanence Ratings:**

n/a – no magnitude of effect, therefore not evaluated

Low – rapidly reversible (e.g., months to years)

Moderate – slowly reversible (e.g., years to decades)

High – largely irreversible (e.g., decades +)

[5] **Uncertainty Ratings:**

? – low uncertainty

?? – moderate uncertainty

??? – high uncertainty

[6] **Management Actions:**

0 – no action

1 – continued trend monitoring in following year

2 – active follow-up with more detailed quantitative assessment in following year

Table 4-2. Example / Template Summary of Exceedances of Triggers and Thresholds for Key AEMP Monitoring Variables.

	AEMP Program[1,2]											
	Core Receiving Environment Monitoring Program	Effects Assessment Studies	Dike Construction Monitoring	Habitat Compensation Monitoring Program	Dewatering Monitoring	Groundwater Monitoring	MMER Monitoring	Water Quality and Flow Monitoring	Fish-Out Studies	AWPAR and Quarry Water Quality Montoring	Blasting	Air quality monitoring
Stressor Variables												
suspended solids	●	●	●	NA	●	NA	○	○	●	◎	NA	NA
sediment deposition												
water-borne toxicants												
sediment toxicants												
nutrients												
other physical stressors												
Effects Variables												
Phytoplankton												
Zooplankton												
Fish												
Benthic invertebrate community												
Periphyton												
Fish habitat												

Notes:

[1] Maximum values from each program are used.

[2] Codes for exceedances of triggers and thresholds:

○ No observed effects

◎ Trigger or guideline exceedance - early warning, explained in report

● Observed effects, explained in report

Table 4-3. Example template for integrated evaluation of monitoring results across all programs for a monitoring variable or group of variables[1].

Variable – TSS (a stressor)

	Magnitude[2]	Spatial Scale[2]	Causation[2]	Permanence[2]	Uncertainty[2]	Comments
EAS and CREMP	2	Large	High	Low	?	
Dike Construction						
INTEGRATED SUMMARY:						

[1] The table would be tailored to the relevant media and programs for each variable.

[2] For all ratings, see Table 4-1.

Table 4-4. Toolbox of some potential receiving environment assessment methods.

Type of Variable Triggered	Potential Assessment Options
Sediment – Contamination	• Bioavailability studies (e.g., ration of AVS:SEM for selected metals) • Bulk sediment toxicity tests for invertebrates • Porewater toxicity tests (e.g., if transport is via groundwater) • Benthic invertebrate abundance / diversity • Development of site-specific sediment quality objectives (if not already done)
Sediment – Deposition of Particulate Matter	• Sediment traps to measure exposure • Literature review and analysis to evaluate likely effect of deposition • Bulk sediment toxicity tests for invertebrates • Benthic invertebrate abundance / diversity • In situ or ex situ experimental testing of effects of different deposition rates of particulate matter
Water – Contamination	• Bioavailability studies (e.g., Biotic Ligand Model for some metals) • Water column toxicity tests for fish and invertebrates • Benthic invertebrate abundance / diversity • In situ or ex situ experimental testing of effects of different contaminant concentrations on receptors • Development of site-specific water quality objectives (if not already done)
Water – Suspended Solids	• Water column toxicity tests for fish and invertebrates • In situ or ex situ experimental testing of effects of different concentrations of suspended solids on receptors
Water – Decrease in measures of productivity	• Literature review and modeling to evaluate likely effect on fish populations
Effects variables (direct measures of zooplankton, benthos, fish, etc.)	• More intensive study to characterize the magnitude of effects, spatial extent, and likely causes (e.g., through evaluation of spatial gradients).

Table 4-5. Toolbox of some potential mitigation options.

Cause of Potential or Known Effect	Potential Mitigation Options
Dike Construction	• Modification of use of turbidity barriers (e.g., use more than one barrier, lower barrier to bottom) • Change material used to construct dike • Modify methods of placing dike construction materials • Slow placement rate • Construct causeway prior to open water season
Dike Materials (e.g., leaching of metals)	• Cover with other material types
Groundwater	• Identify and cut-off pathway from source to groundwater • Cut off pathway from groundwater to receiving environment • Treat groundwater
Effluent and Discharges	• Increase settling times prior to discharge • Treat effluent prior to discharge
Dust	• Increase intensity of dust suppression measures (e.g., water trucks) • Change materials used as top layer for exposed surfaces • Use wind breaks in key places
	•

Figure 4-1. Generic Management Response Process in the Context of the Meadowbank Mine AEMP.

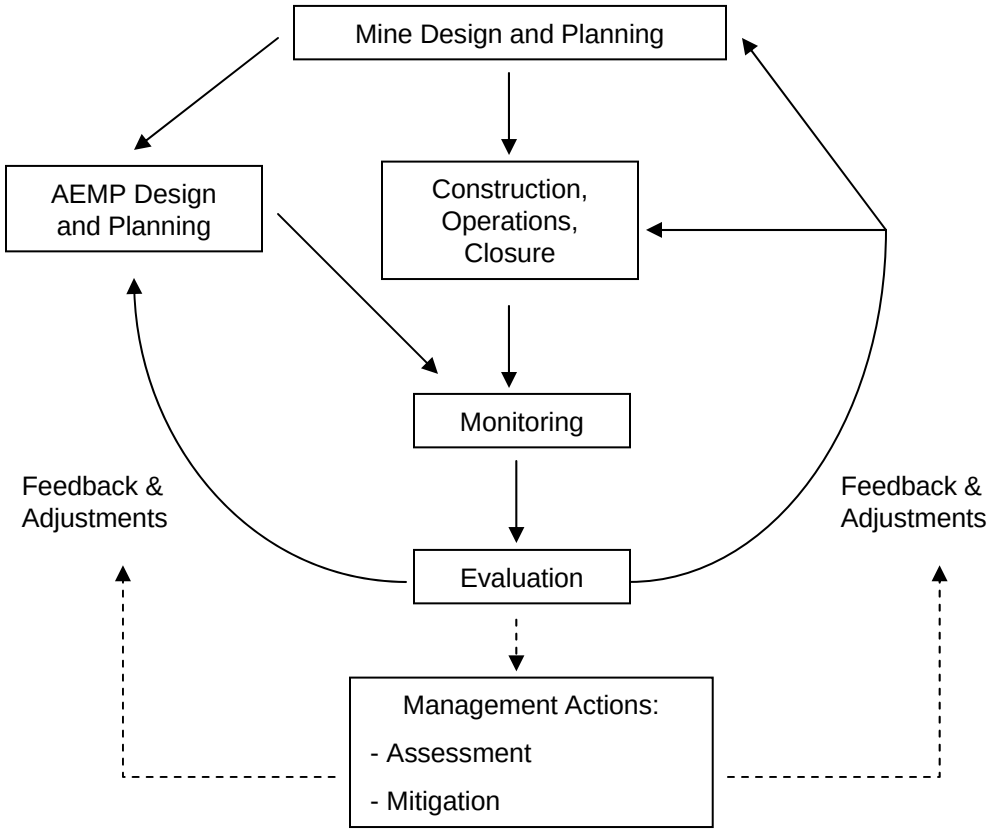


Figure 4-2. Management Response Plan for the Meadowbank Mine AEMP

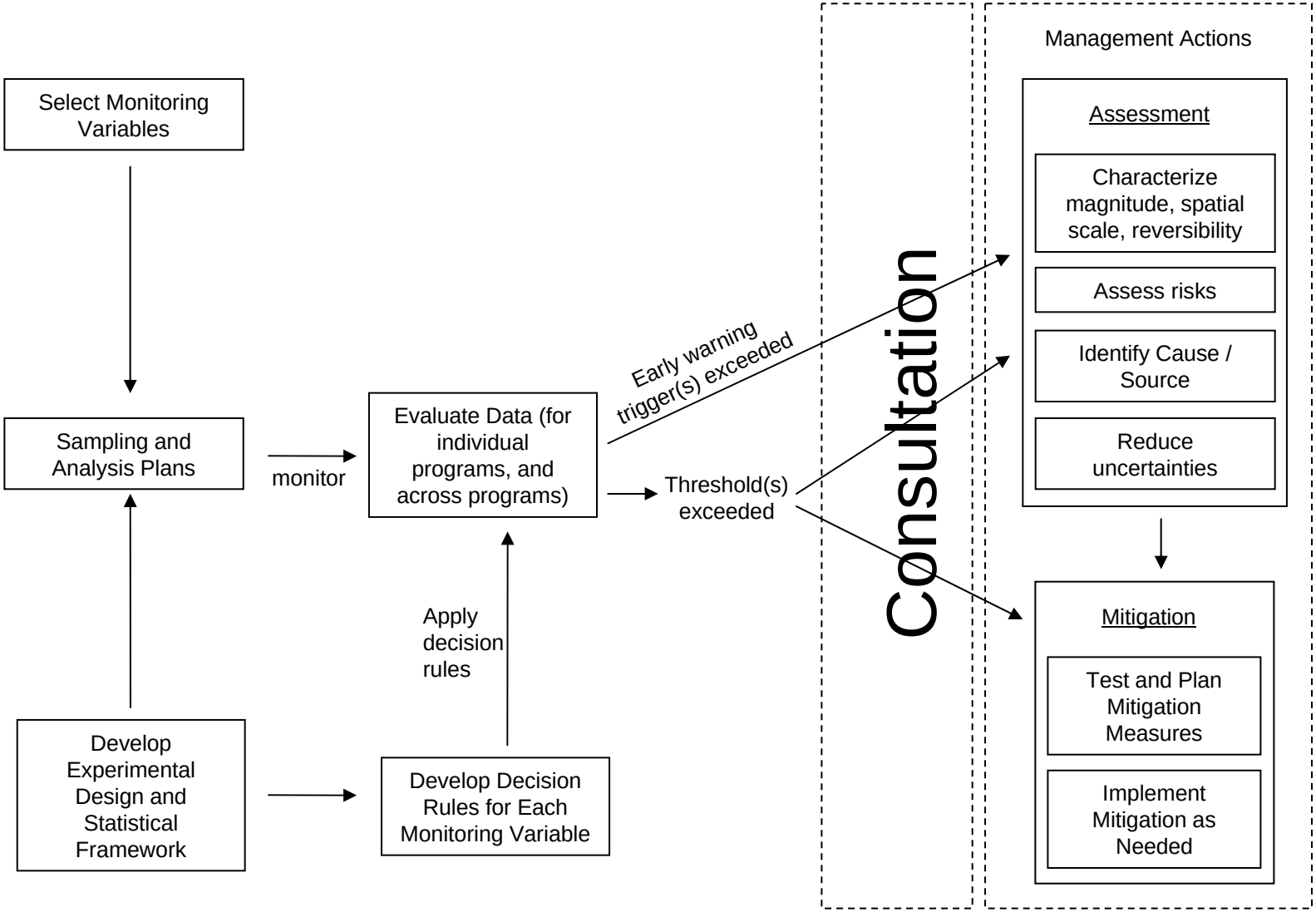
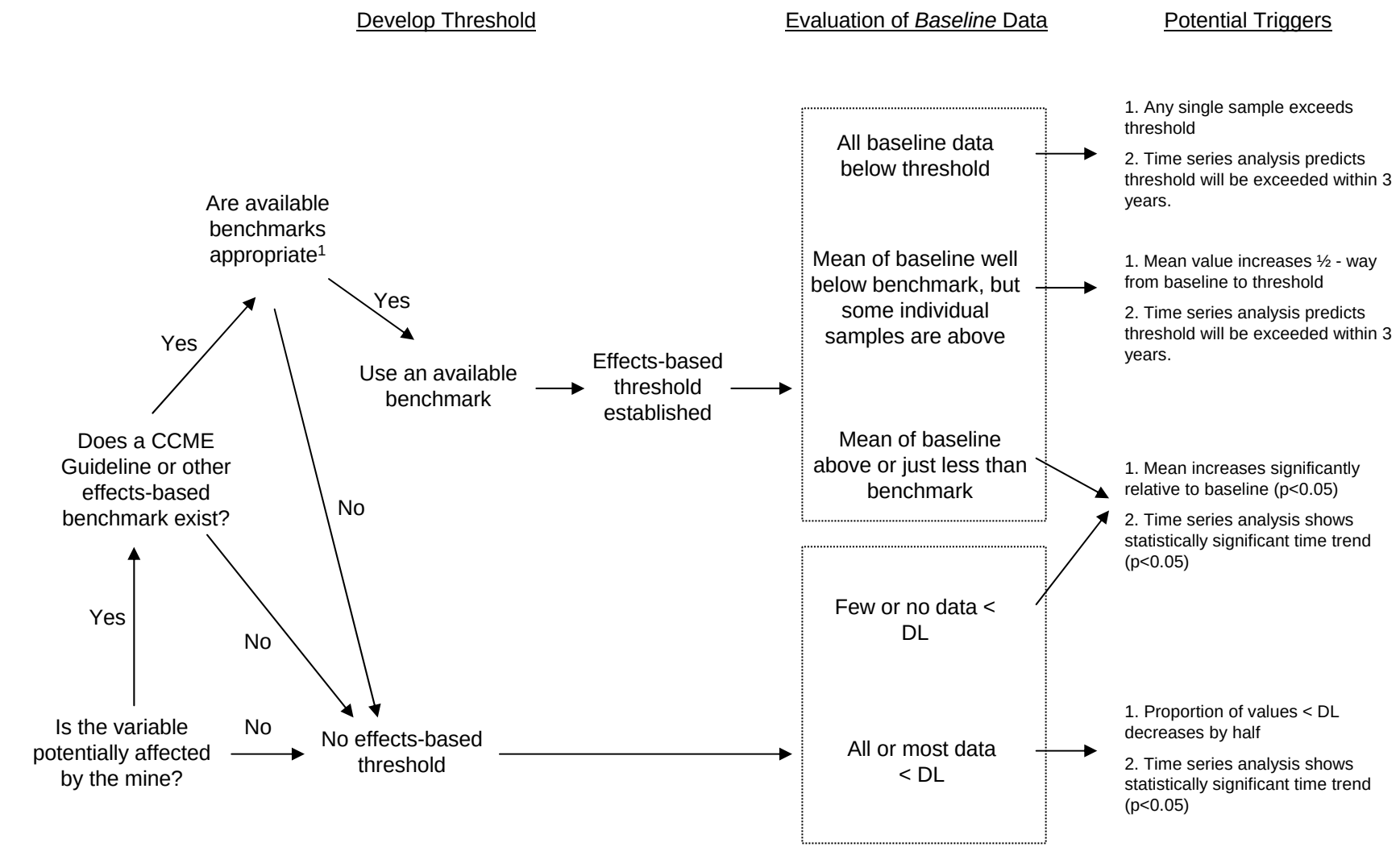
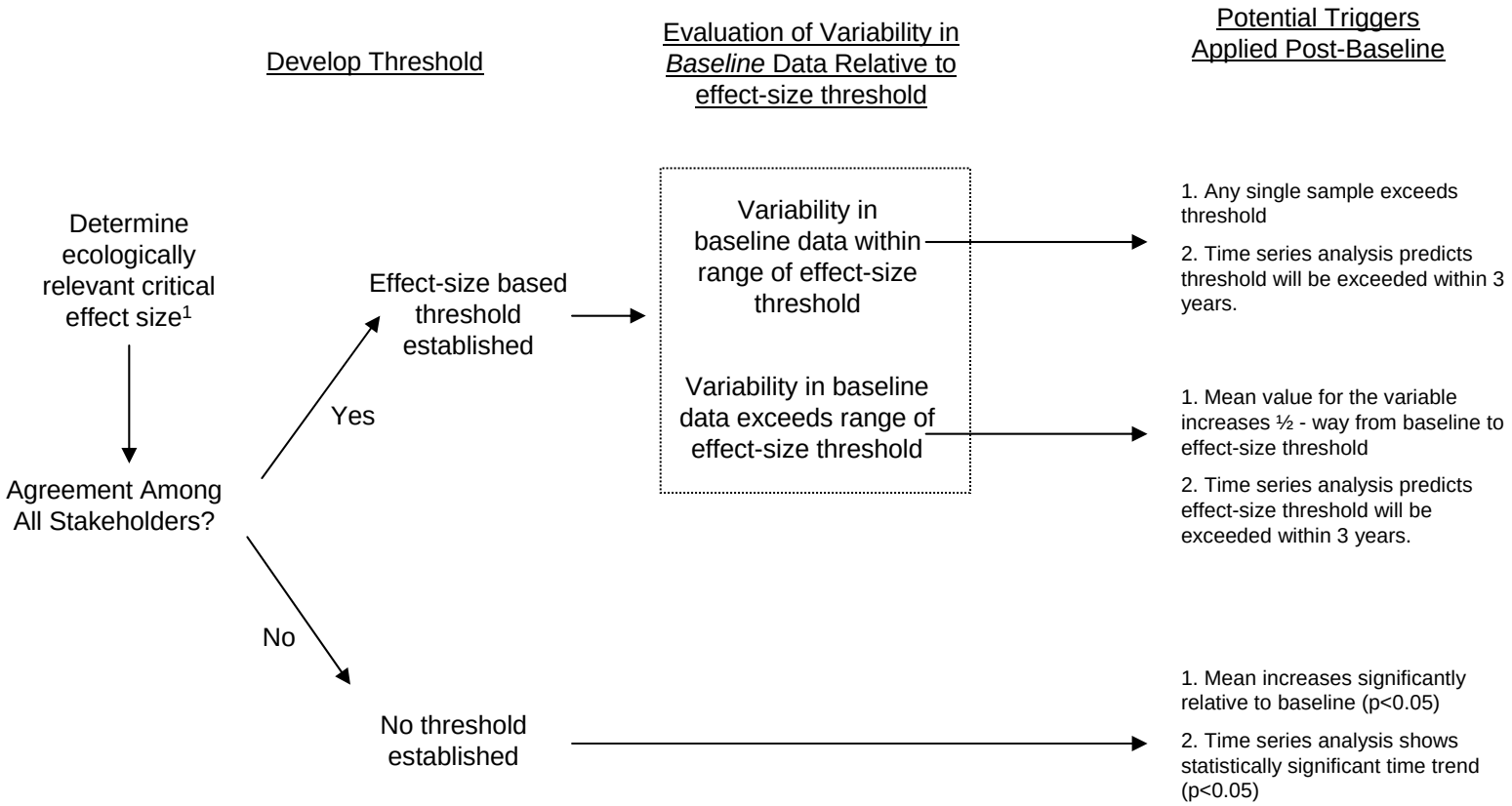


Figure 4-3. Derivation of Thresholds and Potential Triggers for Exposure Variables



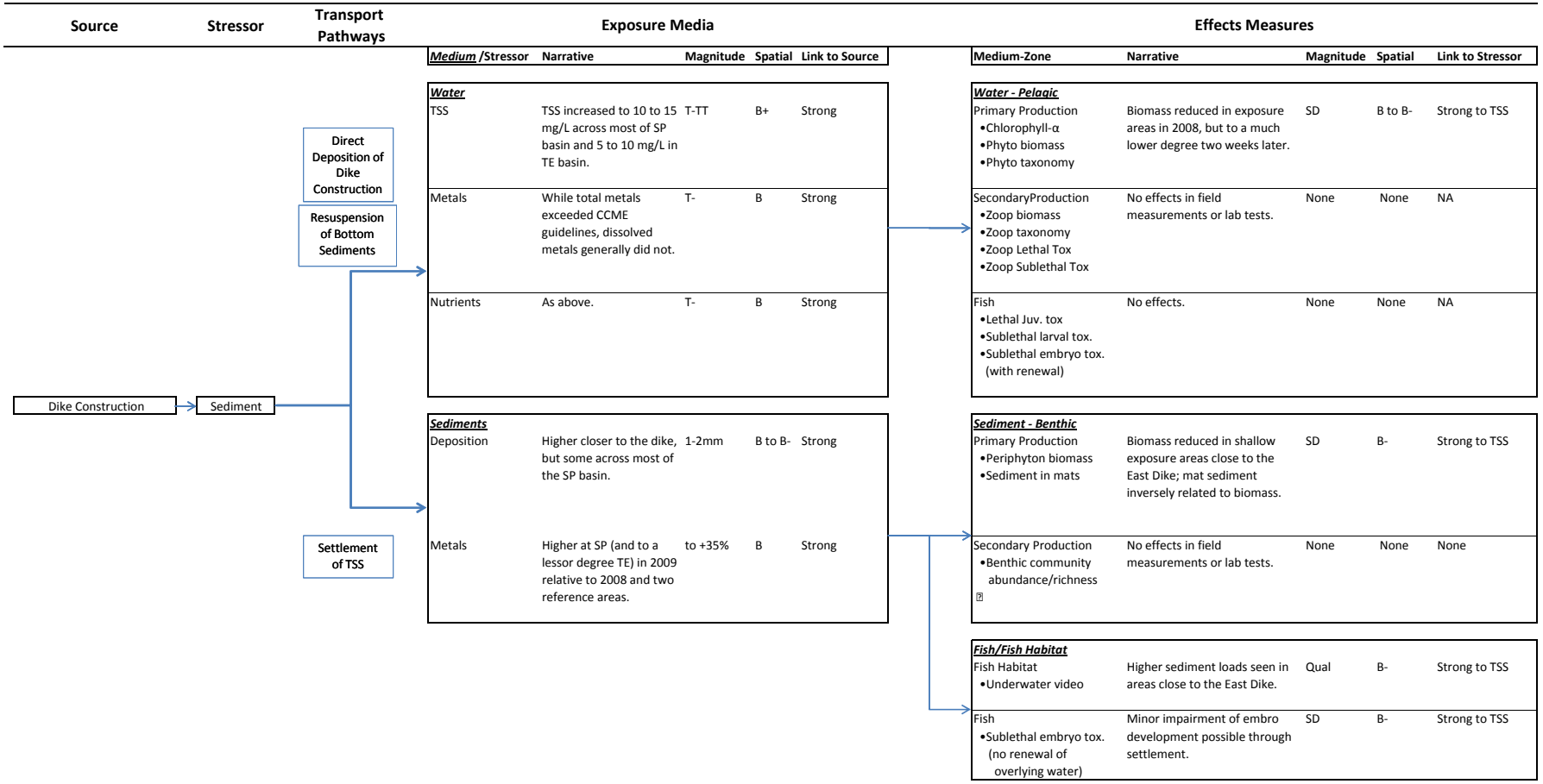
[1] Considering acceptable effect sizes and site-specific information on receptors and exposure pathways.

Figure 4-4. Derivation of Thresholds and Potential Triggers for Effects Variables



[1] Based on risk assessment policy, protection levels inherent in Canadian (e.g., CCME) environmental quality guidelines, and/or information in the Environmental Assessment.

Figure 4-5. Example of an issue-specific conceptual site model for the 2008 sedimentation event during East Dike constructior



Notes: *Magnitudes*

- T- Exceeds relevant threshold due to particulate form.
- T- Exceeds relevant threshold.
- TT Grossly exceeds relevant threshold.
- SD Statistically significant difference
- Qual Qualitative assessment

Spatial Extent

- B- scale less than lake basin
- B basin-wide
- B+ extending beyond a basin

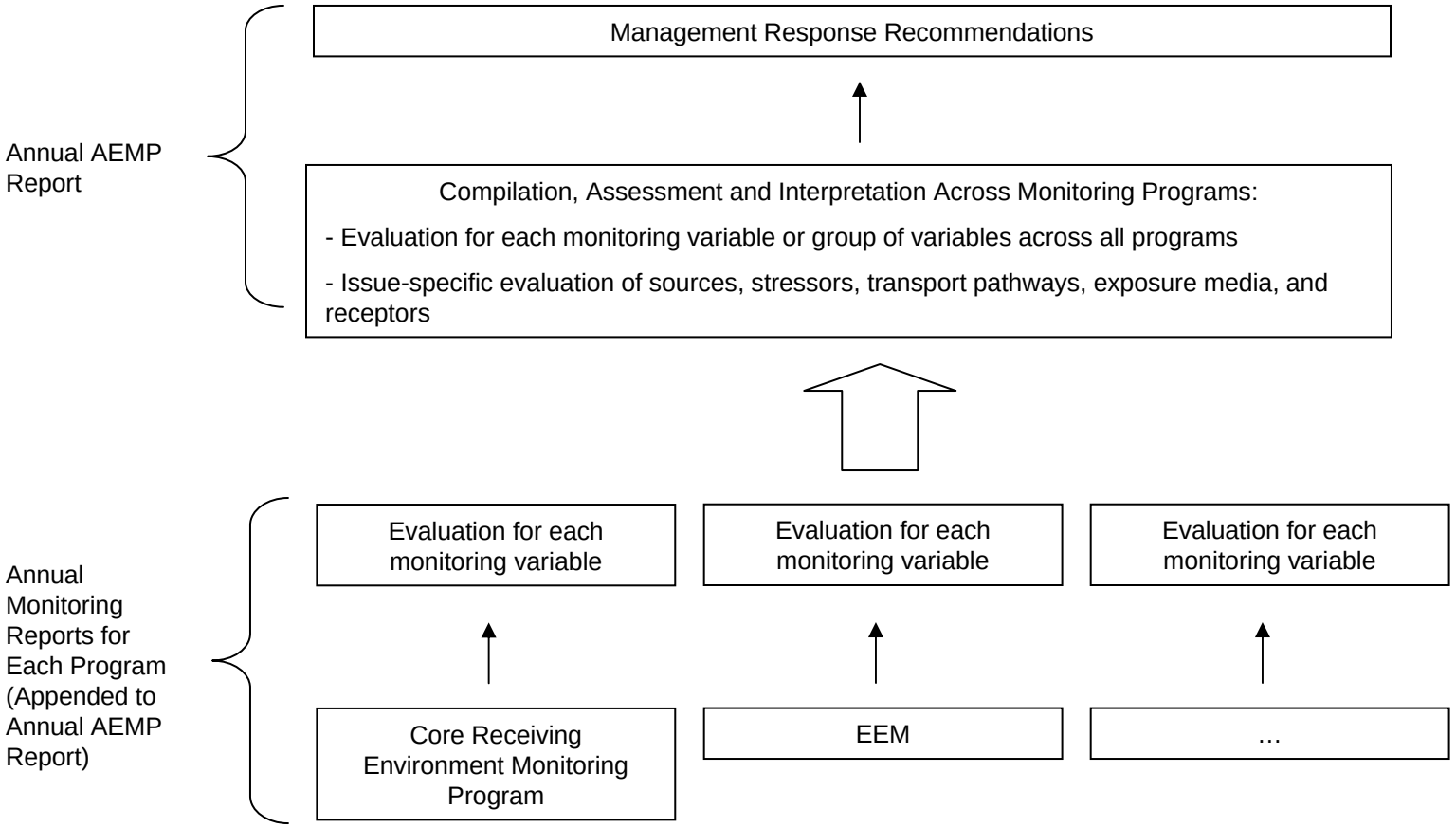
5. STRUCTURE AND CONTENT OF ANNUAL AEMP REPORTS

Following the process outlined in **Section 4**, the annual AEMP report would integrate the key findings from all of the component programs, conduct a meta-analysis of findings across the programs (i.e., through development of issue-specific conceptual site models), and develop corresponding recommendations for management response actions for each key issue. The specific monitoring program annual reports would still be published as stand-alone documents. Under this framework, the structure of the annual AEMP report would be as follows:

1. Introduction
2. Summary of AEMP-related programs with a focus on key findings.
3. Compilation and integration of results across all programs.
4. Discussion and assessment of key issues.
5. Recommendations, including (a) suggested revisions to the design of each monitoring program and (b) management response actions for each key issue.

This reporting process is depicted in **Figure 5-1**.

Figure 5-1. AEMP Annual Reporting Process.



6. REFERENCES

AEIA. 2005. Aquatic Ecosystem/Fish Habitat Impact Assessment. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC, for Cumberland Resources Ltd. (now AEM). October 2005.

Agnico-Eagle Mines (AEM). 2010. Meadowbank Gold Project Blast Monitoring Program, (Currently in consultation with DFO) Version 1 March 2010

AEM. 2009a. Meadowbank Gold Project. 2008 Annual Report. Prepared by Agnico-Eagle Mines Limited- Meadowbank Division. March 2009.

AEM. 2009b. Geochemical Characterization Study: All Weather Private Access Road and Airstrip Quarries. March 2009.

AEM. 2009c. Appendix C3: All-Weather Road Fisheries Monitoring Report within Meadowbank Gold Project 2008 Annual Report. Prepared by Agnico-Eagle Mines Limited-Meadowbank Division.

AEMP (Aquatic Effects Management Program). 2005. A report prepared by Azimuth Consulting Group, Vancouver for Cumberland Resources Ltd. October, 2005.

Azimuth Consulting Group Inc. (Azimuth), 2012. Core Receiving Environment Monitoring Program (CREMP): Design Document 2012, Meadowbank Mine. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. December 2012.

Azimuth. 2010a. Federal Contaminated Sites Action Plan (FCSAP) – Ecological Risk Assessment Guidance. Draft report prepared for Environment Canada, March 2010.

Azimuth. 2010b. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction TSS Effects Assessment Study 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. April 2010.

Azimuth. 2010c. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction Monitoring 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. April 2010.

Azimuth. 2010d. Aquatic Effects Monitoring Program – Core Receiving Environment Monitoring Program 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. April 2010.

Azimuth. 2010e. Aquatic Effects Monitoring Program – Habitat Compensation Monitoring 2009, Meadowbank Gold Project. Report prepared by Azimuth

Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth, 2009. Fish Out Report – Meadowbank Gold Project, 2009. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2008a. Technical Memorandum: Fish-out Program for the Meadowbank Gold Project. Prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. May 2008.

Azimuth. 2008b. All-Weather Private Access Road (AWPAR) Fisheries Monitoring Report – 2007. Meadowbank Gold Project. Prepared for Agnico-Eagle Mines Ltd., Vancouver, BC. Prepared by Azimuth Consulting Group Inc., Vancouver, BC.

Azimuth. 2006. No Net Loss Plan – Meadowbank Gold Project, 2006. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Cumberland Resources Ltd., Vancouver BC. November 2006.

BAER (Baseline Aquatic Ecosystem Report). 2005. A report prepared by Azimuth Consulting Group, Vancouver for Cumberland Resources Ltd. October, 2005.

Diavik Diamond Mines Inc. (Diavik). 2007a. Adaptive management plan for aquatic effects. August 2007.

Diavik. 2007b. AEMP design document. December 2007.

Gelman, A., and J. Hill. 2006. Data Analysis Using Regression and Multilevel/Hierarchal Models. Cambridge University Press.

Golder Associates Ltd. (Golder). 2009a. Fish Habitat Compensation Construction at R02 All Weather Private Access Road, Meadowbank Gold Project, Nunavut. As-Built Report. June 9, 2009

Golder. 2009b. 2008 Groundwater Quality Monitoring Program, Meadowbank Mine. January 14, 2009.

Golder. 2009c. 2009 Groundwater Quality Monitoring Program, Meadowbank Mine. October 29, 2009.

Golder. 2008. Addendum Report: Air Quality Monitoring Meadowbank Gold Project Doc 665A May 16, 2008

Golder. 2004. Meadowbank Baseline Groundwater Quality. April 26, 2004.

Greig, L., D. Marmorek and C. Murray. 2008. Guidelines for preparation of adaptive management plans. Prepared by ESSA Technologies Ltd, Richmond Hill, Ontario, for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife.

Hewitt, J.E., S.E. Thrush and V.J. Cummings. 2001. Assessing environmental impacts: effects of spatial and temporal variability at likely impact scales. Ecological Applications 11(5): 1502-1516.

Hull, R.N., and S. Swanson. 2006. Sequential analysis of lines of evidence – an advanced weight of evidence approach for ecological risk assessment. Integrated Environmental Assessment and Management 2(4): 302-311.

INAC (Indian and Northern Affairs Canada). 2009a. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the northwest territories: Volume 3 – Recommended procedures for developing data quality objectives and a conceptual study design. Report prepared by D.D. Macdonald, B. Zajdlik and INAC Water Resources, June 2009.

INAC (Indian and Northern Affairs Canada). 2009b. Guidelines for designing and implementing aquatic effects monitoring programs for development projects in the northwest territories: overview report. Report prepared by D.D. Macdonald, B. Zajdlik and INAC Water Resources, June 2009.

Murray, C., and M. Nelitz. 2008. Review of Diavik and EKATI adaptive management plans. Prepared by ESSA Technologies Ltd., Vancouver, BC, for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife.

Newman, M.C. 2008. "What exactly are you inferring?" A closer look at hypothesis testing. Environmental Toxicology and Chemistry 27(5): 1013-1019.

North-South Consultants Inc. 2011. Meadowbank Division: 2010 Fish-out of the Bay-Goose Basin in Third Portage Lake. A report prepared for Agnico-Eagle Mines Limited- Meadowbank Division. 2010 Meadowbank Annual Report. Appendix F6

Pinheiro, J.C., and D.M. Bates. 2000. Mixed-Effects Models in S and S-PLUS. Springer, New York.

Rescan. 2009. EKATI Diamond Mine: 2009 Aquatic Effects Monitoring Program Re-Evaluation. Prepared for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd, January 2010.

Rescan. 2008. EKATI Diamond Mine: Watershed Adaptive Management Plan. Prepared for BHP Billiton Canada Inc. by Rescan Environmental Services Ltd, February 2008.

Walters, C. 1986. Adaptive Management of Renewable Resources. MacMillan Publishing, New York.

Weins, J.A. and K.R. Parker. 1995. Analyzing the effects of accidental environmental impacts: approaches and assumptions. Ecological Applications 5(4): 1069-1083.

Wright, D.G., and G.E. Hopky. 1998. Guidelines for the use of Explosives in or near Canadian fisheries waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

Final
Project No. AEM-15-03
November 2015

Core Receiving Environment Monitoring Program (CREMP): 2015 Plan Update

Prepared for:

Agnico-Eagle Mines Ltd.
Meadowbank Division

P.O. Box 540
Baker Lake, Nunavut X0C 0A0

Prepared by:

Azimuth Consulting Group Partnership
218-2902 W. Broadway, Vancouver, BC, V6K 2G8
Tel: 604 - 730 - 1220 * Fax: 604 - 739 - 8511

FINAL

Core Receiving Environment Monitoring Program (CREMP): 2015 Plan Update

Prepared for:

Agnico Eagle Mines Ltd.

Meadowbank Division
Baker Lake, NU
X0C 0A0

November 2015

Azimuth Consulting Group Partnership

218-2902 West Broadway
Vancouver, BC
V6K 2G8

Project No. AEM-15-03

TABLE OF CONTENTS

TABLE OF CONTENTS ii
LIST OF TABLES iii
LIST OF FIGURES iii
LIST OF APPENDICES iii
ACRONYMS iv

1. INTRODUCTION 1
1.1. Overview 1
1.2. Approach 1
1.3. Report Organization 1
2. MEADOWBANK CREMP ROUTINE MONITORING 2
2.1. Introduction 2
2.2. Meadowbank Site Activities and Potential Impacts 2
2.2.1. Historical Site Activities *2*
2.2.2. Ongoing/Future Site Activities *3*
2.3. Study Design 7
2.3.1. Approach *7*
2.3.2. Sampling Areas *8*
2.3.3. Sampling Strategy *9*
2.3.4. Sampling Components *10*
2.3.5. Sampling Effort and Frequency *11*
2.4. Sampling Methods 18
2.4.1. Limnology, Water Chemistry and Phytoplankton *18*
2.4.2. Benthic Invertebrates and Sediment Grab Chemistry *19*
2.4.3. Sediment Coring Chemistry *19*
2.5. Quality Assurance/Quality Control 21
2.5.1. Water Chemistry *21*
2.5.2. Sediment Chemistry *22*
2.5.3. Phytoplankton *22*
2.5.4. Benthic Invertebrates *22*
2.6. Data Evaluation Criteria 23
2.6.1. Water Chemistry *23*
2.6.2. Sediment Chemistry *25*
2.6.3. Phytoplankton *26*
2.6.4. Benthic Invertebrates *26*
3. MEADOWBANK PIT FLOODING MONITORING 31
4. REFERENCES 33

LIST OF TABLES

Table 2-1. Chronology of mine operational activities and associated receiving environment overview from 2008-2014. 6

Table 2-2. Status of all CREMP areas since the beginning of monitoring. 13

Table 2-3. CREMP monitoring component sampling summary for Meadowbank and Baker Lake. 20

Table 2-4. Total metals: summary of thresholds and of trigger values for Meadowbank, Wally and Baker Lakes' water quality. 27

Table 2-5. Dissolved metals: summary of thresholds and of trigger values for Meadowbank, Wally and Baker Lakes' water quality. 28

Table 2-6. Nutrients and conventional parameters: summary of thresholds and of trigger values for Meadowbank, Wally and Baker Lakes' water quality. 29

Table 2-7. Predicted maximum whole lake water quality for Third Portage, Second Portage and Wally Lakes (from Cumberland, 2005a). 30

LIST OF FIGURES

Figure 2-1. CREMP – Meadowbank sampling areas. 14

Figure 2-2. CREMP – Baker Lake sampling areas. 15

Figure 2-3. Annual results-based sampling strategy rules for mid-field and far-field sampling areas. 16

Figure 2-4. Worked example using the annual results-based sampling strategy rules for mid-field and far-field sampling areas. 17

LIST OF APPENDICES

Appendix A Standard Operating Procedure, Meadowbank lakes & Baker Lake, CREMP Water & Phytoplankton Sampling

Appendix B Standard Operating Procedure, Meadowbank lakes & Baker Lake, CREMP Benthos & Sediment Sampling

Appendix C Standard Operating Procedure, Meadowbank lakes & Baker Lake, CREMP Sediment Core Sampling

Appendix D Updated threshold and trigger development for CREMP water parameters

ACRONYMS

AEM Agnico Eagle Mines Ltd.

AEMP Aquatic Effects Monitoring Program

ANOVA Analysis of Variance

AWPAR All weather private access road

BACI Before/After Control/Impact

BACIP Before/After Control/Impact Paired

BAER Baseline Aquatic Ecosystem Report

BAP, BBD, BES, BPJ Baker Lake – Akilahaarjuk Point, Barge Dock, East Shore, Proposed Jetty

CCME Canadian Council of Ministers of the Environment

CREMP Core Receiving Environment Monitoring Program

CRM Certified Reference Material

DQO Data Quality Objective

EAS Effects assessment study

EEM Environmental effects monitoring

EIA Environmental Impact Assessment

FF Far Field

GPS Global Positioning System

INUG Inuggugayualik Lake

KIA Kivalliq Inuit Association

MDL Method detection limit

MF Mid-Field

MMER Metal mining effluent regulations

NF Near Field

NWB Nunavut Water Board

PAH Polycyclic aromatic hydrocarbon

PDL Pipedream Lake

QA/QC Quality Assurance / Quality Control

REF Reference

RPD Relative percent difference

RSF Rock storage facility

SOP Standard Operating Procedure

SP Second Portage Lake

TE Tehek Lake

TEFF Tehek Lake Farfield

TIA Tailings impoundment area

TSF Tailings storage facility

TSS Total Suspended Solids

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

UTM Universal Transverse Mercator

WAL Wally Lake

1. INTRODUCTION

1.1. Overview

In accordance with the terms of the renewed Nunavut Water Board (NWB) Type A Water Licence (2AM-MEA1525), Azimuth Consulting Group Partnership (Azimuth) was retained by Agnico Eagle Mines Ltd. (AEM) to complete an update of the core receiving environment monitoring program (CREMP) plan. This document reflects a broad scope that includes: re-tooling the general CREMP plan to match AEM's upcoming activities at the Meadowbank site and Baker Lake, and developing a CREMP component for monitoring pit flooding. This document also integrates a number of changes from the previous CREMP plan update (Azimuth, 2010a) stemming from comments and recommendations from the Kivalliq Inuit Association (KIA) that came out of the NWB Type A Water Licence renewal process. Finally, this plan update includes a new strategy, based on the existing gradient approach, to improve program efficiency by allowing reduced sampling effort when warranted.

1.2. Approach

The following components are addressed herein:

1. ***Meadowbank CREMP Routine Monitoring*** – the general CREMP monitoring strategy was initially conceived during the permitting process (AEMP, 2005) and has been modified over the years (e.g., Azimuth, 2010a, 2012a) to better support environmental management and decision-making at the Meadowbank Mine. These refinements reflect the adaptive nature of the CREMP, which has been an integral part of the program from its onset (AEMP, 2005). A substantial amount of data has been generated since the start of the program in 2006, leading to a good understanding of the nature of mine-related changes associated with the construction and operation of the Meadowbank Mine. Based on the available data, our understanding of the site construction and operations for the last decade, and future activities within the scope of the renewed NWB Type A Licence, we believe that there are opportunities to simplify the current design while maintaining the protection goals for the aquatic receiving environment.
2. ***Meadowbank Pit Flooding Monitoring*** – As discussed in **Section 2.2**, mining-related activities under the renewed NWB Type A Licence will include flooding the pits, eventually breaching the dikes and repatriating the pit lakes with the adjacent lake ecosystems. Those activities will require specific monitoring and an associated decision framework to guide the repatriation process (i.e., for determining when water quality in the flooded pit areas is acceptable to rejoin to the surrounding receiving environment). As per licence requirements, AEM will continue to implement a detailed program of water quality monitoring (key source areas and the flooding pits) and modelling to track progress and forecast pit lake water quality to support management decisions regarding this activity. Given the CREMP focus on receiving environments, this plan includes a general risk-based framework to ensure that water quality in flooded areas will not pose unacceptable risks to lake ecosystems when the dikes are eventually breached.

1.3. Report Organization

The remainder of this document is organized as follows:

- **Section 2** – Meadowbank CREMP routine monitoring
- **Section 3** – Meadowbank pit flooding monitoring
- **Section 4** – References

2. MEADOWBANK CREMP ROUTINE MONITORING

2.1. Introduction

AEM's Meadowbank Mine is situated approximately 75 km north of the hamlet of Baker Lake, Nunavut. The Aquatic Effects Management Program (AEMP, 2005) was developed to address issues identified during the Environmental Impact Assessment (EIA) process that could potentially impact the aquatic receiving environments surrounding the development. Building from earlier baseline monitoring (BAER, 2005), the 2005 AEMP described the general monitoring strategy designed to detect impacts to the aquatic environment. This strategy relied on two primary components: the core monitoring program[1] and targeted studies. Monitoring following the 2005 AEMP strategy has been implemented as follows:

- 2006 and 2007 – The core monitoring program was implemented over two complete cycles (Azimuth, 2008a, 2008b) prior to construction of the mine (i.e., baseline conditions).
- 2008 – 2014 – Mine construction started in 2008, with dike construction activities occurring directly in the receiving environment. Core receiving environment monitoring (Azimuth, 2009c, 2010b, 2011b, 2012b, 2013, 2014, 2015) was complemented by targeted studies directed towards effects of dike construction (Azimuth, 2009a, 2010c; AEM, 2011) and associated effects related to the effects of total suspended solids (TSS) on water quality and benthic community in affected waterbodies (Azimuth, 2009b, 2010d, 2011a, 2012c).

2.2. Meadowbank Site Activities and Potential Impacts

The site components include the Meadowbank mine site, the Vault Pit area to the north, marshalling and fuel storage facilities in Baker Lake, and the 110-km All Weather Private Access Road (AWPAR) between Baker Lake and the Meadowbank site. The Meadowbank Mine consists of several gold-bearing deposits; mining has targeted three open pits (Portage Pit, Goose Pit, and Vault Pit). Much of the pit development is located in close proximity to the mill, office and lodging infrastructure, with the exception of the Vault Pit which is approximately 8 km northeast of the main mine site. The operations phase of the project began in February 2010 with commercial production from Portage Pit, followed by the Goose Pit in the first quarter of 2012, and finally Vault Pit in the first quarter of 2014. Mining at the Goose Pit has been completed, leaving commercial production to Portage and Vault Pits until the end of the mine life in 2018.

2.2.1. Historical Site Activities

The CREMP study design was tailored to target the identification of effects related to AEM's activities, particularly to those which have the potential to affect the aquatic receiving environment. Key mining activities and their general effects on the aquatic environment are typically described in the routine monitoring reports and used to interpret the CREMP results each year. These activities include:

- Dike construction
- Dewatering
- Effluent Discharge
- Dust from general site-related activities (e.g., rock crushing, road building, pit blasting, ore and waste hauling, ground preparation, vehicle (truck and aircraft) traffic, infrastructure construction)
- Barge traffic (Baker Lake)

[1] Note that this program was designed as a complement to Environmental Effects Monitoring (EEM) requirements under the Metal Mining Effluent Regulations (MMER). EEM activities at Meadowbank have been conducted in 2011 (Cycle 1) and in 2014 (Cycle 2).

A chronological overview of these activities is presented by year in **Table 2-1** alongside related changes observed in the receiving environment.

As outlined in **Table 2-1**, the most significant changes observed in the receiving environment were largely attributable to East Dike and Bay-Goose Dike construction. Specifically, elevated turbidity and TSS concentrations were observed in SP, TPE and TE during active dike construction years (2008-2010), and an increasing trend in sediment chromium concentrations was observed at TPE in recent years (2013-2014), likely attributable to the use of ultramafic rock in the construction of the Bay-Goose Dike. In addition, the program has identified a number of minor water quality changes relative to baseline/reference conditions (e.g., conductivity, hardness, calcium, potassium, magnesium, sodium, and total dissolved solids) at near-field monitoring areas (e.g., the north basin of Third Portage Lake, the east basin of Third Portage Lake and Second Portage Lake); while these changes provide confidence in the CREMP's statistical power to detect mine-related changes in the receiving environment, the magnitude of change in all these cases was considered unlikely to adversely affect aquatic life (Azimuth, 2014). Overall, no apparent mine-related changes to the receiving environment in Baker Lake have been identified, despite the increase in barge traffic observed from 2008-2010.

2.2.2. Ongoing/Future Site Activities

Mining activity at Meadowbank is progressing from the south (Goose and Portage Pits) from early in the mine life (2010-2016), northward (Vault Pit) towards the end of mine life (2014-2018). The staged mine development results in the southern pits being completely mined out and undergoing closure during the operational phase of the Vault Pit, while the mill and tailings storage facility operate throughout the mine life (AEM, 2015).

The mine is now entering the late operational phase and AEM has recently renewed their NWB Type A Licence (NWB 2AM-MEA1525) until July 2025. This licence would take Meadowbank mine through late operations and into closure phase.

The current understanding of planned activities from late operations through closure and post-closure is as follows (AEM, 2015):

- Mining in the Goose Pit was completed in the second quarter of 2015
    - The Goose Pit will be flooded on a controlled basis from Third Portage Lake through until the end of September 2023. Water quality of all water sources to the pit (e.g., seepage water, groundwater, TSF reclaim water, and lake water) will be monitored carefully prior to, during and after flooding; the results will be compared to modelled predictions and managed accordingly (see **Section 3**).
- Mining in the Portage Pit will be completed in 2016
    - There is no planned effluent discharge to Third Portage Lake or Second Portage Lake in the next 10 years
    - Ultramafic waste rock will be used to progressively cap the Portage Rock Storage Facility (RSF) by end of 2016
    - Ultramafic waste rock will be used to progressively cap the Portage Tailings Storage Facility (TSF) for closure after September 2018
    - The Portage Pit will be flooded on a controlled basis from Third Portage Lake through until the end of September 2023. Water quality of all water sources to the pits (e.g., seepage water, groundwater, TSF reclaim water, and lake water) will be monitored

carefully prior to, during and after flooding; the results will be compared to modelled predictions and managed accordingly (see **Section 3**).

- Mining in the Vault Pit, Phaser Pit and BB Phaser Pit will continue through until approximately September 2018
    - Waste rock from the Vault Pit will continue to be delivered to the Vault RSF
    - Ore from the Vault Pit area will continue to be transported to and milled at the Meadowbank Mill
    - Tailings from the Vault Pit area will be transported and deposited in the Portage TSF
    - Runoff and infiltration drainage from the Vault RSF, dike seepage and Vault area contact water will be collected in the Vault Attenuation Pond prior to discharge to Wally Lake (treated as necessary)
    - The Vault RSF will not be capped as it is not expected to generate acid rock drainage
    - The Vault Pit will be flooded on a controlled basis from Wally Lake through until the end of 2023; by this time, the Vault Attenuation Pond and the pit lake will have merged. Water quality of all water sources to the pits (e.g., seepage water, groundwater, and lake water) will be monitored carefully prior to, during, and after flooding; the results will be compared to modelled predictions and managed accordingly (see **Section 3**).
- Flooded pit lakes and the reclaimed Portage TSF will continue to be monitored during the closure and post-closure phases. The Bay-Goose and Vault Dikes will be breached once water quality within the pit lakes meets discharge criteria, including CCME freshwater aquatic life guidelines where available, ambient lake concentrations and/or other risk-based assessment criteria (see **Section 3**).

As outlined above, mining-related activity over the next decade is decreasing in the Goose and Portage areas and remaining the same in the Vault area. Generally, there is a shift in location, but not necessarily in overall mining intensity, until mining at the currently targeted deposits is predicted to be completed in late 2018. After that, mine-related activities in all areas will cease as the mine moves into closure phase. It should be noted that progressive reclamation will be started as early as possible, so while the site as a whole may be in the operations phase, specific site components might already be in closure (e.g., TSF capping and Goose Pit flooding have already begun).

In terms of potential impacts to the aquatic receiving environment, based on historical activity-impact relationships, we would not expect to see any significant[2] impacts from the ongoing/future activities around the Meadowbank Mill, Goose Pit, Portage Pit, Vault Pit and Phaser Pits, described above through the end of 2018:

- *Dewatering* – significant impacts to the aquatic receiving environment at Wally Lake are unlikely given that no significant effects related to dewatering were observed historically in the north basin of Third Portage Lake or into Wally Lake. Furthermore, water treatment will be used if necessary to remove suspended sediments (and sediment-associated metals).

[2] Similar to the subtle changes detected by the CREMP at near-field monitoring areas over the last few years, continued low-magnitude mine-related changes to water quality at near-field areas adjacent to on-going activities would be expected moving forward; based on past results, none of these changes would be of sufficient magnitude to adversely affect aquatic life.

- *Effluent Discharge* – similar to dewatering, significant impacts to Wally Lake (from Vault Attenuation Pond) and to Second Portage Lake (from East Dike seepage) are not expected given that no significant effects were observed from effluent discharge to the north basin of Third Portage Lake historically. Discharge to Third Portage Lake has ceased; site contact water will be directed to the reclaim pond or will contribute to pit flooding.
- *Dust* – as mining and related activities are ongoing and will continue for the next few years, a number of activities could contribute to dust inputs into the aquatic receiving environment such as, blasting in the Vault Pit, waste rock hauling in the Vault area, ore hauling from the Vault area to the Portage area mill, and general mine site vehicle traffic. However, given that these activities are essentially a continuation of historical site activities, we would not expect any significant impacts as these were considered negligible relative to natural variability in the past.
- *Barge Traffic* – barge traffic is expected to remain the same or decrease as the mine approaches closure phase. Impacts are not expected particularly since no mine-related changes to the receiving environment in Baker Lake were identified even in years when barge traffic increased.

The planned cessation of mining Portage Pit, Vault Pit and Phaser Pits at Meadowbank in late 2018 will substantially change the nature of activities conducted on site, likely further reducing the potential for significant changes to the aquatic receiving environment. Accordingly, AEM commits to revisiting the CREMP plan in advance of the completion of mining prior to the closure phase.

Table 2-1. Chronology of mine operational activities and associated receiving environment overview from 2008-2014.

Year	Major Mine-Related Activities	Receiving Environment Overview
2008	●Major in-water construction activities included the East Dike (located in Second Portage Lake) and the Western Channel Dike (located between Third Portage Lake and Second Portage Lake); the closest CREMP sampling area to these activities was the Second Portage Lake area (SP). ●Other site-related activities included rock crushing, road building, pit blasting, ground preparation, and infrastructure construction. ●Barge traffic increases in Baker Lake to support construction.	●As described in detail elsewhere (Azimuth, 2009a; 2009b), East Dike construction led to a sedimentation event that extended through Second Portage Lake (SP) to Tehek Lake (TE). The potential impact of construction-related sediment releases to the aquatic environment was the focus of the four-year EAS study (Azimuth, 2009b, 2010d, 2011a, 2012c).
2009	●Dewatering discharges (i.e., impounded Second Portage Lake water with TSS) were directed primarily into the north basin of Third Portage Lake (TPN), but also into Second Portage Lake (March to July and Oct to Dec, 2009). ●Bay-Goose Dike construction started in late July 2009. ●Most of the site preparation and road infrastructure was completed in 2009. ●North Portage Pit was the primary focus of blasting and mine operations. ●Barge traffic increases in Baker Lake.	●Despite a number of precautions, storm winds broke the Bay-Goose Dike turbidity barrier containment system, leading to another sedimentation event in late August. ●Elevated TSS (and other parameters) was primarily restricted to east basin of Third Portage Lake (TPE) and to a minor extent into SP and TE. The implications of the release were assessed in the EAS study (see above).
2010	●Bay-Goose Dike construction completed using additional mitigation measures. ●Mine officially opened on 27 Feb 2010, marking the started of the operations period. ●Pit development focused on North Portage and South Portage pits. ●Waste rock to rock storage facility (RSF). Tailings to impoundment area (TIA). Contact water from operations not discharged to receiving environment. ●Dewatering of SP impoundment to TPN continued, with discharge now subject to MMER. ●Barge traffic increases in Baker Lake.	●Bay-Goose Dike construction leads to less-pronounced sedimentation event in TPE and extends through SP to TE; EAS studies continue. ●TPN (dewatering) TSS concentrations generally consistent with baseline conditions.
2011	●Mining operations focus on North Portage and South Portage pits. ●Waste rock to rock storage facility (RSF). Tailings to impoundment area (TIA). ●Construction activities limited to mine footprint. ●Dewatering of SP and TPE to TPN continued, with treatment added to reduce fine sediment and turbidity. ●Barge traffic stabilizes in Baker Lake.	●TPN focus of routine EEM study - no mine-related effects detected (Azimuth, 2012e). ●TPN TSS concentrations consistent with baseline. ●The TSS EAS targeting dike construction sedimentation events completed.
2012	●SP and TPE dewatering discharges to TPN finished by spring. Diffuser installed and effluent (mix of residual Bay-Goose water, contact water, East Dike seepage and run-off) discharge to TPN commences; treatment (for fine sediment, turbidity) continues. ●North cell non-contact water diversion completed in August (intercepting run-off prior to the tailings and waste rock areas and diverting to NP2 and Dogleg ponds). ●Vault access road constructed and site preparation activities for the Vault Pit and Vault Dike commence. ●Barge traffic remains stable in Baker Lake; 200-L diesel spill occurs, but cleaned up successfully.	●TPN TSS concentrations generally consistent with baseline. ●Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, sulphate and total dissolved solids. ●Spill-related monitoring show no traces of hydrocarbons in Baker Lake.
2013	●Effluent discharge to TPN continued. ●Fishout activity in Vault lake was completed. ●Vault lake was dewatered into WAL (ongoing) and did not require TSS treatment. ●Minor construction modifications to north cell diversion ditch completed. ●Completion of the Airstrip extension (18m) into Third Portage Lake in March. ●Seepage from Rock Storage Facility (ST-16) through the road into NP2 identified (additional monitoring in NP2 to evaluate near-shore water quality) (Golder, 2014).	●TPN TSS concentrations consistent with baseline. ●Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: alkalinity, conductivity, calcium and total dissolved solids. ●TPE sediment chromium concentrations were elevated above trigger value; better spatial coverage needed to reduce uncertainty in 2014.
2014	•Effluent discharge to TPN from the Portage Attenuation Pond occurred only from June 10 to July 5. Discharge to TPN is now complete. The former Portage Attenuation Pond has now become the South Cell for tailings deposition. •EEM Cycle 2 Study Design was conducted at the end of August through the beginning of September (no TPN discharge at this time). •Vault Dewatering into Wally Lake from June 20 to 29 (now complete); discharge from Vault Attenuation Pond into Wally Lake from July 24 to August 14. No TSS treatment for Vault Discharge. •New discharge into Second Portage Lake during all of 2014 (except from May 3 to July 28): two seepage collection points (North and South) are situated on west side of the East Dike to collect seepage through dike from SP. Water is pumped from both collection points, which are connected together before discharging back into Second Portage Lake through a diffuser. No TSS treatment for East Dike Discharge. •No more seepage water from Rock Storage Facility (ST-16) reaching the NP2 Lake in 2014. •Commercial mining in Vault Pit started at the beginning of 2014. No major construction or modifications in 2014.	●Minor mine-related trends identified for a number of water chemistry parameters at near-field areas: conductivity, hardness, Ca/Mg/K/Na and total dissolved solids. ●Temporal trend in TPE sediment chromium confirmed in coring study; targeted study recommended for 2015.

2.3. Study Design

The study design is based on a before-after-control-impact (BACI) approach, but has also incorporated the concept of gradients in exposure. Tracking spatial and temporal differences related to mining activities relied on categorizing areas using two factors:

- *Area Type* – this concept relates to an area's spatial proximity to the planned mine development (i.e., whether built or not); categories include near-field, mid-field, far-field, and reference (see **Section 2.3.2**).
- *Area Status* – this concept is temporal and has two levels: control (not exposed to mine-related activity) or impact (exposed to mine-related activity). The term "impact" is taken from the BACI statistical study design approach and does not mean that an actual impact has taken place; rather, it designates a time period when potential mine-related impacts may occur for an area (i.e., that an area has been exposed to one or more mining activities).

Together, area categorization by type and status provide a logical framework to facilitate the identification of real mining-related changes to the aquatic receiving environment (as opposed to natural regional changes due to climate or other factors).

The onset of construction activities in proximity to a CREMP monitoring area formally ends the baseline phase and changes the status of that area from "control" to "impact". Status changes are also important for any statistical analyses, as they dictate how data are grouped when assessing potential trends. Note that the end of the baseline phase is specific to each area. The status of all CREMP areas since monitoring started is provided in **Table 2-2**.

2.3.1. Approach

The 2012 AEMP (Azimuth, 2012d) described a two-tiered approach for decision criteria at Meadowbank based on 'trigger' and 'threshold' level concentrations. These are defined as:

- Triggers are early warning criteria that may lead to action. Exceedence of a trigger value does not necessarily imply that an adverse effect may be expected. The triggers may be based on absolute numbers (e.g., an increases half-way from baseline to an identified effects-based threshold) or statistical criteria (e.g., statistically significant difference from baseline-reference conditions; these are used in the absence of an effects-based threshold for a substance and may be very conservative).
- Thresholds are legal requirements, regulatory guidelines (e.g., CCME), or other discrete benchmarks, below which unacceptable adverse effects are not expected and above which adverse effects may occur. If effects-based thresholds do not exist or are not warranted for a particular variable, then early warning triggers (based on statistical criteria) will be developed without thresholds. In such cases, if triggers are exceeded then the implications of such exceedences can only be understood through the integration of results from other AEMP monitoring programs, or, if important information gaps still exist, through prescribed EEM studies or targeted studies.

Thus, comparison of the data to the early warning trigger values is the initial analytical focus; only if trigger values are exceeded are data then compared to the applicable thresholds (if available). Details regarding the derivation of trigger and threshold values for the CREMP are presented in the CREMP Design Document 2012 (Azimuth, 2012a).

2.3.2. Sampling Areas

The program consists of 13 sampling areas, each categorized into one of the four main types of areas described below. Sampling areas are shown in **Figure 2-1** (Meadowbank) and **Figure 2-2** (Baker Lake).

- Near-field (NF) areas – Areas are situated in close proximity to the development, in particular near dikes, dewatering discharge, and proposed effluent sources. These areas provide the first line of early-warning for introductions of stressors into the receiving environment. In the Meadowbank study lakes, these areas include: Third Portage Lake North (TPN), Third Portage Lake East (TPE), Second Portage Lake (SP), and Wally Lake (WAL). 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]).
- Mid-field (MF) area – This area designation was added in 2011 to be consistent with the area categorizations used in the CREMP Design Document 2012 (Azimuth, 2012a) and includes Tehek Lake (TE) and Third Portage Lake South (TPS). TE is adjacent to the inlet from Second Portage Lake and was exposed to elevated TSS during construction of the East Dike in 2008, prompting the addition of a new far-field area (TEFF [Tehek Farfield]) in 2009; consequently, MF designation is more accurate for TE. TPS was an internal reference area in the 2005 AEMP. However, given the connectivity to TPN, it is more appropriately considered a MF area. Given that discharges to TPN are finished, TPS should still be appropriate as a reference area for EEM monitoring.
- Far-field (FF) area – The intent of this area is to monitor water and sediment quality 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 SP are extending into TE and beyond into TEFF.
- Reference (Ref) areas – By definition, reference areas are sufficiently removed from mine activities that they are presumed to be unaffected by any infrastructure and point sources (e.g. aerial deposition and effluent) associated with mine development and activities. Inuggugayualik Lake (INUG) and Pipedream Lake (PDL) are external reference areas chosen for the purposes of making comparisons with the project lakes (EVS, 1999; 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 reference areas are situated about 16 km west at INUG and 12 km northwest at PDL of the mine site. They are both headwater lakes and flow north into the Arctic Ocean. Despite the different drainage basin, both these lakes satisfy the requirements of an external reference lake from a physical/chemical perspective because they are at similar in latitude, have similar geology, relief and climate, do not have any significant inflows and has generally similar limnological features, water chemistry and aquatic biological community structure to the project lakes (BAER, 2005). Pipedream Lake, added to the CREMP in 2009, was originally investigated as a candidate reference area in 1998 (EVS, 1999) from a fisheries perspective; it provides a second context for assessing regional changes due to climatic factors. For Baker Lake, the internal reference area is located several kilometers to the east of the hamlet along the north shore of the lake (Baker Akilahaarjuk Point

[BAP]) and a second reference area, primarily for interpretation of benthic invertebrate data, was added in 2011 based on a recommendation from additional analysis and interpretation of the historical Baker Lake data, which is located on the same shoreline, east of BPJ and west of BAP (Baker East Shore [BES]).

Thus, the core monitoring program is intended to detect changes at a basin or lake scale of inference and to help define the extent (both spatially and temporally) of any adverse effects identified.

2.3.3. Sampling Strategy

As prescribed in Schedule I Table 2 of the Type A water licence (NWB, 2015), the intensity of CREMP monitoring currently varies by component and location. For example, winter sampling is limited to limnological sampling at NF areas (SP, TPE, TPN, and WAL) only and benthic invertebrate sampling is conducted once per year during the August open water period. These component- and location-specific differences are intended to optimize the efficiency of the CREMP to detect changes in the aquatic receiving environment and to address safety concerns (e.g., avoiding on-ice work during dangerous conditions). That said, apart from winter sampling, the program was largely carried out with the same frequency at all locations (i.e., NF, MF, FF and Ref). The variable frequencies and locations of sampling were reviewed beginning in 2012 and approved during the NWB Type A renewal process.

The past decade of CREMP implementation has shown that the design is effective in identifying changes in the aquatic receiving environment (e.g., the low magnitude changes in conductivity, TDS and other parameters are detected at low levels). The results have also shown that the pattern of results is consistent with the conceptual model that mining-related changes will be seen first and most intensely at NF areas. While the significant changes in water quality associated with dike construction were also detected in Tehek Lake (i.e., at MF area TE), the more recent low magnitude changes in water quality have not extended to this area. These results support the introduction of further efficiencies into the CREMP sampling program without sacrificing protection of the aquatic receiving environment.

To that end, we propose a results-driven strategy that reduces sampling frequency at MF and FF sampling areas provided that the decision is supported by previous NF results and MF results for FF. The annual decision framework is presented in **Figure 2-3**. The framework applies to MF area TE (which is paired with upstream NF areas TPE, SP, and WAL), MF area TPS (which is paired with NF area TPN), and to FF area TEFF (paired with upstream MF area TE); this framework does not apply to the Baker Lake areas as there are no MF or FF areas in Baker Lake. As per the normal CREMP data analysis process (see **Section 2.6**), NF results are evaluated on an annual basis (i.e., with CREMP reporting due at the end of March following each monitoring year), with the NF results (i.e., for "Year") dictating the monitoring requirements for the MF area in the subsequent year (i.e., "Year +1"). The Year +1 NF and MF results are used as the basis to determine the MF and FF monitoring requirements for Year +2, and so on. While the full CREMP program will be conducted at each NF area each year, the specific monitoring requirements for the MF and FF areas vary based on the NF and MF results, respectively, as follows (see **Figure 2-3**):

- *No changes identified* – no statistical changes above any trigger values. No further sampling required.
- *Minor changes identified* – statistically significant changes exceeding the early warning trigger values for parameters without effects-based threshold values (i.e., trigger values are based on the 95th percentile of the baseline distribution). Spot sampling through-ice is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).

- *Moderate changes identified* – statistically significant changes exceeding the early warning trigger values for parameters with effects-based thresholds (e.g., CCME water quality guidelines for water chemistry parameters). Full CREMP water sampling (all events) is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).
- *Major changes identified* – statistically significant changes exceeding the effects-based threshold values. Full CREMP program (i.e., including sediment and biological components) is required to determine if changes extend to MF area (or to FF if such changes are seen at an MF area).

This strategy improves the efficiency of the CREMP without compromising the high level of protection for the receiving environment. Furthermore, based on a decade of monitoring at Meadowbank and the nature of activities planned over the next few years, it would be unexpected to see bigger changes in the NF areas relative to what has been observed to date (i.e., minor changes only with the exception of during dike construction). As the site transitions from late operations to closure, it is anticipated that a greater emphasis of the CREMP will be placed on monitoring pit flooding and supporting environmental management decisions regarding breaching the dikes (see **Section 3**).

To help clarify how this strategy would be used, we provide a worked example in **Figure 2-4** which is supported in the text below:

Worked example

- The **2015** ("Year") CREMP data for all areas and components undergo analysis as per the normal annual data analysis process. Results of this analysis show that the yearly mean of the water chemistry parameter TSS significantly exceeds its trigger at WAL. TSS is a parameter with an effects-based threshold so this change constitutes a "Moderate change identified" in the above rule set.
- WAL is a NF area that is paired with MF area TE. In **2016** ("Year +1"), sampling at TE would be conducted in all 5 events but for water chemistry (and limnology) components only. No sampling would be required at TEFF in 2016 unless a change was identified at TE in the 2015 dataset.
- The TE water chemistry results from 2016 sampling undergo analysis as per the normal annual data analysis process. Results of this analysis show no exceedences of trigger values by the yearly means at TE; "No changes identified". Therefore, no sampling is required at both TE and TEFF in **2017** ("Year +2").
- Note that all 2016 NF data would be assessed separately to determine if sampling is required at MF areas in 2017 (i.e., the assessment of NF results occurs on an annual basis).

2.3.4. Sampling Components

CREMP monitoring has included the following components in one or more years since 2006: limnology, water chemistry, sediment chemistry, phytoplankton, periphyton, benthic invertebrates, and zooplankton. Fish are included in the EEM and MMER program as a component in the AEMP. Limnology, water chemistry, sediment chemistry, phytoplankton, and benthic invertebrates have been conducted each year and are the core of the program. Periphyton was included in the first few years of monitoring to characterize natural communities in the Meadowbank lakes to help interpret habitat-related monitoring of the dike faces; while it is still included in habitat monitoring, it has not been included in CREMP monitoring since 2008. Zooplankton was initially excluded from the CREMP due to the influences of high variability (AEMP, 2005).

As part of a two-year consultative process to ensure that the program was meeting its intended goal of protecting the aquatic receiving environment, the study design of the CREMP was formally reviewed, culminating in the preparation of the CREMP Design Document 2012 (Azimuth, 2012a). In the interest of transparency, this review included zooplankton (based on data collected in 2010 and 2011) and periphyton to formally assess their suitability as monitoring components in the CREMP.

The CREMP Design Document 2012 (Azimuth, 2012a) included recommendations on each component with regards to sample timing, frequency, and number of samples required (sampling effort). These recommendations (which were subsequently approved) were derived from statistical testing (using the BACI or BA framework) and used power analysis to determine the adequacy of statistical power to detect a change in a particular variable from baseline levels to the relevant trigger value. The review supported the initial decisions regarding zooplankton and periphyton, as both had low statistical power to detect effects for these components. Note that both these tools may have a role in more targeted studies, if warranted for specific issues.

2.3.5. Sampling Effort and Frequency

As mentioned above in **Section 2.3.4**, the CREMP Design Document 2012 (Azimuth, 2012a) also made recommendations on sampling effort (i.e., number of replicates per event) and frequency (i.e., number of events per year). The following details for each component were approved by regulators:

- *Water chemistry* – data should be collected for up to 6 months (events) per year, recognizing that in any given year there may be logistical constraints (e.g., snow and ice conditions). Sampling should be limited to open-water months only for PDL and for the Baker Lake areas. It is recommended that two randomly located samples be collected at each area in each month (event). In addition to the core water chemistry program, basic limnology data should be collected at key near-field areas (TPN, TPE, SP, and WAL) at least once mid-winter to reduce uncertainty regarding the potential occurrence of changes over winter.
- *Sediment chemistry* – grab samples should be collected once per year, synoptically with benthic invertebrates, to ensure collection of basic physical variables (e.g., particle size and organic carbon) which may affect benthic invertebrates. Coring samples should be collected at sampling frequency of approximately every three years. Core samples should be collected during open-water at all potentially impacted areas as well as INUG and BAP (reference areas). Ten independent samples per impact area should be collected, but only 5 should be submitted for analysis as a first cut. Collecting 5 independent replicate samples at the reference areas is sufficient as changes are assessed using a BA (before-after) design (i.e., as temporal changes in sediment chemistry are not expected to occur naturally in these low sedimentation environments).
- *Phytoplankton* – data should be collected whenever the water chemistry data are collected, but only the open-water samples need to be analyzed while it is recommended that the other samples be archived. As per water chemistry, it is recommended that two randomly located samples be collected at each area in each month (event).
- *Benthic Invertebrates* – data should be collected once per year in August at all areas, with 5 samples per area.

After 2012, these recommendations were approved and put into place and continue to be part of the routine CREMP. However, as time progresses towards the end of mine life, and mining activities change or decrease through late operations, closure and post-closure phases, there is a rationale for a

corresponding decrease in sampling effort and frequency as monitoring will put greater emphasis on pit flooding (as discussed in **Section 2.3.3**).

Table 2-2. Status of all CREMP areas since the beginning of monitoring.

	Meadowbank Areas									Baker Lake Areas			
	REF	REF	NF	NF	NF	NF	MF	MF	FF	REF	REF	NF	NF
Year	INUG	PDL	TPN	SP	TPE	WAL	TPS	TE	TEFF	BAP	BES	BBD	BPJ
2006	C		C	C	C	C	C	C					
2007	C		C	C	C	C	C	C					
2008	C		C	I (Aug)	C	C	C	I (Aug)		C		I	I
2009	C	C	I (Mar)	I	I (Aug)	C	C	I	C	C		I	I
2010	C	C	I	I	I	C	C	I	C	C		I	I
2011	C	C	I	I	I	C	C	I	C	C	C	I	I
2012	C	C	I	I	I	C	C	I	C	C	C	I	I
2013	C	C	I	I	I	I (Jul)	C	I	C	C	C	I	I
2014	C	C	I	I	I	I	C	I	C	C	C	I	I
2015	C	C	I	I	I	I	C	I	C	C	C	I	I

Notes: Area designations: C=Control; I=Impact; REF=reference (in grey shading); NF=near-field (in blue shading); MF=mid-field (in pink shading); FF=far-field (in teal shading); Blank denotes that the area was not part of the monitoring program that year. Area IDs: INUG=Inuggugayualik Lake; PDL=Pipedream Lake; TPN, TPE, TPS=Third Portage Lake - North, East, South basins; SP=Second Portage Lake; WAL=Wally Lake; TE, TEFF=Tehek Lake – Mid-field and Far-field; BAP, BES, BBD, BPJ=Baker Lake - Akilahaarjuk Point, East Shore, Barge Dock, Proposed Jetty.

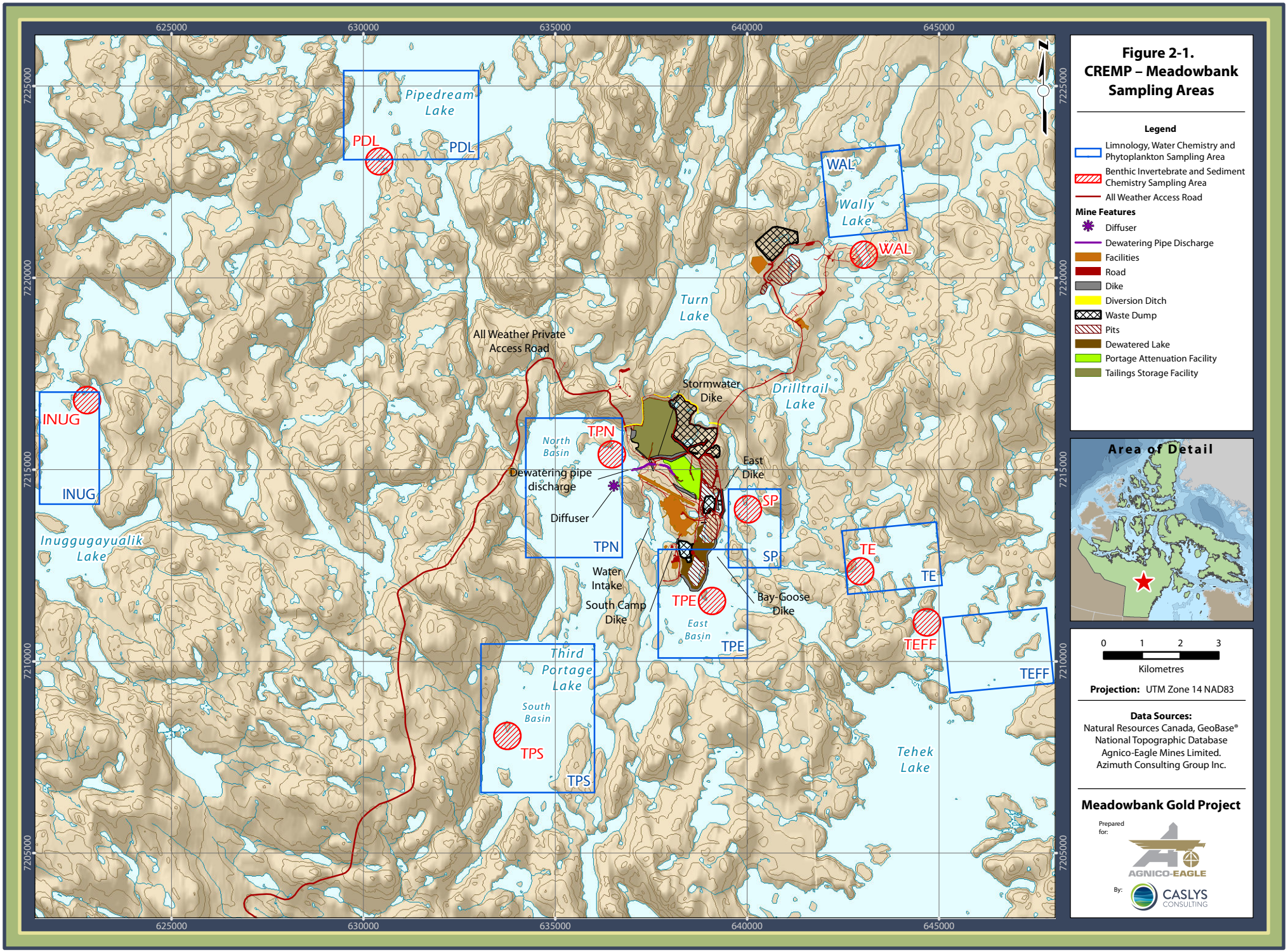


Figure 2-1. CREMP – Meadowbank Sampling Areas

Legend

- Limnology, Water Chemistry and Phytoplankton Sampling Area
- Benthic Invertebrate and Sediment Chemistry Sampling Area
- All Weather Access Road

Mine Features

- Diffuser
- Dewatering Pipe Discharge
- Facilities
- Road
- Dike
- Diversion Ditch
- Waste Dump
- Pits
- Dewatered Lake
- Portage Attenuation Facility
- Tailings Storage Facility

Area of Detail

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

Legend

- Limnology, Water Chemistry and Phytoplankton Sampling Area
- Benthic Invertebrate and Sediment Chemistry Sampling Area
- All Weather Access Road

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 2-2.
CREMP – Baker Lake Sampling Areas

Meadowbank Gold Project

Prepared for: AGNICO-EAGLE

By: CASLYS CONSULTING

Figure 2-3. Annual results-based sampling strategy rules for mid-field and far-field sampling areas.

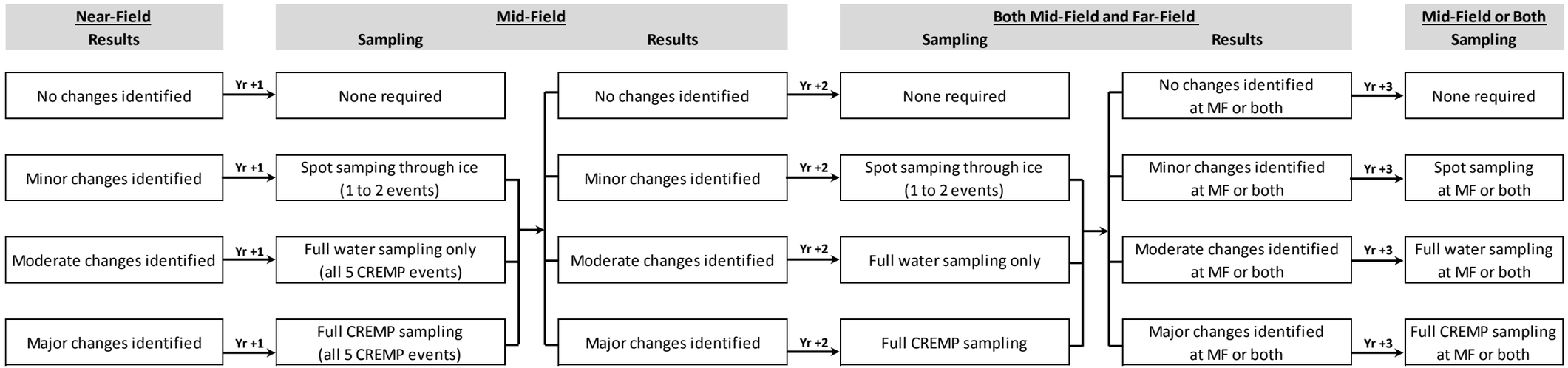
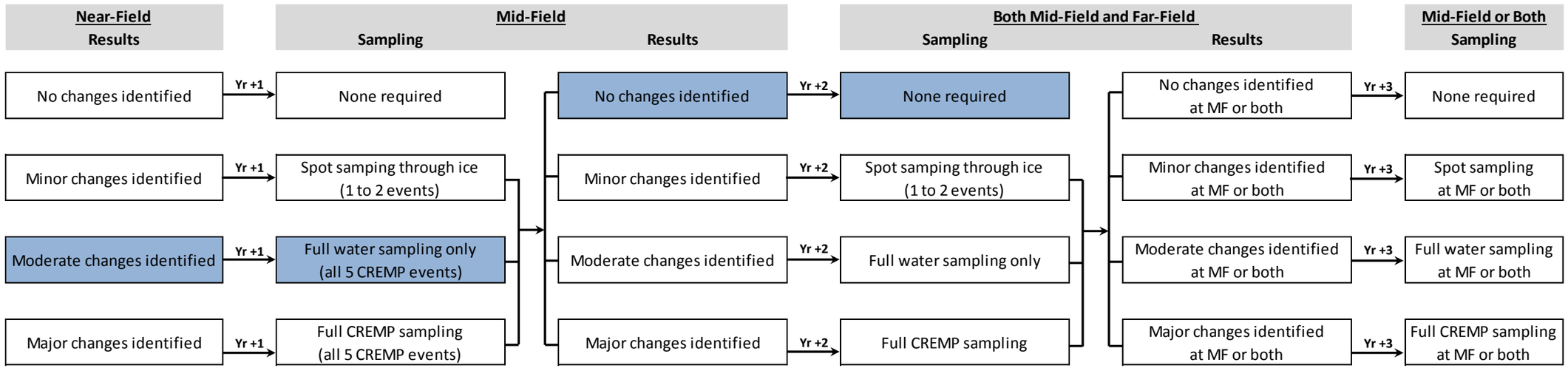


Figure 2-4. Worked example using the annual results-based sampling strategy rules for mid-field and far-field sampling areas.



Notes: The worked example follows a scenario which is highlighted in blue shading; each step and outcome is explained in text, see **Section 2.3.3**.

2.4. Sampling Methods

A summary of timing and frequency of sampling for each of the CREMP monitoring components is shown in **Table 2-3** by sampling season and month.

Sampling for the CREMP program is undertaken according to the Standard Operating Procedures (SOPs) for each of the monitoring components. The SOPs are appended herein and include general information on field collections, as well as detailed information on the location and timing of sampling, pre-trip planning, field collection materials, field quality assurance / quality control protocols, step-by-step instructions on sample collection, bottle requirements and list of parameters, sample preservation, and sample handling and transportation.

In accordance with the sampling strategy presented in **Section 2.3.3**, sampling frequency *may* be reduced or dropped altogether at MF and/or FF areas depending on the results of the paired NF areas.

2.4.1. Limnology, Water Chemistry and Phytoplankton

Sampling procedures for limnology, water chemistry, and phytoplankton are addressed together in one SOP (**Appendix A**). A brief overview is given below.

During each sampling event, limnology data, water chemistry samples, and phytoplankton samples are collected concurrently from two locations in each sampling area. These sampling locations are selected randomly for each sampling event from within the larger marked areas (blue rectangles) shown in **Figure 2-1** and **Figure 2-2**. This selection is done by bounding the sample areas and using a random number generator to select coordinates within those bounds. Coordinates are then recorded in MapSource and in the hand-held GPS units (NAD 83) before going out into the field. Selecting coordinates on a map does not ensure suitable locations in the field and occasionally field crew will move the sampling location away from shore to ensure a depth of at least 5 m is obtained.

Limnological parameters include a secchi depth measurement and vertical profiling for temperature (°C), dissolved oxygen (mg/L), specific conductivity (µS/cm), and pH at every meter from surface to 1 m off the bottom (or up to 20 m) using the YSI Professional Plus meter. If, during an open-water sampling month (July-September), a vertical profile shows abnormally low dissolved oxygen, or abnormally high conductivity or temperature for a particular depth, then a water chemistry sample is collected from that depth and analysed alongside the other water chemistry samples (see below). A description of the acceptable ranges for each of these limnological parameters for NF areas only is included in Table 3 of **Appendix A**.

Water chemistry samples are collected from approximately 3 m depth[3] by pumping lake water through a flexible (food-grade silicone) tube using a 12-V diaphragm pump. Water is pumped directly into sample bottles or first through a high-capacity 45-µm inline filter for dissolved parameters (all sample bottle and preservative requirements are listed in Table 1 of **Appendix A**). Water chemistry parameters include physical tests, anions and nutrients, organic and inorganic carbon, chlorophyll-a, cyanide, and total and dissolved metals. A full detailed list of parameters is shown in Table 2 of **Appendix A**.

Phytoplankton samples are collected from the same depth (3 m) and pump system used for water chemistry samples, prior to attaching a filter. Samples are preserved with a few drops of Lugol's solution and sent for taxonomic identification and biomass analyses.

[3] This depth was selected to provide a consistent depth at which to sample during any season, including during winter months when ice thickness can exceed 2 m.

2.4.2. Benthic Invertebrates and Sediment Grab Chemistry

Sampling procedures for benthic invertebrates and sediment grab chemistry are addressed together in one SOP (**Appendix B**). A brief overview is given below.

During the August sampling event only, benthic invertebrates and sediment chemistry grab samples are collected concurrently from five locations (replicates) in each sampling area. These sampling locations are selected in the field using a target depth range of 6.5-9.5 m each year from within the small marked areas (red hatched circles) shown in **Figure 2-1** and **Figure 2-2**. The depth zone is limited to this fairly narrow range to reduce the influence of depth-related variability on the analyses.

Benthic invertebrates are collected first in the sequence, using a Petite Ponar grab (0.023 m^2) and a 500-µm sieve. Two independent grabs per replicate are composited to form a single sample to reduce sampling variation within areas and to increase the surface area sampled. Samples are preserved in the field with a 10% buffered formalin solution and sent for taxonomic identification and analysis.

Sediment grab chemistry samples are collected second in the sequence, from the same depth and grab sampler used for benthic invertebrates. The top 3-5 cm of sediment from two independent grabs per replicate are homogenized in a bowl. Sediment is scooped into sample jars for the following chemistry parameters: physical tests, particle size, organic carbon, and metals. Another scoop of sediment is set aside from each of the 5 replicate locations, homogenized and placed into a sample jar for the following chemistry parameters: aggregate organics, hydrocarbons, and polycyclic aromatic hydrocarbons (PAHs). A full detailed list of parameters is shown in Table 1 of **Appendix B**.

2.4.3. Sediment Coring Chemistry

Sampling procedures for sediment coring chemistry are presented in **Appendix C**. A brief overview is given below.

Sediment coring is only conducted every three years to match monitoring for EEM field studies. In a coring year, samples are collected during the August sampling event only, and collected concurrently with benthic invertebrates and sediment grab chemistry. Core sediment samples are collected prior to benthic invertebrate grab sampling and use the same general sampling area (and depths). However, an additional five locations (replicates) are sampled in each sampling area, for a total of 10 coring replicate samples. While 10 independent replicates are collected from each area, in some cases, only five cores are sent for analysis. This decision is based on whether acceptable statistical power can be achieved from only 5 samples (i.e., as predicted by the CREMP Design Document 2012 [Azimuth, 2012a]).

Sediment cores are collected using a hand-operated gravity corer (barrel diameter of 7 cm). The top 1.5 cm of sediment from one independent core per replicate is sampled. Sediment is transferred into a sample jar for the following chemistry parameters: pH, total organic carbon, and metals.

Table 2-3. CREMP monitoring component sampling summary for Meadowbank and Baker Lake.

Sampling Season	Sampling Month	Sampling Crew	Monitoring Conditions	Monitoring Components	Meadowbank Areas									Baker Areas			
					INUG	PDL	TPN	SP	TPE	WAL	TPS	TE	TEFF	BAP	BES	BBD	BPJ
					REF	REF	NF	NF	NF	NF	MF	MF	FF	REF	REF	NF	NF
Winter	January	AEM	Ice	L			✓	✓	✓	✓							
	February	AEM	Ice	L			✓	✓	✓	✓							
	March	AEM	Ice	L			✓	✓	✓	✓							
Spring	April or May	AEM	Ice	L,W,P	✓		✓	✓	✓	✓		?					
	June		***Ice not safe***														
Summer	July	AEM	Open-water	L,W,P	✓	✓	✓	✓	✓	✓	?	?	?	✓		✓	✓
	August	Azimuth	Open-water	L,W,P	✓	✓	✓	✓	✓	✓	?	?	?	✓		✓	✓
				B,S,C*	✓	✓	✓	✓	✓	✓	?	?	?	✓	✓	✓	✓
	September	AEM	Open-water	L,W,P	✓	✓	✓	✓	✓	✓	?	?	?	✓		✓	✓
Autumn	***October***		***Ice not safe***														
	November or December	AEM	Ice	L,W,P	✓		✓	✓	✓	✓		?					

Notes: Components: L=Limnology; W=Water chemistry; P=Phytoplankton; B=Benthic invertebrates; S=Sediment grab chemistry; C=Sediment coring chemistry. *Sediment coring is conducted to match the timing of EEM field studies program (i.e., in 2014, 2017, 2020…). Area IDs: TPN, TPE, TPS=Third Portage Lake - North, East, South basins; SP=Second Portage Lake; TE, TEFF=Tehek Lake – Mid-field and Far-field; WAL=Wally Lake; INUG=Inuggugayualik Lake; PDL=Pipedream Lake; BBD, BPJ, BAP, BES=Baker Lake - Barge Dock, Proposed Jetty, Akilahaarjuk Point, East Shore. Area types: REF=reference (in grey shading); NF=near-field (in blue shading); MF=mid-field (in pink shading); FF=far-field (in teal shading). ✓ indicates that monitoring components are conducted at the area/month given. ? indicates that sampling frequency *may* change from what is shown in this table for any mid-field and/or far-field areas if the sampling strategy is used to reduce sampling frequency for these areas.

2.5. Quality Assurance/Quality Control

The objective of quality assurance / 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, have sufficient laboratory precision to be highly repeatable, are properly documented, and are scientifically defensible. Data quality was assured throughout the collection and analysis of samples using specified standardized procedures, by the employment of laboratories that have been certified for all applicable methods, and by staffing the program with experienced technicians.

2.5.1. Water Chemistry

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. The laboratory duplicate is a new aliquot from the sample bottle/jar and is analyzed from the start in the same manner as the original aliquot taken from the bottle/jar. Also, Certified Reference Materials (CRM) are always included as part of routine laboratory QA/QC. The full list of laboratory DQOs for each parameter are presented in **Appendix A**.

Field QA/QC: The standard QA/QC procedures include thoroughly flushing the flexible tubing and pump to prevent cross-contamination between areas and thoroughly rinsing the sample containers with site water prior to sample collection. Field QA procedures include collection and/or analysis of the following:

- *Field Duplicates* – An independent collection of water samples at the same time and location as the original, as a measure of consistency in sampling methodology and heterogeneity of chemical parameters at discrete locations. The number of field duplicates taken is approximately 10% of original samples.
- *Travel Blanks* – Laboratory supplied bottles of distilled water that are transported to site, carried back and forth into the field and returned to the laboratory, unopened, to test for inadvertent contamination during the transport and field sampling process.
- *Equipment Blanks* – At the beginning or end of a field sampling episode, after routine rinsing of the pump and tubing, distilled water is run through the equipment and placed in sampling bottles for analysis of a wide suite of parameters (e.g., metals, nutrients, and conventionals). This sample tests for possible cross-contamination of samples from the water sampling equipment.

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 laboratory method detection limits (MDLs).

Quality assurance results of the laboratory and field duplicates are assessed by measuring the relative percent difference (RPD) between original and duplicate measurements as measure of precision by the laboratory and the magnitude of variability between original and field duplicate samples respectively. The equation used to calculate a RPD is:

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

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

The DQOs for CREMP monitoring are:

- Laboratory Duplicate = 20% RPD (for most parameters; see Table 2 of **Appendix A** for a list of RPDs for all parameters) for concentrations that exceed 10 x MDL.

- Field Duplicate = 50% RPD for concentrations that exceed 10 x MDL.

RPD values may be either positive or negative, and ideally should provide a mix of the two, clustered around zero. 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.

2.5.2. Sediment Chemistry

Laboratory QA/QC: Laboratory duplicates are also conducted for sediment chemistry parameters, similar to water chemistry parameters. The DQO for laboratory duplicate samples is based on an RPD of 20-50% (see Table 1 of **Appendix B** for a list of RPDs for all parameters) for concentrations that are >10 x MDL. The full list of laboratory DQOs for each parameter are presented in **Appendix B**.

Field QA/QC: Field QA/QC standards during sediment sampling consisted of taking care between sampling areas, by rinsing and cleaning the sampling gear for sediment grabs (Petite Ponar grab, stainless steel compositing bowls and spoons) and sediment cores (corer and spatula) using site water and phosphate-free cleaning detergent, avoids the possibility of cross-contamination. Field QA procedures include collection and/or analysis of the following:

- *Field Duplicates* – Field duplicate samples are collected in the immediate vicinity of original samples from randomly selected locations as a test of consistency in field methodology and to characterize heterogeneity of sediment chemistry within discrete areas. The number of field duplicates taken is approximately 10% of original samples. The DQO for field duplicate samples is based on an RPD of 50% for concentrations that are >10 x MDL.
- *Filter Swipes* – Metals analysis is conducted on an ashless filter that is swiped over the pre-cleaned bowl for 10% of the samples 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 comparisons were required, the concentration of metals originating from any equipment was estimated by dividing the amount detected on the filter (weight) by the surface area of 2 Petite Ponar grabs (assuming a thickness of 3 cm was collected from each), that was multiplied by the density of sediment (assumed to be 2 g/cm^3).

2.5.3. Phytoplankton

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 laboratory QA/QC on the enumeration method, replicate counts are performed on 10% of the samples. Replicate samples are chosen at random and processed at different times from the original analysis to reduce biases. The laboratory replicate is a new aliquot (10 ml) from the sample jar and is counted from the start in the same manner as the original aliquot (10 ml) taken from the jar.

2.5.4. Benthic Invertebrates

Field replicates (5 per area) are collected for benthos to determine natural variability and heterogeneity. Replicates are collected at least 20 m apart from one another, within the defined sampling areas.

The laboratory (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, and re-counted, targeting >90% recovery;
- Precision and accuracy estimates are calculated;
- A voucher collection is compiled;
- Sorted sediments and debris are re-preserved in 10% formalin and are retained for up to three months. For samples subject to subsampling, sorted and unsorted fractions are re-preserved separately.

2.6. Data Evaluation Criteria

The specific methods used to develop triggers and thresholds are described in detail in the CREMP Design Document 2012 (Azimuth, 2012a). Since 2012, the water chemistry triggers/thresholds were updated in 2013, with minor updates in 2014, to include more recent monitoring data, to reflect new thresholds (e.g., adopted from other jurisdictions where not covered by CCME), or to add field pH triggers. These updates have been prepared as an amendment to Appendix A of the CREMP Design Document 2012 (Azimuth, 2012a), were included in the 2014 CREMP report (Azimuth, 2015), and are provided in **Appendix D** for completeness.

The specific methods used to apply triggers/thresholds in the evaluation of CREMP monitoring parameters vary by variable group; details are presented in the following sections. As discussed in **Section 2.3.1**, the evaluation process focuses on comparisons to early warning triggers; only when triggers are exceeded are monitoring results compared to thresholds. Consequently, methods for applying numerical decision criteria focus on triggers only, but apply equally to threshold values.

It is important to note that trigger values (and threshold values) may be exceeded for reasons unrelated to mining activity. For example, trigger values for parameters derived in the absence of effects-based thresholds (or where such thresholds were already exceeded prior to mine development) are set at the 95th percentile of the background data; we would expect 5% of values to exceed triggers naturally, in the absence of any mine-related changes. Thus, to avoid making false positive errors (i.e., characterizing a change or difference as mine-related when it is not), when triggers are exceeded we compare the observed pattern of change to our expectations of a mine-related effect (e.g., we would generally expect to see a gradient with NF>MF>FF); where a pattern was absent (e.g., an increase only seen at a FF area), the observed change is inferred as unrelated to mining activity. Thus, it is important to realize that trigger exceedences do not necessarily mean that mine-related changes have occurred. Rather, they highlight cases that should be looked at more closely to determine the most plausible.

2.6.1. Water Chemistry

As discussed in the CREMP Design Document 2012 (Azimuth, 2012a) while monthly mean values are compared to trigger values to identify short-term, episodic exceedences in water chemistry parameters, formal application of the trigger for decision-making purposes is to the yearly mean for each sampling area. Current thresholds and trigger values for Meadowbank, Wally, and Baker Lakes are shown in **Table 2-4** (total metals), **Table 2-5** (dissolved metals), and **Table 2-6** (nutrients and conventional parameters).

The hierarchical process for water chemistry variables is as follows (implemented separately for Meadowbank lakes and Baker Lake, for which triggers were independently derived [Azimuth, 2012a]):

1. *Computation of Yearly Means* – monthly means calculated first for each parameter, then yearly means on an area-specific (i.e., lake or basin-specific) basis. Note that values < MDL are conservatively set equal to the MDL.
2. *Comparisons of Yearly Means to Triggers* – yearly means for each sampling area are compared to the triggers to identify all cases for which the mean equals or exceeds the trigger.
3. *Statistical Testing of Yearly Means Exceeding Triggers* – cases where the yearly means exceed the triggers are formally tested using statistical analyses; this process is conducted differently for Meadowbank lakes and Baker Lake:

   Meadowbank Lakes

   - Before-After-Control-Impact statistical framework with multiple paired "before" and "after" period events (BACIP) is applied.
   - INUG is used as the reference ("control") area; the other areas are tested as exposure ("impact") areas. Neither PDL nor TEFF can be utilized as controls for BACIP as no data exists for 2006 – 2008 for these areas[4]. Instead, these areas are used to compare reference and exposure area data patterns.
   - True "pre-impact" data (i.e., when both INUG and the test area had "control" ("C") status; see **Table 2-2**) are used for the "before" data; the data for the year being tested (e.g., 2015) are used as the "after" data (only events when both INUG and the test area were sampled).
   - All data are log-transformed (natural logs). Thus, the exponent of the BACI interaction term coefficient provides the proportional change in the year being tested (e.g., 2015) relative to the "before" period.
   - One-tailed tests of the null hypothesis (i.e., that test areas experienced no relative change) are conducted; the alternative hypothesis is a relative increase in a parameter at the test area.

   Baker Lake (where different from above)

   - Baker Lake areas are designated as "control" or "impact" when sampling started in 2008 (i.e., there was no detailed baseline sampling was conducted for Baker Lake; see **Table 2-2**), so there are no true "pre-impact" "before" data. While a spatial "CI" design could be used to test for differences between reference "control" and exposure "impact" areas, the design does not allow for distinguishing natural differences between areas from development-related changes. Rather, since no development-related changes have been identified to date, all years of data up to and including the year prior to the year being tested (e.g., 2014) are considered "before" and the year being tested (e.g., 2015) data as "after" period data (i.e., allowing the more robust BACIP analysis). Thus, while the trend plots are used to assess temporal trends at the "impact" areas since monitoring started, the BACIP analyses specifically looks at changes in the year being tested (e.g., 2015) at the two "impact" areas relative to previous years.
   - The Akilahaarjuk Point (BAP) area is used as the reference "control" area.

[4] This does not apply to WAL, which does have overlapping baseline data with both PDL and TEFF. That said, effects relative to PDL and TEFF will only be looked at to provide additional context should changes be identified at WAL relative to INUG.

In addition to the trigger/threshold evaluation, annual CREMP water chemistry data will now also be compared to the maximum whole lake average water quality predictions (shown in **Table 2-7**) for Third Portage, Second Portage, and Wally Lakes from modelling conducted during the environmental assessment process (Cumberland, 2005a). While direct comparisons will be made, the difference in spatial focus (i.e., the CREMP at the basin scale and the water quality model at the lake scale) warrants caution interpreting any differences. To that end, the significance criteria used to assess changes in water quality (Cumberland, 2005a) will be used to provide the appropriate context for interpreting the results.

Annual CREMP reporting includes a process to streamline the interpretation process. Many water quality parameters have concentrations that are routinely below laboratory MDLs, thus providing little insight into the assessment of mine-related changes to water quality. We use a conservative three-step screening process to identify parameters for inclusion into the formal trend assessment:

1. *Overall Detection Frequency* - Only those water quality parameters that exceeded MDLs in at least 10% of the samples were included in this discussion. Because the project lakes are ultra-oligotrophic, it is normal for many parameters to routinely be below MDLs.
2. *Control-Impact Detection Frequency Comparison* – In order to avoid screening out infrequently detected parameters that were detected more often in association with mining activities, the proportion of samples exceeding MDLs between "control" and "impact" samples were compared; the intent of this screen was to identify parameters with <10% detection frequency (i.e., those screened out above) for which there were detection frequency changes potentially associated with mining activity (i.e., where the proportion of detected values increased by 0.1 or more).
3. *Apparent Detection Pattern Matching Mining Activity* – In order to avoid screening out infrequently detected parameters that may be associated with mining activities, trend plots were used to identify parameters with measured values associated with periods/locations of known mining activities. Where such patterns were observed, or where parameters were measured at > 5x MDL at near-field sampling areas in at least one event, these parameters were added back into the trend assessment process.

2.6.2. Sediment Chemistry

As discussed in the CREMP Design Document 2012 (Azimuth, 2012a), the sediment coring samples are used to screen against trigger values. In years when sediment cores are collected, the core chemistry results are compared to site-specific triggers/thresholds and cases where means exceed triggers are formally tested using a before-after (BA) statistical model. In years when only sediment grabs are collected, the approach to describing trends is purely visual. Methods for years when sediment cores are collected, which did not vary between the Meadowbank lakes and Baker Lake, are as follows:

1. *Computation of Yearly Means* – the sediment coring data for the year being tested (e.g., 2014) are used to calculate means for each parameter at each sampling area. Note that values < MDL are conservatively set equal to the MDL.
2. *Comparisons of Yearly Means to Triggers* – yearly means for core samples from each sampling area are compared to the triggers to identify all cases for which the mean equals or exceeds the trigger.
3. *Statistical Testing of Yearly Means Exceeding Triggers* – cases where the yearly means exceed the triggers are formally tested using statistical analyses. Unlike water chemistry, as sediment concentrations are not expected to vary annually due to climatic changes, a "before" – "after" (BA) analysis is used to test for temporal differences at each exposure "impact" area. Sediment is

inherently much more variable than water however, and greater natural variability is to be expected.

2.6.3. Phytoplankton

As discussed in the CREMP Design Document 2012 (Azimuth, 2012a), triggers and thresholds are set to relative changes (increases or decreases of 20% and 50%, respectively) in total biomass and species richness at test areas using the BACIP framework (i.e., paired monthly sampling events at "control" [INUG or BAP] and "impact" [i.e., NF or MF areas] areas over two periods ["before" and "after"], with "months" as the unit for temporal replication). The evaluation procedure is analogous to that used for water chemistry, except that area means for the year being tested (e.g., 2015) are not directly comparable to triggers (i.e., since the triggers/thresholds are based on the relative change over time in a parameter rather than on a finite value), so the process started with the BACIP testing. Two-tailed tests of the null hypothesis (i.e., that test areas experienced no relative change up or down) are conducted.

2.6.4. Benthic Invertebrates

Similar to phytoplankton, triggers and thresholds are set to relative changes (decreases of 20% and 50%, respectively) in total biomass and species richness at test areas using the BACI framework. As discussed in the CREMP Design Document 2012 (Azimuth, 2012a), statistical power increases with consideration of more "after" period years (Note: benthic invertebrates are sampled yearly in August). Consequently, BACI analyses (analogous to phytoplankton, except that unit of temporal replication is "years" instead of "months") are conducted on four "after" data period lengths: one year (e.g., 2015 only), two years (e.g., 2014-2015), three years (e.g., 2013-2015), and four years (e.g., 2012-2015).

Similar to water chemistry (**Section 2.6.1**), there is no baseline benthic community data for Baker Lake, so there are no true "pre-impact" "before" data. While a spatial "CI" design could be used to test for differences between reference "control" and exposure "impact" areas, the design does not allow for distinguishing natural differences between areas from development-related changes. Rather, since no development-related changes have been identified to date, the temporal scenarios for Baker Lake use all the data (e.g., 2015 is compared to 2008 – 2014; 2014/2015 is compared to 2008 – 2013…and so on).

Table 2-4. Total metals: summary of thresholds and of trigger values for Meadowbank, Wally and Baker Lakes' water quality.

			Meadowbank						**Wally**						**Baker**					
Variable	Threshold	DL	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M
Aluminum (T)	0.1	0.003	204	169	0.007	0.014	0.054	A	34	23	0.006	0.011	0.053	A	31	30	0.011	0.023	0.056	A
Antimony (T)	0.02	0.0001	204	0	NA	NA	0.010	A	34	0	NA	NA	0.010	A	31	0	NA	NA	0.010	A
Arsenic (T)	0.005	0.0001	204	14	NA	NA	0.0026	A	34	14	0.00025	0.00029	0.0026	A	31	4	0.00015	NA	0.0026	A
Barium (T)	1.0	0.00005	204	79	0.0021	0.0030	0.50	A	34	14	0.0019	0.0030	0.50	A	31	14	0.0177	0.0196	0.51	A
Beryllium (T)	0.0053	0.0001	204	0	NA	NA	0.0027	A	34	0	NA	NA	0.0027	A	31	0	NA	NA	0.0027	A
Boron (T)	1.5	0.01	204	1	NA	NA	0.76	A	34	0	NA	NA	0.76	A	31	3	0.011	0.011	0.76	A
Cadmium (T)	0.00004	0.00001	204	10	NA	NA	0.000025	A	34	1	NA	NA	0.000025	A	31	0	NA	NA	0.000025	A
Chromium (T)	0.001	0.0001	204	14	0.00011	0.00046	0.00056	A	34	0	NA	NA	0.00055	A	31	2	NA	NA	0.00055	A
Copper (T)	0.002	0.0005	204	61	0.00047	0.00068	0.00124	A	34	16	0.00098	0.00129	0.00149	A	31	11	0.00049	0.00060	0.00125	A
Iron (T)	0.3	0.01	204	26	NA	NA	0.155	A	34	6	0.015	0.025	0.157	A	31	9	0.020	0.063	0.160	A
Lead (T)	0.001	0.00005	204	7	NA	NA	0.00053	A	34	2	NA	0.00015	0.00053	A	31	1	NA	NA	0.00053	A
Lithium (T)	0.096	0.0005	204	6	0.00042	0.00063	0.048	A	34	2	0.00085	NA	0.048	A	31	6	0.0010	0.0036	0.048	A
Manganese (T)	See text	0.00005	204	198	0.0013	0.0043	0.316	A	34	34	0.0014	0.0020	0.330	A	31	31	0.0024	0.0038	0.340	A
Mercury (T)	0.000026	0.00001	204	1	NA	NA	0.000018	A	34	0	NA	NA	0.000018	A	31	0	NA	NA	0.000018	A
Molybdenum (T)	0.073	0.00005	204	5	NA	NA	0.037	A	34	3	0.00013	0.00019	0.037	A	31	4	0.00008	NA	0.037	A
Nickel (T)	0.025	0.0005	204	8	0.0005	0.0007	0.013	A	34	0	NA	NA	0.013	A	31	0	NA	NA	0.013	A
Selenium (T)	0.001	0.0001	204	0	NA	NA	0.00055	A	34	0	NA	NA	0.00055	A	31	0	NA	NA	0.00055	A
Strontium (T)	0.049	0.0002	192	188	0.0068	0.0095	0.028	A	32	32	0.016	0.022	0.033	A	31	31	0.025	0.056	0.056	B
Thallium (T)	0.0008	0.00001	204	0	NA	NA	0.00041	A	34	0	NA	NA	0.00041	A	31	0	NA	NA	0.00041	A
Tin (T)		0.0001	204	2	NA	NA	0.0002	C	34	0	NA	NA	0.0002	C	31	0	NA	NA	0.0002	C
Titanium (T)	2.0	0.01	204	14	0.00016	0.00044	1.0	A	34	3	0.00013	0.00049	1.0	A	31	4	0.00038	NA	1.0	A
Uranium (T)	0.015	0.00001	204	20	0.00004	0.00006	0.0075	A	34	2	0.00004	NA	0.0075	A	31	4	0.00005	NA	0.0075	A
Vanadium (T)	0.006	0.001	204	0	NA	NA	0.0035	A	34	0	NA	NA	0.0035	A	31	0	NA	NA	0.0035	A
Zinc (T)	See text	0.003	204	4	NA	NA	0.0063	A	34	2	NA	NA	0.0106	A	31	0	NA	NA	0.0132	A

Notes: For each variable, thresholds (guidelines) are shown if applicable (see **Appendix D** for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; Med = median if estimable; P95 = 95th percentile if estimable; M = method used to determine the trigger, where A = halfway from median (or DL if median not estimable) to threshold, B = 95th percentile, and C = 2*DL.

Table 2-5. Dissolved metals: summary of thresholds and of trigger values for Meadowbank, Wally and Baker Lakes' water quality.

			Meadowbank						**Wally**						**Baker**					
Variable	Threshold	DL	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M
Aluminum (D)	0.05	0.001	164	69	0.003	0.005	0.026	A	27	13	0.003	0.006	0.026	A	28	17	0.005	0.006	0.027	A
Antimony (D)	0.02	0.0001	164	0	NA	NA	0.010	A	27	0	NA	NA	0.010	A	28	0	NA	NA	0.010	A
Arsenic (D)	0.005	0.0001	164	12	NA	NA	0.0026	A	27	13	0.00024	0.00034	0.0026	A	28	6	0.00012	0.00024	0.0026	A
Barium (D)	1.0	0.00005	164	79	0.0020	0.0029	0.50	A	27	13	0.0018	0.0030	0.50	A	28	14	0.0178	0.0200	0.51	A
Beryllium (D)	0.0053	0.0001	164	0	NA	NA	0.0027	A	27	0	NA	NA	0.0027	A	28	0	NA	NA	0.0027	A
Boron (D)	1.5	0.01	164	0	NA	NA	0.76	A	27	0	NA	NA	0.76	A	28	0	NA	NA	0.76	A
Cadmium (D)	0.00004	0.00001	164	3	NA	NA	0.000025	A	27	0	NA	NA	0.000025	A	28	0	NA	NA	0.000025	A
Chromium (D)	0.001	0.0001	164	1	NA	NA	0.00055	A	27	0	NA	NA	0.00055	A	28	1	NA	NA	0.00055	A
Copper (D)	0.002	0.0002	164	77	0.00038	0.00049	0.00119	A	27	15	0.00087	0.00148	0.00148	B	28	13	0.00033	0.00044	0.00116	A
Iron (D)	0.3	0.01	164	0	NA	NA	0.155	A	27	0	NA	NA	0.155	A	28	1	NA	NA	0.155	A
Lead (D)	0.001	0.00005	164	3	NA	NA	0.00053	A	27	2	NA	0.00015	0.000525	A	28	0	NA	NA	0.000525	A
Lithium (D)	0.096	0.0005	164	2	NA	0.00053	0.048	A	27	2	0.00099	NA	0.048	A	28	4	0.0008	NA	0.048	A
Manganese (D)	See text	0.00005	164	114	0.0004	0.0029	0.315	A	27	22	0.0004	0.0015	0.330	A	28	24	0.0006	0.0019	0.339	A
Mercury (D)	0.000026	0.00001	153	2	NA	NA	0.000018	A	25	0	NA	NA	0.000018	A	26	0	NA	NA	0.000018	A
Molybdenum (D)	0.073	0.00005	164	17	0.00010	0.00018	0.037	A	27	8	0.00011	0.00019	0.037	A	28	3	0.00006	NA	0.037	A
Nickel (D)	0.025	0.0005	164	6	NA	NA	0.013	A	27	1	NA	NA	0.013	A	28	0	NA	NA	0.013	A
Selenium (D)	0.001	0.0001	164	0	NA	NA	0.00055	A	27	0	NA	NA	0.00055	A	28	0	NA	NA	0.00055	A
Strontium (D)	0.049	0.002	164	161	0.0069	0.0090	0.028	A	27	27	0.016	0.023	0.033	A	28	28	0.023	0.049	0.049	B
Thallium (D)	0.0008	0.00001	164	0	NA	NA	0.00041	A	27	0	NA	NA	0.00041	A	28	0	NA	NA	0.00041	A
Tin (D)		0.0001	164	0	NA	NA	0.0002	C	27	0	NA	NA	0.0002	C	28	0	NA	NA	0.0002	C
Titanium (D)	2.0	0.01	164	0	NA	NA	1.0	A	27	0	NA	NA	1.0	A	28	0	NA	NA	1.0	A
Uranium (D)	0.015	0.00001	164	20	0.00003	0.00005	0.0075	A	27	2	0.00004	NA	0.0075	A	28	4	0.00004	NA	0.0075	A
Vanadium (D)	0.006	0.001	164	0	NA	NA	0.0035	A	27	0	NA	NA	0.0035	A	28	0	NA	NA	0.0035	A
Zinc (D)	See text	0.001	164	6	NA	0.0021	0.0053	A	27	2	NA	NA	0.0096	A	28	2	NA	0.0028	0.0122	A

Notes: For each variable, thresholds (guidelines) are shown if applicable (see **Appendix D** for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; Med = median if estimable; P95 = 95th percentile if estimable; M = method used to determine the trigger, where A = halfway from median (or DL if median not estimable) to threshold, B = 95th percentile, and C = 2*DL.

Table 2-6. Nutrients and conventional parameters: summary of thresholds and of trigger values for Meadowbank, Wally and Baker Lakes' water quality.

			Meadowbank						**Wally**						**Baker**					
Variable	Threshold	DL	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M
Ammonia-N	0.126	0.005	204	52	0.005	0.046	0.065	A	34	12	0.007	0.024	0.067	A	31	13	0.007	0.031	0.067	A
TKN		0.05	204	178	0.097	0.170	0.170	B	34	31	0.111	0.163	0.163	B	31	28	0.157	0.214	0.214	B
Nitrate-N	3.0	0.005	204	26	NA	0.025	1.503	A	34	2	NA	NA	1.503	A	31	26	0.014	0.030	1.507	A
Nitrite-N	0.06	0.001	204	6	NA	NA	0.031	A	34	2	NA	NA	0.031	A	31	2	NA	NA	0.031	A
Ortho-phosphate		0.001	192	10	NA	0.0010	0.0020	C	34	3	NA	0.0010	0.0020	C	31	5	0.0007	0.0013	0.0020	C
T. phosphorous	0.004	0.002	192	84	0.0019	0.0060	0.0060	B	34	21	0.0028	0.0067	0.0067	B	31	23	0.0036	0.0096	0.0096	B
TOC		0.5	204	204	1.74	2.79	2.79	B	34	34	2.18	4.11	4.11	B	31	31	3.16	4.25	4.25	B
DOC		0.5	204	204	1.70	2.60	2.60	B	34	34	2.20	3.21	3.21	B	31	31	3.17	4.05	4.05	B
Reactive silica		0.5	185	56	0.28	0.44	1.00	C	32	14	0.74	1.08	1.08	B	28	10	0.31	0.42	1.00	C
Bicarb. alkalinity		2.0	192	192	5.2	8.6	8.6	B	34	34	10.0	17.8	17.8	B	31	31	9.3	10.6	10.6	B
Chloride	120	0.1	204	141	0.550	0.809	60.3	A	34	15	0.469	0.639	60.2	A	31	31	24.4	95.7	95.7	B
Carb. alkalinity		2.0	192	0	NA	NA	4.0	C	34	0	NA	NA	4.0	C	31	0	NA	NA	4.0	C
Conductivity		2.0	204	204	15.2	23.5	23.5	B	34	34	28.7	36.6	36.6	B	31	31	110.0	494.5	494.5	B
Hardness		0.5	204	204	5.7	8.5	8.5	B	34	34	12.2	16.7	16.7	B	31	31	16.5	41.2	41.2	B
Calcium		0.5	204	204	1.30	2.15	2.15	B	34	34	3.34	4.88	4.88	B	31	31	3.02	4.50	4.50	B
Potassium		0.1	204	79	0.37	0.50	0.50	B	34	14	0.37	0.59	0.59	B	31	20	0.93	2.43	2.43	B
Magnesium		0.1	204	204	0.64	0.83	0.83	B	34	34	0.96	1.36	1.36	B	31	31	2.61	7.44	7.44	B
Sodium		0.05	204	79	0.55	0.98	0.98	B	34	14	0.48	0.72	0.72	B	31	31	12.1	54.0	54.0	B
Sulphate	128	0.5	204	204	1.42	2.83	64.7	A	34	34	2.34	3.38	65.2	A	31	31	3.84	13.80	65.9	A
pH Field (Upper)	9.0	0.1	174	174	7.24	8.25	8.25	B	32	32	7.67	8.26	8.34	A	26	26	7.41	8.32	8.32	B
pH Field (Lower)	6.5	0.1	174	174	7.24	6.30[a]	6.30	B	32	32	7.67	6.54[a]	6.54	B	26	26	7.41	6.50[a]	6.50	B
pH Lab (Upper)	9.0	0.1	204	204	6.89	7.27	7.94	A	34	34	7.35	7.44	8.17	A	31	31	7.21	7.66	8.11	A
pH Lab (Lower)	6.5	0.1	204	204	6.89	6.50[a]	6.50	B	34	34	7.35	7.00[a]	6.92	A	31	31	7.21	6.99[a]	6.86	A
Total Alkalinity		2.0	192	192	5.20	8.55	8.55	B	34	34	10.0	17.8	17.8	B	31	31	9.3	10.6	10.6	B
TDS		3.0	204	134	11.0	18.0	18.0	B	34	34	18.0	25.3	25.3	B	31	31	64.0	208.0	208.0	B
TSS	5.0	1.0	204	9	NA	NA	3.00	A	34	1	NA	NA	3.00	A	31	2	NA	NA	3.00	A

Notes: For each variable, thresholds (guidelines) are shown if applicable (see **Appendix D** for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; Med = median if estimable; P95 = 95th percentile if estimable; M = method used to determine the trigger, where A = halfway from median (or DL if median not estimable) to threshold, B = 95th percentile, and C = 2*DL.

Table 2-7. Predicted maximum whole lake water quality for Third Portage, Second Portage and Wally Lakes (from Cumberland, 2005a).

Lake	Simulated Maximum Whole Lake Concentration (mg/L)									
	Third Portage Lake[1]				Second Portage Lake[2]				Wally Lake[3]	
Model Scenario	Mid-range Mixing Estimate (92 Mm^3)		Upper Mixing Estimate (169 Mm^3)		Lower Mixing Estimate (92 Mm^3)		Upper Mixing Estimate (169 Mm^3)			
	Without Dike Leaching	With Dike Leaching	Without Dike Leaching	With Dike Leaching	Without Dike Leaching	With Dike Leaching	Without Dike Leaching	With Dike Leaching	Without Dike Leaching	With Dike Leaching
Conventional Parameters										
Hardness	6.0	6.4	5.7	6.0	8.9	8.9	8.9	8.9	17.2	17.2
pH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dissolved Anions										
Total Alkalinity	4.23	4.24	4.13	4.14	7.00	7.00	7.00	7.00	13.24	13.34
Chloride	1.0	1.1	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Fluoride	0.07	0.09	0.07	0.08	0.070	0.071	0.070	0.071	0.05	0.05
Sulphate	2.0	2.0	1.7	1.7	2.8	2.8	2.8	2.8	5.3	5.3
Nutrients										
Ammonia (as N)	0.0497	0.0497	0.0333	0.0333	0.031	0.031	0.025	0.025	0.0890	0.0890
Total Kjeldahl Nitrogen	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nitrate (as N)	0.0569	0.0588	0.0351	0.0363	0.025	0.025	0.017	0.017	0.1020	0.1020
Nitrite (as N)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ortho Phosphate (as P)	0.0024	0.0024	0.0022	0.0022	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Phosphorus (P)-Total	0.0032	0.0035	0.0027	0.0029	0.0031	0.0031	0.0030	0.0030	0.0039	0.0040
Organic Parameters										
Dissolved Organic Carbon	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cyanides										
Total Cyanide	0	0	0	0	0	0	0	0	0	0
Total Metals										
Aluminum	0.007	0.010	0.007	0.009	0.007	0.007	0.007	0.007	0.012	0.013
Antimony	0.00060	0.00062	0.00056	0.00057	0.0005	0.0005	0.0005	0.0005	0.0009	0.0009
Arsenic	0.00072	0.00072	0.00062	0.00062	0.0006	0.0006	0.0005	0.0005	0.005	0.006
Barium	0.020	0.023	0.020	0.022	0.02	0.02	0.02	0.02	0.02	0.02
Beryllium	0.001	0.001	0.001	0.001	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Boron	0.104	0.104	0.102	0.102	0.1	0.1	0.1	0.1	0.100	0.100
Bismuth	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
Cadmium	<0.000052	<0.000052	<0.000051	<0.000051	<0.000051	<0.000051	<0.000050	<0.000050	0.00018	0.00019
Calcium	1.5	1.5	1.3	1.4	2.3	2.3	2.3	2.3	4.7	4.7
Chromium	0.001	0.001	0.001	0.001	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cobalt	0.0004	0.0017	0.0040	0.0013	0.0003	0.0004	0.0003	0.0004	0.0003	0.0003
Copper	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0011	0.002	0.002
Iron	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Lead	0.0006	0.0007	0.0006	0.0006	0.0009	0.0009	0.0009	0.0009	0.0007	0.0007
Lithium	0.005	0.005	0.005	0.005	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Magnesium	0.6	0.7	0.6	0.6	0.8	0.8	0.8	0.8	1.3	1.3
Manganese	0.015	0.072	0.009	0.052	0.0066	0.0089	0.0044	0.0067	0.002	0.002
Mercury	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.00005	0.0001	0.0001
Molybdenum	0.001	0.001	0.001	0.001	0.0010	0.0010	0.0010	0.0010	0.002	0.002
Nickel	0.0020	0.0021	0.0016	0.0016	0.001	0.001	0.001	0.001	0.0010	0.0010
Potassium	2.0	2.1	2.0	2.1	2.0	2.0	2.0	2.0	2.0	2.0
Selenium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0010	0.0010
Silver	0.00002	0.00002	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00002	0.00002
Silicon	0.02	0.12	0.01	0.08	0.01	0.01	0.01	0.01	0.04	0.04
Sodium	2.0	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Strontium	0.004	0.007	0.002	0.005	0.8	0.8	0.8	0.8		
Thallium	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Tin	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Titanium	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Uranium	0.0002	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0007	0.0007
Vanadium	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Zinc	0.015	0.015	0.011	0.011	0.009	0.009	0.007	0.007	0.013	0.013

Notes: [1]Whole lake data are given for a range of mixing conditions, representing lower and upper mixing estimate for the north basin discharge location. [2]The Second Portage Lake water quality model includes substance loading from the Third Portage and East Dikes and inflow from Third Portage and Wally lakes. [3]Preliminary modelling of whole lake water quality in the receiving environment water bodies incorporates long-term loadings from the Vault Dike and effluent releases from the Vault Attenuation pond (Cumberland, 2005a).

3. MEADOWBANK PIT FLOODING MONITORING

Flooding of the Goose Pit, Portage Pit, Vault Pit and Phaser Pits (and nearby attenuation ponds; e.g., Vault Attenuation Pond) will begin after completion of mining in these areas. The expectation, based on current pit water quality modelling, is that upon completion of this gradual flooding process (i.e., on the order of 5 to 8 years), water quality in these areas will be considered acceptable for aquatic life, thus allowing the breaching of the dikes and the repatriation of these areas with the surrounding receiving environments. While the primary water sources (i.e., Third Portage Lake and Wally Lake) are uncontaminated, water quality in the other contributing sources (e.g., dike seepage, pit seepage, TSF water) may be sufficiently poor as to detrimentally affect final pit lake water quality and therefore may not allow for dike breaching to occur.

This issue was identified early in the mine planning process and was included in both the EIS (*Meadowbank Gold Project: Aquatic Ecosystem/Fish Habitat Impact Assessment*; Cumberland, 2005b) and the NWB A Licence application (*Meadowbank Gold Project: Type A Water Licence Application;* AEM, 2007). Recognizing that it would be far more efficient to treat a water quality problem at its source rather than in a fully-diluted pit lake, the NWB Type A Licence includes a requirement for monitoring and modelling end pit water quality (NWB, 2015).

As part of their annual Water Management Plan, AEM has been monitoring source water quality and quantity to forecast pit lake water quality using a mass balance model. Work conducted in 2014 to support this effort predicted that source water treatment might be needed for various parameters in order to meet CCME water quality guidelines. Monitoring details for this effort are included in AEM's *Water Quality and Flow Monitoring Plan* (v4 January 2015).

The renewed NWB A Licence (2AM-MEA1525) identifies specific monitoring locations, parameters and frequencies for operations (early/late) and closure phases for each of the pits (NWB, 2015):

- *Pit Sumps* (Operations) – each of the pit sumps (i.e., the North Portage Pit Sump [ST-17], South Portage Pit Sump [ST-19], Goose Sump [ST-20], and Vault Pit Sump [ST-23]) will be monitored during open water monthly for water quality (for Group 1 parameters, except for ST-23, which is Group 2[5]) and daily for discharge volume.
- *Pit Lakes* (Late Operations/Closure) – Upon flooding, the two Portage Pit basins will join to form Portage Pit Lake, but will still be monitored separately (on a monthly basis during open water for the Group 2 parameters) during operations. During closure, ST-17 and ST-19 will become a single station to be monitored bi-annually (the licence does not specify the frequency/parameter details included in this phase specifically for this location, so this is based on the requirements for the other pit lakes) for Group 2 parameters. For Goose Pit, the monitoring station name changes to Goose Pit Lake (ST-20) during late operations (monitored monthly during open water for Group 2); at closure, monitoring frequency of ST-20 drops to bi-annual (Group 2). For Vault Pit, the monitoring station name changes to Vault Pit Lake upon closure and will be subject to bi-annual monitoring of Group 2 parameters during open water.
- *Pit Lakes* (Post Closure) – For post-closure, the licence identifies Portage-Goose Pit Lake (ST-12) and Vault Pit Lake (ST-13) for annual monitoring of the Full Suite[6] parameters during open water.

[5] The Group 2 parameters are the same as those specified for the CREMP.

[6] The "Full Suite" is comprised of the Group 2 water quality parameters (i.e., the same as the CREMP) as well as Total Petroleum Hydrocarbons, and Turbidity (but not the acute lethality tests, which are for discharges only).

While the NWB Type A Licence (2AM-MEA1525) describes specific pit-related monitoring requirements for each mine development phase, there are no details regarding the transitions between phases.

Consistent with the ideals of progressive reclamation, it is assumed herein that those transitions are defined on a location-specific basis rather than on the general stage of mine development for the project. For example, mining (i.e., operations) at Goose Pit was completed in early 2015 and flooding (i.e., starting closure for this feature) is scheduled to start in June 2016 and finish by September 2021; the post-closure phase would only start once water quality was deemed acceptable and the dikes were breached (i.e., at the point when the pit lakes and surrounding impoundments formally become part of the receiving environment). This approach ensures that monitoring is tailored to the specific requirements of the pit lake and not to the general status of the mine development. Following this logic, pit lake monitoring would formally move from falling under the *Water Quality and Flow Monitoring Plan* to the CREMP at the transition to the post-closure phase (i.e., when the pit lakes are deemed receiving environment). Thus, CREMP monitoring would target Portage-Goose Pit Lake (ST-12) and Vault Pit Lake (ST-13) after breaching the dikes following the parameter and frequency stipulations in the licence.

Part E(7) of the NWB A Licence presents the expectations of breaching the dikes (NWB, 2015):

> *The Licensee shall not breach dikes until the water quality in the re-flooded area meets CCME Water Quality Guidelines for the Protection of Aquatic Life, baseline concentrations, or appropriate site specific water quality objectives. Subject to the Board approval, if water quality parameters are above CCME Guidelines, a site specific risk assessment must be conducted to identify water quality objectives that are protective of the aquatic environment.*

AEM's commitment is to meet CCME water quality guidelines in each of the fully-flooded pit lakes. AEM's annual monitoring and water quality forecast modelling efforts will support making timely management decisions regarding the need for water treatment to achieve this commitment. If early forecasting predicts that AEM's objectives will not be met, then the potential use of site-specific water quality objectives or of site-specific risk assessment to provide further clarity on water quality acceptability will be considered as early as possible.

4. REFERENCES

Agnico Eagle Mines Ltd. (AEM). 2015. Water Quality and Flow Monitoring Plan. Version 4, January 2015.

AEM. 2014. Nunavut Water Board (NWB 2AM-MEA0815) Type A Water Licence Renewal Application – Main Supporting Document. July 2014.

AEM. 2011. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction Monitoring 2010, Meadowbank Mine. Report prepared by Agnico-Eagle Mines Ltd., Baker Lake, NU.

AEM. 2007. Meadowbank Gold Project: Type A Water Licence Application. August 2007.

AEMP (Aquatic Effects Management Program). 2005. A report prepared by Azimuth Consulting Group, Vancouver for Cumberland Resources Ltd. October, 2005.

Azimuth Consulting Group (Azimuth). 2015. Core Receiving Environment Monitoring Program (CREMP) 2014, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2015.

Azimuth. 2014. Core Receiving Environment Monitoring Program (CREMP) 2013, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2014.

Azimuth. 2013. Core Receiving Environment Monitoring Program (CREMP) 2012, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2013.

Azimuth. 2012a. Core Receiving Environment Monitoring Program (CREMP): Design Document 2012, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. December, 2012. Available at: ftp://ftp.nwb-oen.ca/1%20PRUC%20PUBLIC%20REGISTRY/2%20MINING%20MILLING/2A/2AM%20-%20Mining/2AM-MEA1525%20Agnico/3%20TECH/9%20MONITORING%20(I)/I1%20Aquatic%20Effects%20Management%20Program/130108%202AM-MEA0813%20AEM%20Meadowbank_CREMP_Design%20Doc%20v1_December_2012%20final-IAAE.pdf

Azimuth. 2012b. Aquatic Effects Monitoring Program – Core Receiving Environment Monitoring Program 2011, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2012.

Azimuth. 2012c. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction TSS Effects Assessment Study 2011, Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2012.

Azimuth. 2012d. Aquatic Effects Management Program (AEMP), Meadowbank Mine. Report prepared by Azimuth Consulting Group, Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. December, 2012.

Azimuth. 2012e. Environmental Effects Monitoring (EEM): Cycle 1 Reporting, Meadowbank Division, Nunavut. Report prepared by Azimuth Consulting Group, Vancouver, BC for Environment Canada, Edmonton, AB on behalf of Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2011a. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction TSS Effects Assessment Study 2010, Meadowbank Mine. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2011.

Azimuth. 2011b. Aquatic Effects Monitoring Program – Core Receiving Environment Monitoring Program 2010, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. March, 2011.

Azimuth. 2010a. Core receiving environment monitoring program (CREMP) 2010 plan update. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU. June, 2010.

Azimuth. 2010b. Aquatic Effects Monitoring Program – Core Receiving Environment Monitoring Program 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2010c. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction Monitoring 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2010d. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction TSS Effects Assessment Study 2009, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Baker Lake, NU.

Azimuth. 2009a. Aquatic Effects Monitoring Program – Targeted Study: Dike Construction Monitoring 2008, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. March 2009.

Azimuth. 2009b. Aquatic Effects Monitoring Program – Targeted Study: Second Portage Lake TSS Effects Assessment Study 2008, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. March 2009.

Azimuth. 2009c. Aquatic Effects Monitoring Program – Receiving Environment Monitoring 2008, Meadowbank Gold Project. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. March 2009.

Azimuth. 2008a. Aquatic Effects Management Program Monitoring – Meadowbank Gold Project, 2007. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. March 2008.

Azimuth. 2008b. Aquatic Effects Management Program Monitoring – Meadowbank Gold Project, 2006. Report prepared by Azimuth Consulting Group Inc., Vancouver, BC for Agnico-Eagle Mines Ltd., Vancouver, BC. March 2008.

BAER (Baseline Aquatic Ecosystem Report). 2005. A report prepared by Azimuth Consulting Group, Vancouver for Cumberland Resources Ltd. October, 2005.

Cumberland Resources Ltd. (Cumberland). 2005a. Meadowbank gold project. Physical environment impact assessment report. October, 2005.

Cumberland. 2005b. Meadowbank gold project. Aquatic ecosystem / fish habitat impact assessment. October, 2005.

EVS Environment Consultants. 1999. Fisheries evaluation of candidate reference lakes, Meadowbank Gold Project Nunavut, 1998. A report prepared for Cumberland Resources Ltd., Vancouver BC by EVS Environment Consultants, North Vancouver, April 1999. 60 pp.

Golder Associates (Golder). 2014. Rock storage facility seepage – Meadowbank Gold Mine, Nunavut. Report prepared by Golder Associates for Agnico-Eagle Mines Ltd., Baker Lake, NU. January 2014.

Nunavut Water Board (NWB). 2015. Nunavut Water Board Water Licence No: 2AM-MEA1525.

APPENDICES

APPENDIX A

STANDARD OPERATING PROCEDURE
MEADOWBANK LAKES AND BAKER LAKE
CREMP WATER & PHYTOPLANKTON SAMPLING

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

GENERAL:

Project Coordinator:
Eric Franz
Azimuth Consulting Group
218-2902 West Broadway
Vancouver, BC, V6K 2G8
Telephone: 604-730-1220
Email: efranz@azimuthgroup.ca

In case of **emergency**, contact Gary Mann ([redacted]).
Azimuth office telephone number 604-730-1220.

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Twelve (12) sampling stations have been chosen for water quality monitoring in the Meadowbank project lakes and Baker Lake:

Meadowbank Lakes

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

Baker Lake

- Baker Lake – Barge Dock (BBD)
- Baker Lake – Proposed Jetty (BPJ)
- Baker Lake – Akilahaarjuk Point (BAP)

Water sampling activities are scheduled roughly once a month for 6 months (5 months in some years), including winter ice sampling. The first 5 stations listed above are sampled through the ice in April, May, and November. All of the above stations are sampled during open water in July, August, and September. Sampling will not be conducted in June and October because of thin ice conditions. **Check the monthly water sampling schedule to confirm which samples are to be collected where, BEFORE going into the field.**

All samples are now collected from **3 m below the water surface**, which is indicated by "-S" at the end of the sample ID (S=Surface). **Two** target sample locations for each station listed above have been

randomly pre-determined and recorded in MapSource and in the hand-held GPS units (NAD 83). Confirm before going into the field.

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-36-S, INUG-24-S)
   - Date of sample collection
   - Parameters to be measured from individual bottle (TOC, 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 (4 meter length and 1 meter length) & weight (& extra C-clamps and cable ties)
   - In-line filter and a spare
   - YSI meter, batteries
   - Secchi disk
   - Hand held pH meter, batteries
   - Depth meter, batteries
   - Rope
   - Sampling gloves
   - Field sample bottles & preservatives (per sample) see **Table 1** below
   - Glass vials (50 mL) for phytoplankton. Preserve with Lugol's back at the laboratory
   - Extra sample bottles in case of breakage or loss
   - QA/QC field duplicate sampling containers & preservatives (same as above)
   - 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, and black tubes for chlorophyll-a
   - 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)

Starting in 2015, some of the water analyses with short hold-times are being shipped by express and the rest are being shipped by ground, but all parameters are being analysed at ALS laboratory in Burnaby, BC. The specific bottles to be filled, parameters to be measured and preservatives required for each is in **Table 1**. ALS Laboratory data quality objectives for individual water parameter analyses are in **Table 2**. Affix the labels to the sampling containers and then prior to shipping, wrap packing tape around the labels to ensure a waterproof seal.

Table 1. Water samples collected as part of the CREMP program.

ALS Burnaby Parameters	Bottle and Sample Volume	Preservative	Filter?
Alkalinity species, pH, Turbidity, EC, Cconductivity, Anions (F, NO_2, NO_3, Br, SO_4), Low-level Chloride, Silicate, Ortho-PO_4, Total Dissolved Phosphorus	1L HDPE Bottle	None	No
TSS (low-level), TDS (low-level)	1L HDPE Bottle	None	No
TOC, Total Phosphorus, TKN, NH_3	250mL Amber glass bottle	1 mL H_2SO_4	No
DOC	125mL Amber Glass Bottle	1 mL H_2SO_4	Yes
Cyanide (total low-level and free low-level)	145 mL HDPE Bottle	0.5 mL 50% NaOH	No
Total Mercury	40 mL Glass Vial	0.5 mL Hydrochloric Acid	No
Dissolved Mercury	40 mL Glass Vial	0.5 mL Hydrochloric Acid	Yes
Total Metals	250 mL HDPE Bottle	3 mL Nitric Acid	No
Dissolved Metals	250 mL HDPE Bottle	3 mL Nitric Acid	Yes
Chlorophyll-a	filter 500 mL through 0.45um MCE Filter place filter in 15 mL Black Tube	Freeze	No

Table 2. Laboratory data quality objectives (from ALS) for water chemistry analyses.

Parameter	Target D.L.	Units	Accuracy [1] DQO	Matrix Spike [2] DQO	Precision [3] (RPD) DQO	Hold Times	Bottle Required	Bottle Volume	Filter (Yes/No)	Preservative	Method Reference
Water - Physical Tests											
Conductivity	2	µS/cm	90-110%	n/a	10%	28 days	Plastic	1.0 L	No	None	APHA 2510 Auto. Conduc.
Hardness (as $CaCO_3$)	0.5	S/c	75-125%	65-135%	25%	6 months	Plastic, Verified	250 ml	No	HNO_3	APHA 2340B
pH	0.1	pH	± 0.10 pH units	n/a	± 0.20 pH units	0.25 hours	Plastic	1.0 L	No	None	APHA 4500-H pH Value
Total Suspended Solids	1	mg/L	85-115%	n/a	20%	7 days	Plastic	1.0 L	No	None	APHA 2540 D
Total Dissolved Solids	3	mg/L	85-115%	n/a	20%	7 days	Plastic	1.0 L	No	None	APHA 2540 C
Turbidity	0.1	NTU	85-115%	n/a	15%	3 days	Plastic	1.0 L	No	None	APHA 2130 Turbidity
Water - Anions and Nutrients											
Alkalinity, Bicarbonate (as $CaCO_3$)	2	mg/L	85-115%	n/a	20%	14 days	Plastic	1.0 L	No	None	APHA 2320
Alkalinity, Carbonate (as $CaCO_3$)	2	mg/L	85-115%	n/a	20%	14 days	Plastic	1.0 L	No	None	APHA 2320
Alkalinity, Hydroxide (as $CaCO_3$)	2	mg/L	85-115%	n/a	20%	14 days	Plastic	1.0 L	No	None	APHA 2320
Alkalinity, Total (as $CaCO_3$)	2	mg/L	85-115%	n/a	20%	14 days	Plastic	1.0 L	No	None	APHA 2320
Ammonia, Total (as N)	0.005	mg/L	85-115%	75-125%	20%	28 days	Amber Glass	250 ml	No	H_2SO_4	J. ENV. MONIT.,2005,7,37-42,RSC
Bromide (Br)	0.05	mg/L	85-115%	75-125%	20%	28 days	Plastic	1.0 L	No	None	EPA 300.1 (mod)
Chloride (Cl)	0.1	mg/L	90-110%	75-125%	20%	28 days	Plastic	1.0 L	No	None	EPA 300.1 (mod)
Fluoride (F)	0.02	mg/L	90-110%	75-125%	20%	28 days	Plastic	1.0 L	No	None	EPA 300.1 (mod)
Nitrate (as N)	0.005	mg/L	90-110%	75-125%	20%	3 days	Plastic	1.0 L	No	None	EPA 300.1 (mod)
Nitrite (as N)	0.001	mg/L	90-110%	75-125%	20%	3 days	Plastic	1.0 L	No	None	EPA 300.1 (mod)
Total Kjeldahl Nitrogen	0.05	mg/L	75-125%	70-130%	20%	28 days	Amber Glass	250 ml	No	H_2SO_4	APHA 4500-NORG D.
Orthophosphate-Dissolved (as P)	0.001	mg/L	80-120%	70-130%	20%	3 days	Plastic	1.0 L	No	None	APHA 4500-P Phosphorous
Phosphorus (P)-Total Dissolved	0.002	mg/L	80-120%	70-130%	20%	3 days	Plastic	1.0 L	No	None	APHA 4500-P Phosphorous
Phosphorus (P)-Total	0.002	mg/L	80-120%	70-130%	20%	28 days	Amber Glass	250 ml	No	H_2SO_4	APHA 4500-P Phosphorous
Silicate (SiO_2)	0.5	mg/L	85-115%	75-125%	20%	28 days	Plastic	1.0 L	No	None	APHA 4500-SiO2 E.
Sulfate (SO_4)	0.3	mg/L	90-110%	75-125%	20%	28 days	Plastic	1.0 L	No	None	EPA 300.1 (mod)
Water - Organic / Inorganic Carbon											
Dissolved Organic Carbon	0.5	mg/L	80-120%	70-130%	20%	28 days	Amber Glass	125 ml	Yes	H_2SO_4	APHA 5310B TOTAL ORGANIC CARBON
Total Organic Carbon	0.5	mg/L	80-120%	70-130%	20%	28 days	Amber Glass	250 ml	No	H_2SO_4	APHA 5310B TOTAL ORGANIC CARBON
Chlorophyll-*a*											
Chlorophyll-*a* [4]	0.01	µg/L	80-120%	n/a	35%	28 days	15 ml plastic tube	500 ml	Footnote 4	Freeze	EPA Method 445.0
Cyanides											
Total Cyanide	0.001	mg/L	80-120%	70-130%	20%	14 days	Plastic	145 ml	No	NaOH	ISO 14403:2002
Free Cyanide	0.001	mg/L	80-120%	70-130%	20%	14 days	Plastic	145 ml	No	NaOH	ASTM 7237

Table 2 con't. Laboratory data quality objectives (from ALS) for water chemistry analyses.

Parameter	Target D.L.	Units	Accuracy [1] DQO	Matrix Spike [2] DQO	Precision [3] (RPD) DQO	Hold Times	Bottle Required	Bottle Volume	Filter (Yes/No)	Preservative	Method Reference
Water - Total Metals											
Aluminum (Al)-Total	0.003	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Antimony (Sb)-Total	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Arsenic (As)-Total	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Barium (Ba)-Total	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Beryllium (Be)-Total	0.00002	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod)
Bismuth (Bi)-Total	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Boron (B)-Total	0.01	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Cadmium (Cd)-Total	0.000005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Calcium (Ca)-Total	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Chromium (Cr)-Total	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Cobalt (Co)-Total	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Copper (Cu)-Total	0.0005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Iron (Fe)-Total	0.01	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Lead (Pb)-Total	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Lithium (Li)-Total	0.001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Magnesium (Mg)-Total	0.1	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Manganese (Mn)-Total	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Mercury (Hg)-Total	0.000005	mg/L	80-120%	70-130%	20%	28 days	Glass	40 ml	No	HCl	EPA 1631E (mod)
Molybdenum (Mo)-Total	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Nickel (Ni)-Total	0.0005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Phosphorus (P)-Total	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Potassium (K)-Total	0.1	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Selenium (Se)-Total	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Silicon (Si)-Total	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Silver (Ag)-Total	0.00001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Sodium (Na)-Total	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Strontium (Sr)-Total	0.0002	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Sulfur (S)-Total	0.5	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA SW-846 3005A/6010B
Thallium (Tl)-Total	0.00001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Tin (Sn)-Total	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Titanium (Ti)-Total	0.0003	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Uranium (U)-Total	0.00001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Vanadium (V)-Total	0.0005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Zinc (Zn) - Total	0.003	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B
Zirconium (Zr) - Total	0.0003	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	No	HNO_3	EPA 200.2/6020A (mod) or EPA 3005A/6010B

Table 2 con't. Laboratory data quality objectives (from ALS) for water chemistry analyses.

Parameter	Target D.L.	Units	Accuracy [1] DQO	Matrix Spike [2] DQO	Precision [3] (RPD) DQO	Hold Times	Bottle Required	Bottle Volume	Filter (Yes/No)	Preservative	Method Reference
Water - Dissolved Metals											
Aluminum (Al)-Dissolved	0.001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Antimony (Sb)-Dissolved	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Arsenic (As)-Dissolved	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Barium (Ba)-Dissolved	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Beryllium (Be)-Dissolved	0.00002	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod)
Bismuth (Bi)-Dissolved	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Boron (B)-Dissolved	0.01	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Cadmium (Cd)-Dissolved	0.000005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Calcium (Ca)-Dissolved	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Chromium (Cr)-Dissolved	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Cobalt (Co)-Dissolved	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Copper (Cu)-Dissolved	0.0002	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Iron (Fe)-Dissolved	0.01	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Lead (Pb)-Dissolved	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Lithium (Li)-Dissolved	0.001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Magnesium (Mg)-Dissolved	0.1	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Manganese (Mn)-Dissolved	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Mercury (Hg)-Dissolved	0.000005	mg/L	80-120%	70-130%	20%	28 days	Glass	40 ml	Yes	HCl	APHA 3030B/EPA 1631E (mod)
Molybdenum (Mo)-Dissolved	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Nickel (Ni)-Dissolved	0.0005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Phosphorus (P)-Dissolved	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Potassium (K)-Dissolved	0.1	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Selenium (Se)-Dissolved	0.00005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Silicon (Si)-Dissolved	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Silver (Ag)-Dissolved	0.00001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Sodium (Na)-Dissolved	0.05	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Strontium (Sr)-Dissolved	0.0002	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Sulfur (S)-Dissolved	0.5	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	EPA SW-846 3005A/6010B
Thallium (Tl)-Dissolved	0.00001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Tin (Sn)-Dissolved	0.0001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Titanium (Ti)-Dissolved	0.0003	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Uranium (U)-Dissolved	0.00001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Vanadium (V)-Dissolved	0.0005	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Zinc (Zn) - Dissolved	0.001	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B
Zirconium (Zr) - Dissolved	0.0003	mg/L	80-120%	70-130%	20%	6 months	Plastic, Verified	250 ml	Yes	HNO_3	APHA 3030 B/6020A (mod) or EPA 3005A/6010B

Notes: All bottles should be kept cool from sampling to lab receiving. If possible, Dissolved Metals should be filtered and preserved as soon as possible.

[1] Accuracy is measured as Percent Difference from True Value or Certified Target for Reference Materials and/or Method Analyte Spikes and Surrogates where applicable. For Matrix Spikes, accuracy is measured as the measured amount minus the sample background amount divided by the spiked amount. For low level results the accuracy objective is for the measured result to lie within +/- 1 times the LOR from the target.

[2] Matrix Spike (MS) recovery, expressed as a percentage is defined as:

100 * {[(Measured Concentration) - (Background Analyte Concentration in Sample)] ÷ (Spike Concentration)}

High analyte background may prevent accurate determination of MS recovery. MS recoveries are not calculated or evaluated when the spiked amount is less than the background analyte concentration in the sample.

[3] Precision is measured as the absolute value of Relative Percent Difference (RPD) for Laboratory Duplicate Samples. RPD = |(Result2 - Result1) / Mean| * 100. For low level results, the precision objective is for the difference of the two results to be less than 2 times the LOR.

[4] Filter 500 ml through a 0.45um MCE filter, place filter in 15 mL black plastic tube provided by ALS and freeze.

3. For **QAQC** purposes four kinds of samples are required:

Field duplicate: All parameters measured in the original sample are measured in the field duplicate. The sampling station is selected at random 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.

Travel blank: These 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. Ship back to the lab, each set with different shipment.

Equipment blank: For this sample you should be using one 4-L jug of DI-water just to re-circulate water through the pump for at least 2 minutes. Then DISCARD those 4L. Use a new 4-L jug of DI-water to first rinse out another 2L, discard that, empty the pump, then start filling bottles with the remaining 2L plus whatever is needed from a third new 4-L jug of DI-water. PRESERVE and FILTER the sample bottles as indicated in **Table 1**, using the most recent filter you've used in the field during this event. ***Discard any DI-water that is left in the 4-L jugs and recycle the empty jugs***. Use the new COC, fill in for every parameter except chlorophyll-a. Label this sample according to the name listed in the excel sheet "Water data sheet & stations 2015 -CREMP" under the tab for whichever month you are in. Be sure to label all 9 sample bottles also.

DI (De-ionized water) Blank: Using a second set of sample bottles you will be collecting a DI Blank. To do this, use another brand new 4-L jug of DI (***do not use DI water from last year or DI water that you have just had the pump tubing sitting in!***). You will simply fill the entire set of sample bottles using the new clean DI-water (you may need more than one 4-L jug) by pouring from the DI jugs into the sample bottles. PRESERVE as indicated above. You will NOT need to filter anything, as you will not be using the pump to collect these samples. Fill up sample bottles for dissolved parameters anyway. Add this sample to the same COC, fill in for every parameter except chlorophyll-a. Label this sample according to the name listed in the excel sheet "Water data sheet & stations 2015 -CREMP" under the tab for whichever month you are in. Be sure to label all 9 sample bottles also.

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 **UTM coordinates** on the field data form.

6. Measure **water depth** at the sampling station using the 'Hawkeye' hand-held depth meter (or transom-mounted lowrance). 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 meters depth**), 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** (unless the YSI includes this parameter). 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. Check the DO calibration (adjust barometric pressure based on airport data) but also check the DO membrane (it may need to be replaced). At Meadowbank DO readings should be about 8 – 12mg/L; if meter is reading much lower/higher than this, membrane likely needs to be replaced. Keep a calibration log which includes date and time, type of calibration, results, and troubleshooting.

10. 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).

    It is important to ensure your instruments are calibrated, as mentioned above, but also to check that the readings are 'making sense' while collecting data in the field. If you notice that a reading is ***abnormally low*** (for DO) ***or abnormally high*** (for conductivity or temperature) and the meter appears to be working correctly, then you should collect a second water chemistry sample at the anomalous depth (following the steps below). To help guide field crew, **Table 3** shows limnological parameter values (conductivity, DO, temperature) that should be achieved under normal circumstances. Note that these values are a guide for the open-water months only and for near-field stations only (TPE, TPN, SP, and WAL).

    Table 3. The parameter value should be as indicated under normal circumstances, during each month-parameter combination.

Sampling Month	Parameter (units)	TPN	TPE	SP	WAL
July	Conductivity (µS/cm)	< 20	< 22	< 25	< 28
	Temperature (°C)	< 13	< 15	< 18	< 17
	DO (mg/L)	> 8	> 8	> 7	> 6
August	Conductivity (µS/cm)	< 28	< 31	< 38	< 35
	Temperature (°C)	< 12	< 14	< 14	< 16
	DO (mg/L)	> 6	> 7	> 7	> 8
September	Conductivity (µS/cm)	< 31	< 30	< 36	< 35
	Temperature (°C)	< 10	< 11	< 11	< 10
	DO (mg/L)	> 7	> 6	> 6	> 7

    As an example, in August at station TPE, conductivity should be less than 31 uS/cm, temperature should be less than 14 ^{o}C, and DO should be greater than 7 mg/L. If the profile shows that at 7 meters depth conductivity is 36 uS/cm or that DO is 5 mg/L, for example, then collect a full water chemistry sample at 7 meters (no phytoplankton, no chlorophyll-a) following the steps below.

11. Set up the **water pump** in the boat; attach the tubing to the pump using the C-clamps and attach the 12-V battery. Attach the 4 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 4 meter length of tubing. Lower the 4 meter length of tubing into the water to ***3 meters 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.

12. For each sampling station, **fill** the required **pre-labeled sampling containers** with water from the 1 meter length of tubing.

13. 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 (and dissolved Hg) 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 typically low, filters can be re-used for up to 10 samples. Remember to use the same filter when collecting equipment blank samples, not a new filter.

14. **Add the specified preservatives** to the appropriate sampling containers (according to the information on the labels and tables above), seal and mix thoroughly by turning upside down and then upright a number of times.

15. To collect a phytoplankton sample, add site water from appropriate depth (i.e., 3 m) 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.

16. Back in the office, to process the chlorophyll-a 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, then screw the two sections together and attach the hand-held vacuum pump. **Filter 500 mL of water** through the water filter apparatus. After filtering the 500 mL of water, remove the filter and place in the 15 mL black plastic tube provided by ALS. With a sharpie pen, write the appropriate sampling information on a label and stick to the plastic tube. Place the tubes in a Ziploc bag and put into the **freezer**. Mark on the field collection data sheet the volume of water filtered.

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, fill the pre-labeled sampling containers, including the phytoplankton vial (repeat step 11-15) and collect a second filtered chlorophyll-a sample (step 16). 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 tables above), 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. Note that there are pre-made COCs for ALS water chemistry – separated by Ground shipments, Express shipments and Chlorophyll-a. These have been separated because they will be shipped separately.

A **digital COC** form is most commonly used; 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). Any questions regarding the COC form should be directed to the Azimuth project coordinator – Eric Franz. 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). Separate all the 1-L plastic bottles from the rest of the bottles, the former will be shipped express and the latter will be shipped ground. Chlorophyll-a samples tubes will be sent in their own mini cooler with plenty of ice packs.

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: Brent Mack

   Ship the water samples to ALS in Burnaby as indicated on the label (either 'ground' or 'express'). Please email Eric Franz at Azimuth (efranz@azimuthgroup.ca) when water samples are being sent from Meadowbank.

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 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, attention the project coordinator – Eric Franz.

APPENDIX B

STANDARD OPERATING PROCEDURE
MEADOWBANK LAKES AND BAKER LAKE
CREMP BENTHOS & SEDIMENT SAMPLING

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

GENERAL:

Project Coordinator:
Morgan Finley
Azimuth Consulting Group
304-2537 Beacon Avenue,
Sidney, BC, V8L 1Y3
Telephone: 778-426-0112
Email: mfinley@azimuthgroup.ca

In case of **emergency**, contact Gary Mann ([redacted]).
Azimuth office telephone number 604-730-1220 or 778-426-0112.

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Thirteen (13) sampling stations have been chosen for benthos and sediment quality monitoring in the Meadowbank project lakes. These stations (with their corresponding abbreviation) are:

- Third Portage Lake – North Basin (TPN)
- Third Portage Lake – East Basin (TPE)
- Second Portage Lake (SP)
- Tehek Lake (TE)
- Inuggugayualik Lake (INUG)

- Tehek Lake – Far-field (TEFF)
- Third Portage Lake – South Basin (TPS)
- Wally Lake (WAL)
- Pipedream Lake (PDL)

- Baker Lake – Barge Dock (BBD)
- Baker Lake – Proposed Jetty (BPJ)
- Baker Lake – Akilahaarjuk Point (BAP)
- Baker Lake – East Shore (BES)

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**.

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
- 3 stainless steel bowls
- 2 stainless steel spoons
- Liquinox detergent and dish cleaning brush
- Plastic squirt bottle
- Sampling gloves
- Safety glasses
- Field sample jars & preservatives (per sampling station):
  - 11 – 125 mL glass jars (sediment samples : 2 jars for 5 reps; 1 jar for composite)
  - 5 – 500 mL plastic jars (benthos: 1 jar for each rep)
- QA/QC field duplicate sediment jars
- Ashless filter paper & tweezers; 1-125 mL glass jar

In camp:

- Formalin (10% of pure 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 (5 x 125 mL – total metals, pH, moisture; 5 x 125 mL – grain size (PSA), TOC; 1 x 125 mL – PAHs, LEPHs & HEPHs, Mineral Oil & Grease.

   ALS Laboratory data quality objectives for individual water parameter analyses are in **Table 1**. Affix the labels to the sediment jars and then wrap packing tape around the labels to ensure a waterproof seal.

Table 1. Laboratory data quality objectives (from ALS) for sediment chemistry analyses.

Parameter	Target D.L.	Units	Accuracy [1] DQO	Matrix Spike [2] DQO	Precision [3] (RPD) DQO	Hold Times	Bottle Required	Volume Required	Method Reference
Soil - Physical Tests									
Moisture	0.25	%	90-110%	n/a	20%	14 days	Glass	125 ml	ASTM D2974-00 Method A
pH (1:2 soil:water)	0.10	pH	± 0.3 pH units	n/a	± 0.3 pH units	1 year	Glass	125 ml	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL
Soil - Particle Size									
% Gravel (>2mm)	0.10	%	LTM ± 5% [5 6]	n/a	Diff < 5% [6]	6 months	Glass	125 ml	SSIR-51 METHOD 3.2.1
% Sand (2.0mm - 0.063mm)	0.10	%	LTM ± 5% [5 6]	n/a	Diff < 5% [6]	6 months	Glass	125 ml	SSIR-51 METHOD 3.2.1
% Silt (0.063mm - 4um)	0.10	%	LTM ± 5% [5 6]	n/a	Diff < 5% [6]	6 months	Glass	125 ml	SSIR-51 METHOD 3.2.1
% Clay (<4um)	0.10	%	LTM ± 5% [5 6]	n/a	Diff < 5% [6]	6 months	Glass	125 ml	SSIR-51 METHOD 3.2.1
Soil - Organic / Inorganic Carbon									
Total Organic Carbon	0.10	%	80-120%	70-130%	30%	28 days	Glass	125 ml	SSSA (1996) p. 973
Soil - Metals									
Aluminum (Al)	50	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Antimony (Sb)	0.10	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Arsenic (As)	0.100	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Barium (Ba)	0.50	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Beryllium (Be)	0.10	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Bismuth (Bi)	0.20	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Boron (B)	5.0	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Cadmium (Cd)	0.020	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Calcium (Ca)	50	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Chromium (Cr)	0.50	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Cobalt (Co)	0.10	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Copper (Cu)	0.50	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Iron (Fe)	50	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Lead (Pb)	0.50	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Lithium (Li)	2.0	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Magnesium (Mg)	20	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Manganese (Mn)	1.0	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Mercury (Hg)	0.0050	mg/kg	70-130% [4]	n/a	40%	28 days	Glass	125 ml	EPA 200.2/1631E (mod)
Molybdenum (Mo)	0.10	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Nickel (Ni)	0.50	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Phosphorus (P)	50	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Potassium (K)	100	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Selenium (Se)	0.20	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Silver (Ag)	0.10	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Sodium (Na)	50	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Strontium (Sr)	0.50	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Thallium (Tl)	0.050	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Tin (Sn)	2.0	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Titanium (Ti)	1.0	mg/kg	70-130% [4]	n/a	40%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Uranium (U)	0.050	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Vanadium (V)	0.20	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Zinc (Zn)	2.0	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)
Zirconium (Zr)	1.0	mg/kg	70-130% [4]	n/a	30%	6 months	Glass	125 ml	EPA 200.2/6020A (mod)

Table 1 con't. Laboratory data quality objectives (from ALS) for sediment chemistry analyses.

Parameter	Target D.L.	Units	Accuracy [1] DQO	Matrix Spike [2] DQO	Precision [3] (RPD) DQO	Hold Times	Bottle Required	Volume Required	Method Reference
Soil - Aggregate Organics									
Mineral Oil and Grease	500	mg/kg	70-130%	60-140%	40%	28 days	Glass	125 ml	CCME PETROLEUM HYDROCARBONS-GRAVIMETRIC
Soil - Hydrocarbons									
EPH10-19	200	mg/kg	70-130%	60-140%	40%	14 days	Glass	125 ml	BC MOE EPH GCFID
EPH19-32	200	mg/kg	70-130%	60-140%	40%	14 days	Glass	125 ml	BC MOE EPH GCFID
LEPH	200	mg/kg	70-130%	60-140%	40%	14 days	Glass	125 ml	BC MOE LABORATORY MANUAL (2005)
HEPH	200	mg/kg	70-130%	60-140%	40%	14 days	Glass	125 ml	BC MOE LABORATORY MANUAL (2005)
Soil - Polycyclic Aromatic Hydrocarbons									
Acenaphthene	0.0050	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Acenaphthylene	0.0050	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Anthracene	0.0040	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Benz(a)anthracene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Benzo(a)pyrene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Benzo(b)fluoranthene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Benzo(b+j+k)fluoranthene	0.015	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Benzo(g,h,i)perylene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Benzo(k)fluoranthene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Chrysene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Dibenz(a,h)anthracene	0.0050	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Fluoranthene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Fluorene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Indeno(1,2,3-c,d)pyrene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
2-Methylnaphthalene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Naphthalene	0.010	mg/kg	50-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Phenanthrene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270
Pyrene	0.010	mg/kg	60-130%	50-140%	50%	14 days	Glass	125 ml	EPA 3570/8270

Notes: All jars should be kept cool from sampling to lab receiving.

[1] Accuracy is measured as Percent Difference from True Value or Certified Target for Reference Materials and/or Method Analyte Spikes and Surrogates where applicable. For Matrix Spikes, accuracy is measured as the measured amount minus the sample background amount divided by the spiked amount. For low level results the accuracy objective is for the measured result to lie within +/- 1 times the LOR from the target.

[2] Matrix Spike (MS) recovery, expressed as a percentage is defined as:

100 * {[(Measured Concentration) - (Background Analyte Concentration in Sample)] ÷ (Spike Concentration)}

High analyte background may prevent accurate determination of MS recovery. MS recoveries are not calculated or evaluated when the spiked amount is less than the background analyte concentration in the sample.

[3] Precision is measured as the absolute value of Relative Percent Difference (RPD) for Laboratory Duplicate Samples. RPD = |(Result2 - Result1) / Mean| * 100. For low level results, the precision objective is for the difference of the two results to be less than 2 times the LOR.

[4] Accuracy targets for metals in soils are expressed relative to the ALS long term mean for each method where certified method-specific reference material targets are unavailable. Full recovery of matrix-bound elements is not expected or intended for environmental acid digestion methods.

[5] Long Term Mean (LTM) ± 5% sand, silt, clay.

[6] The recovery is calculated from the absolute difference (DIFF).

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 8 replicate station every sampling event (DUP + Swipe). All parameters measured in the original sample are measured in the field duplicate. The sampling station is selected randomly from the 65 replicate stations, and labeled as station DUP (or Swipe). Prepare the QAQC labels and affix to the sediment jars, as described in step 2. And label one new 125 mL glass jars with the Azimuth company name, date, QAQC filter and total metals for each swipe sample.

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 **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 UTM coordinates on the field data form.

7. Measure the **water depth** at the sampling station. It is recommended to use a transom mounted sonar to first "view" each rep location looking for a smooth, relatively flat lake bottom. Record the depth information on the field data form. Ensure sample depth is within the target (8 meters +/- 1.5 m).

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, 3 stainless steel bowls and a 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 two stainless steel bowls and spoon until later (step 18) and ready the largest stainless bowl for the Ponar.

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 though in some locations if the substrate is particularly hard it may be necessary to accept smaller grabs);
    - is not overfilled (sediment surface must not be touching the top of the Ponar, though in reality there will be occasions when the Ponar is full, careful judgment is required to determine if the grab is too full);
    - 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 the large 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 massage 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. Refer to step 18. At this point while you are still at the first rep you can also collect the Ponar grabs for the sediment chemistry composite.

16. **Repeat steps 10-14** four more times; there must be a separation of ***20 meters*** or more from other replicate stations. Prior to collecting the next REP, clean ponar and both bowls with liquinox and scrub brush, rinse with lake 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, 10 Ponar grabs will be collected for benthos collection, two grabs per replicate.

17. 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.

18. 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).

19. 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.

20. **Repeat steps 18 and 19** one more time, placing the sediment into the bowl with the other sediment sample(s).

21. **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.

22. Add one level-scoop of sediment from the sediment chemistry bowl to the last, clean, stainless bowl. This process is completed at each rep until there are 5 good scoops (one from each rep) in the "composite" bowl. Homogenize thoroughly and fill 1 x 125 mL jar for analysis (LEPHs&HEPHs, MOG, and PAHS). Be sure label ID includes "COMP" (e.g., TPE-COMP).

23. 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** (or a "ghost wipe") and store in the pre-labeled 125 mL glass jar. Collect the duplicate sediment sample from the same sediment collected in steps 18-20. Fill the sampling containers labeled as station DUP. Record that the QAQC samples were collected from this sampling station on the field data form.

24. **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.

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

26. 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**.

27. 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 most commonly used; 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). Any questions regarding the COC form should be directed to the Azimuth project coordinator – Morgan Finley. Put the completed COC form in a sealed ziploc plastic bag in the cooler with the samples.

28. 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: Brent Mack

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 (ZEAS)

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, attention the project coordinator – Morgan Finley and Eric Franz (efranz@azimuthgroup.ca).

APPENDIX C

STANDARD OPERATING PROCEDURE
MEADOWBANK LAKES AND BAKER LAKE
CREMP SEDIMENT CORE SAMPLING

Standard Operating Procedure
Meadowbank Lakes & Baker Lake
CREMP Sediment Core Sampling

GENERAL:

Project Coordinator:
Morgan Finley
Azimuth Consulting Group
304-2537 Beacon Avenue,
Sidney, BC, V8L 1Y3
Telephone: 778-426-0112
Email: mfinley@azimuthgroup.ca

In case of **emergency**, contact Gary Mann ([redacted]).
Azimuth office telephone number 604-730-1220 or 778-426-0112.

LOCATION AND TIMING FOR FIELD ACTIVITIES:

Thirteen (13) sampling stations have been chosen for benthos and sediment quality monitoring in the Meadowbank project lakes. These stations (with their corresponding abbreviation) are:

- Third Portage Lake – North Basin (TPN)
- Third Portage Lake – East Basin (TPE)
- Third Portage Lake – East Basin B (TPE-B)
- Second Portage Lake (SP)
- Tehek Lake (TE)
- Inuggugayualik Lake (INUG)

- Tehek Lake – Far-field (TEFF)
- Third Portage Lake – South Basin (TPS)
- Wally Lake (WAL)
- Pipedream Lake (PDL)

- Baker Lake – Barge Dock (BBD)
- Baker Lake – Proposed Jetty (BPJ)
- Baker Lake – Akilahaarjuk Point (BAP)
- Baker Lake – East Shore (BES)

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**.

Sediment Coring Program:

An average top 1.5cm of sediment chemistry at all CREMP stations will be characterized using sediment cores. Note that this complements, rather than replaces, the grab samples (top 3 to 5 cm) collected synoptically with benthic community samples in late August. This is in addition to the traditional

composite sample using the petite Ponar grab. Ten (10) independent cores are to be collected from each of the stations. Cores will be collected within a 250 m radius around the center of each sampling area. The intent is to collect cores over a wide area, targeting depths of 6.5-9.5 m to match benthos sampling within the basin being sampled. The protocol for collecting sediment cores is as follows:

1. Core sampling is conducted prior to benthic sampling and will most often be paired with benthic sampling reps. Consideration can be given to identifying core sample locations prior to field collections.
2. If conditions are windy, anchor the boat. If calm, anchoring is not necessary. Survey the area to be sampled with the sonar to determine bottom type.
3. Deploy the corer from the boat and try to ensure that the core barrel is perpendicular with the surface before penetration. Depending on results, the corer can free-fall from 1 m above the surface. Avoid sampling over steep gradient slopes or over coarse grain substrate.
4. When the boat is anchored, deploy the corer from the boat and lower it when the boat has reached its furthest point in its swing to the right. This will be an odd numbered core. For the second core wait until the boat swings to the left, check the GPS to make sure this is around 5 m from the first core. This core will be an even numbered core. Cores can be taken from new locations each time and do not need to be at the exact same location as the other benthos work.
5. Raise the core to just below the water surface and cap prior to bringing above the water to ensure sediment is not lost out the bottom.
6. Check to make sure that the surface of the core is intact and is not mixed or disturbed and that the overlying water is clear. Record water depth and UTM location (NAD 83) of all successful core samples.
7. Process the core on the boat. Decant overlying water and collect only the top 1.5 cm of sediment.
8. Place the entire 1.5 cm slice into a 125 mL glass jar. Discard the remaining core sample.
9. Label the jars as per CREMP protocol (e.g., TE-x) but with a suffix indicating a core sample (e.g., TE-SC-01 to TE-SC-10).
10. Fill in the data sheet and record any observations about the core sample such as presence of varves, distinct changes in color, grain size, or any other unusual features.
11. Repeat the procedure above until all 5 or 10 core samples (depending on the needs outlined in the planning phase) have been collected, randomly covering the general area depicted on the map.
12. For 2014 ten cores from TPE, TPE-B, TPN, SP, TE, WAL, BBD, and BPJ. Five samples from TPS, TEFF, PDL, INUG, BAP, and BES.
13. Randomly from one of the 10 coring locations, take a duplicate core (independent deployment of corer) for QAQC purposes.

14. Even number core samples will be archived for those sites where ten samples are collected. For the 2014 sampling year, TPE and TPE-B will have 10 samples collected in each location with no archival.
15. All core samples are to be analysed for total metals, pH and total organic carbon. Fill in CoCs as necessary.
16. Hold on ice or in the refrigerator until shipping to ALS, Vancouver.
17. Hold times for pH and grease are only 14 days. TOC is 28 days.
18. 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.
19. A digital COC form is most commonly used; 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). Any questions regarding the COC form should be directed to the Azimuth project coordinator – Morgan Finley. Put the completed COC form in a sealed ziploc plastic bag in the cooler with the 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: Brent Mack

3. Send completed **COC forms** and **field data forms** to **Azimuth** Consulting Group, attention the project coordinator – Morgan Finley and Eric Franz (efranz@azimuthgroup.ca).

APPENDIX D

UPDATED THRESHOLD AND TRIGGER DEVELOPMENT FOR CREMP WATER PARAMETERS

Updated threshold and trigger development for CREMP water parameters

Data – The data used to develop triggers were the standard control ("baseline") samples – duplicates and depth replicates were excluded as they are pseudo-replicates of standard samples. All baseline samples through December 2013 were used. The number of baseline samples collected for each system was 204 for Meadowbank, 34 for Wally, and 31 for Baker (total = 269). The development of triggers was based on baseline data specific to each system (Meadowbank, Wally, and Baker).

Methods – The main text has described the rationale and approach for development of thresholds and triggers. There were three basic methods of trigger development as follows:

1. When a threshold (e.g., CCME guideline) was established, the trigger was set as the maximum of either (a) the value halfway between the baseline median and the threshold ("Method A"), or (b) the 95th percentile of the baseline data ("Method B").
2. When a threshold was not established, the trigger was set equal to the maximum of either the 95th percentile of the baseline data ("Method B") or two times the current detection limit ("Method C").

Medians and 95th percentiles were chosen as metrics rather than means, standard deviations, or maximums, because the former are generally robust to skewed distributions and potential outliers. When required, robust methods were used to estimate medians and 95th percentiles to account for values below detection limits (i.e., censored data; Helsel 2012). The analytical procedures for a given variable were as follows. First, all data reported detection limits greater than the maximum observed value were removed (such values contain no information regarding summary statistics of the data distribution; Helsel 2012). Next, classical estimates of medians and 95th percentiles were computed if possible (i.e., when there was the required number of observations exceeding detection limits). When there was insufficient data to compute a classical estimate, the median and/or 95th percentile were estimated using the robust "Regression on Order Statistics" (ROS) method as recommended by Helsel (2012) and implemented in the function "cenros" in the R package NADA. However, Helsel (2012) suggests that estimates of summary statistics such as the median are typically unreliable when more than 80% of the observations are censored (below detection limits). Thus, ROS estimates were only used when at least 20% of the observations were above detection limits. When a threshold was established but there was no viable estimate of the median, the current detection limit was used in "Method A" above. When a threshold was not established and there was no viable estimate of the 95th percentile, "Method C" was used.

There were special considerations for several variables, specifically t-Al, t-Cd, t-Mn, t-Zn, d-Al, ammonia-N, t-P, pH and TSS. These cases are explained in detail below.

Results – Thresholds and triggers are summarized in **Tables 1-3** for total metals, dissolved metals, and nutrients/conventionals. Thresholds were established for 54 variables based on water-quality guidelines (**Table 4**). In most cases, the threshold was equal to a given guideline, but there were exceptions for a few variables as discussed below. Note that in cases where a

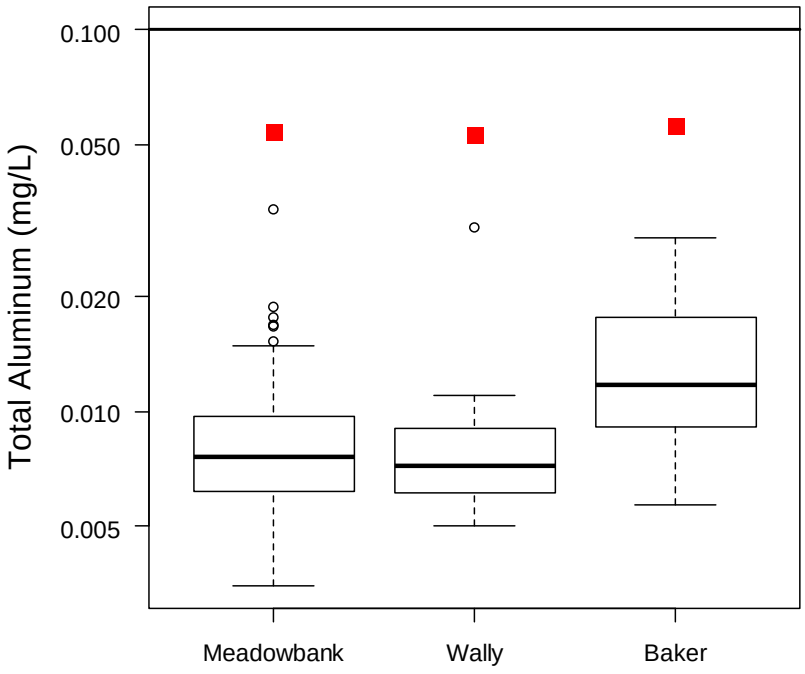
water quality guideline exists but Method B was used for trigger development (i.e., cases where baseline data already exceed the guideline for > 5% of cases), it is possible for the trigger to equal or exceed the guideline (e.g., this occurs for total phosphorus, the lower pH trigger for Meadowbank, and the Baker triggers for total and dissolved strontium). In such cases, the guideline is reported as the threshold but is not used as a criterion for action; rather, the trigger is the only criterion for action as is the case for variables lacking water quality guidelines.

There are three variables (t-Cu, t-Pb, t-Ni) for which the water quality guidelines are specific to water hardness ranges below 82, 60, and 60 mg/L $CaCO_3$, respectively. Hardness levels for Meadowbank, Wally, and Baker samples were consistently below 60 mg/L $CaCO_3$. For example, as reported in **Table 3**, the 95th percentiles for hardness were 8.5, 16.7, and 41.2 for Meadowbank, Wally, and Baker samples, respectively. Thus for these three variables, the guidelines associated with low hardness ranges were used as thresholds.

Special Cases – There were several variables that warranted special consideration in the development of thresholds and/or triggers. These are discussed in the following pages.

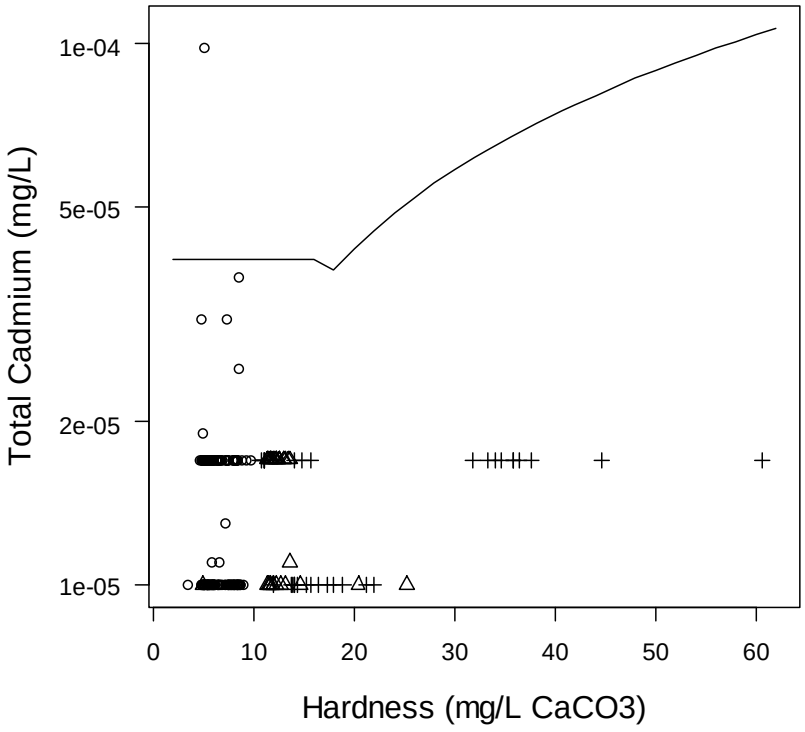
Total aluminum -- The CCME guideline for t-Al in water is 0.005 mg/L when pH < 6.5, and 0.1 mg/L when pH ≥ 6.5. Across baseline samples for Meadowbank/Wally/Baker (n = 269), there were only 9 cases of pH < 6.5 (two for station TPE, six for TPS, and one for INUG), of which only three were below pH = 6.47 (values = 6.18, 6.20, and 6.34). For these nine samples, only four t-Al measurements were above the current DL (0.005 mg/L), with a maximum value of 0.0076 mg/L.

Given the strong tendency for pH to equal or exceed 6.5 across baseline samples, the CCME guideline of 0.1 mg/L was adopted as the threshold for t-Al (**Table 1**). Triggers were computed for each system based on Method A (**Table 1**). For example, across the 204 Meadowbank samples, the median t-Al was 0.007 mg/L and the 95th percentile was 0.014 mg/L (**Table 1**). Based on Method A, the value halfway between the median t-Al and the threshold is 0.054 mg/L (i.e., [0.1 – 0.007]/2 = 0.054), which is larger than the 95% percentile (Method B), and thus the proposed trigger for Meadowbank t-Al is 0.054 mg/L. Similar trigger values were computed for Wally and Baker (**Table 1**). As an example, the following figure shows box-plots of t-Al values (> DL; in log scale) for each of Meadowbank/Wally/Baker, as well as the guideline (solid line) and proposed triggers (solid red squares).



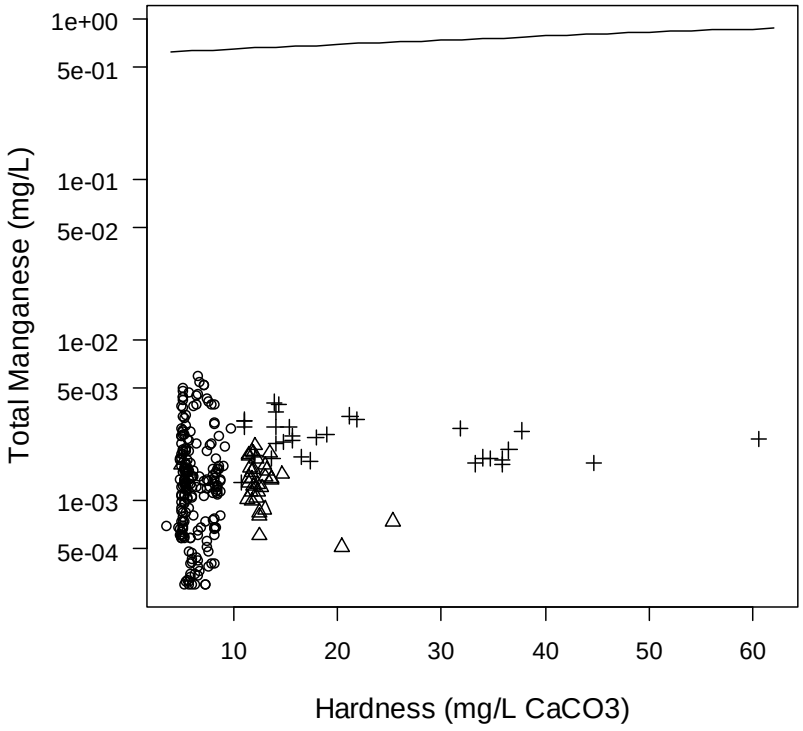
Total cadmium -- The hardness-dependent CCME guideline for t-Cd (mg/L) is 0.00004 when water hardness (mg/L $CaCO_3$) is less than 17.0, and equal to $0.001*10^{0.83*\log10(H)-2.46}$ (where H = hardness) when water hardness is ≥ 17.0 and ≤ 280. The relationship is illustrated in the figure below (solid curve) across the range of baseline observations of hardness for Meadowbank (circles), Wally (triangles), and Baker ("+"). Note that baseline measurements of t-Cd exceeded detection limits for only 10 of 204 Meadowbank samples and one of 34 Wally samples, and just one measure exceeded the CCME guideline (station TPE, hardness = 5.05, t-Cd = 0.000098 mg/L).

For simplicity, we propose a single t-Cd trigger applicable to all three systems (**Table 1**). The median sample values of hardness for Meadowbank (5.7), Wally (12.2), and Baker (16.5) were all less than 17.0 mg/L $CaCO_3$, and hence, the CCME guideline of 0.00004 mg/L was set as the threshold for each system. Because there were insufficient data to compute medians or 95th percentiles, the trigger was computed via Method A using the current detection limit (i.e., halfway between 0.00001 and 0.00004), providing a trigger value of 0.000025 (**Table 1**).



Total manganese -- There is no CCME water quality guideline for t-Mn. The hardness-dependent BC MOE guideline for t-Mn (mg/L) is 0.0044*H + 0.605, where H = hardness (mg/L $CaCO_3$). This guideline is based on numerous studies for fish, invertebrates and plants. The relationship is illustrated in the figure below (solid curve) across the range of baseline observations of hardness for Meadowbank (circles), Wally (triangles), and Baker ("+"). The guideline greatly exceeds observed t-Mn values for all samples.

For simplicity, we propose a single t-Mn trigger for each system. To compute the t-Mn trigger, we first computed the guidelines corresponding to the median values of hardness observed for Meadowbank samples (median hardness = 5.70, t-Mn guideline = 0.63), Wally samples (median hardness = 12.2, t-Mn guideline = 0.66), and Baker samples (median hardness = 16.5, t-Mn guideline = 0.68). The corresponding lake-specific triggers for t-Mn (using Method A) are 0.32 for Meadowbank, 0.33 for Wally, and 0.34 for Baker (**Table 1**).

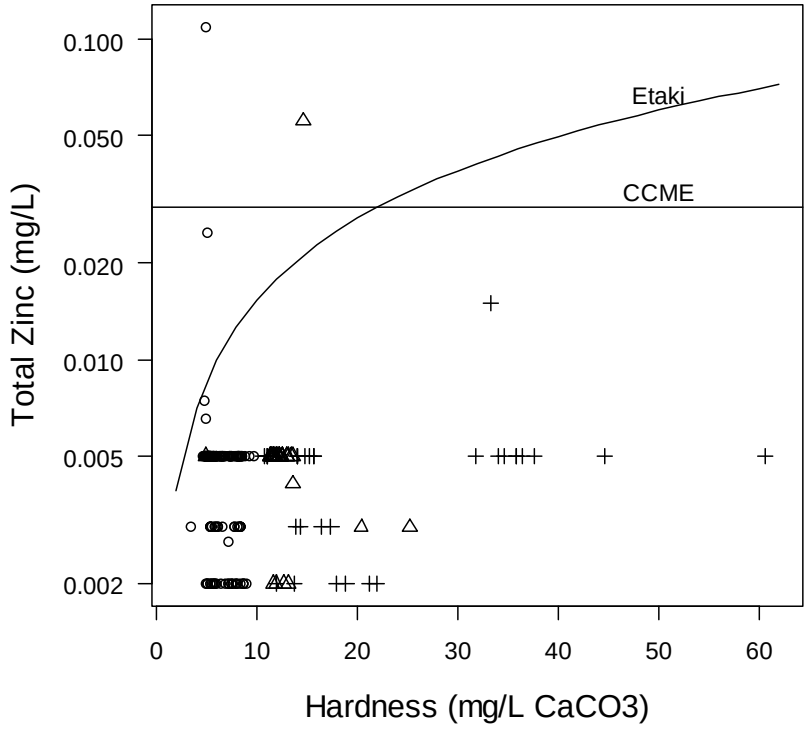


Total zinc -- The CCME water quality guideline for Zn is 0.030 mg/L. However, this guideline does not take into account hardness, and zinc toxicity is known to be hardness-dependent. An assessment for Ekati by EVS (2004) compiled data on species applicable to oligotrophic systems with low hardness, and developed a chronic benchmark for that was hardness dependent. The Ekati benchmark, denoted HC_5, represents the concentration of t-Zn at which 95% of species are likely to be protected against chronic effects (EVS 2004):

Hardness (mg/L CaCO3)	t-Zn level (HC_5) (mg/L)
5	0.0085
10	0.0153
15	0.0216
20	0.0276
25	0.0334
30	0.0389
35	0.0444
40	0.0497
45	0.0549
50	0.0600
55	0.0651
60	0.0700
65	0.0750
70	0.0798
75	0.0846
80	0.0894

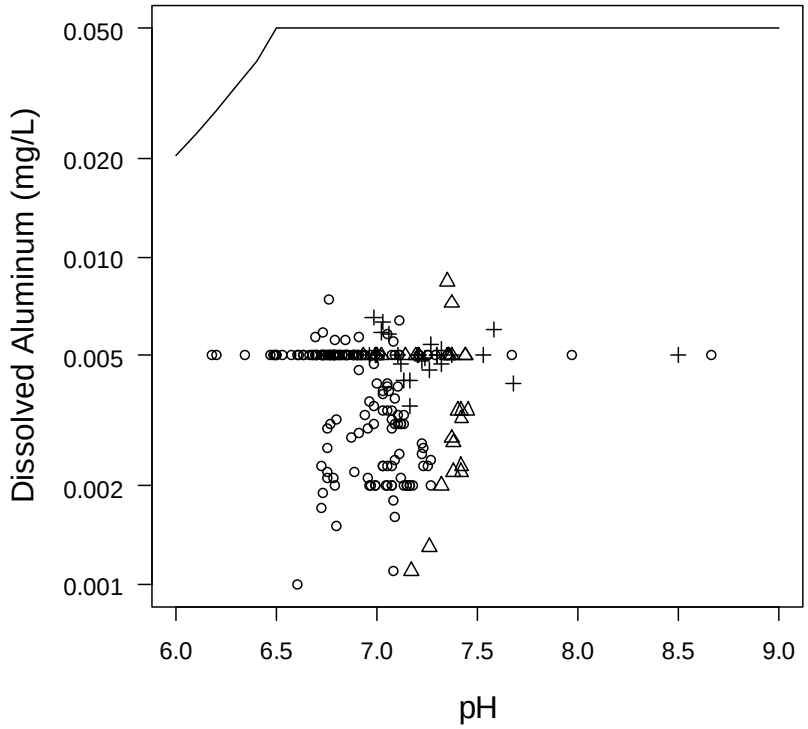
To express benchmarks as a continuous relationship, we fit a power function to the hardness-HC_5 data, which provided a near-perfect fit: t-Zn (HC_5) in mg/L $= 0.00217*H^{0.8486}$, where H = hardness (mg/L $CaCO_3$). This relationship is illustrated in the figure below (solid curve) across the range of baseline observations of hardness for Meadowbank (circles), Wally (triangles), and Baker ("+"). Note that the Ekati t-Zn benchmark is lower than the CCME guideline of 0.03 mg/L for hardness less than about 23. Only six of 269 baseline measurements of t-Zn have exceeded detection limits (four for Meadowbank, including the anomalous high value of t-Zn = 0.109 mg/L that occurred for station TPS in July 2009, and two for Wally).

As for t-Mn, we propose a single t-Zn trigger for each system. First, we computed the t-Zn benchmark (HC_5) corresponding to the median values of hardness observed for Meadowbank samples (median hardness = 5.70, t-Zn benchmark = 0.0095), Wally samples (median hardness = 12.2, t-Zn benchmark = 0.0181), and Baker samples (median hardness = 16.5, t-Zn benchmark = 0.0234). The corresponding lake-specific triggers for t-Zn (using Method A with the current DL = 0.003 mg/L) are 0.006 for Meadowbank, 0.011 for Wally, and 0.013 for Baker (**Table 1**).


0.100
0.050
0.020
0.010
0.005
0.002
Total Zinc (mg/L)
Etaki
CCME
0
10
20
30
40
50
60
Hardness (mg/L CaCO3)

Dissolved aluminum – There is no CCME guideline for d-Al in water. However, a pH-dependent water quality guideline for d-Al (mg/L) has been developed by BC MOE for protection of freshwater aquatic life. For pH < 6.5, the guideline is as follows: d-Al = $e^{(1.6-3.327*pH + 0.402*K)}$ where $K = pH^2$. For pH ≥ 6.5, the guideline is 0.05 mg/L. This relationship is illustrated in the figure below (solid curve) across the range of baseline observations of pH for Meadowbank (circles), Wally (triangles), and Baker ("+"). The BC MOE guideline greatly exceeds all observed values of d-Al.

Again, we propose a single d-Al trigger for each system. Based on the median pH observed for Meadowbank (6.89), Wally (7.35), and Baker (7.21), the corresponding BC MOE guideline for d-Al is 0.05 mg/L in each case. As documented in **Table 2**, the proposed triggers for d-Al (based on Method A and ROS estimates for median d-Al) are 0.026 for Meadowbank, 0.026 for Wally, and 0.027 for Baker.



Ammonia-N -- The CCME guideline for total ammonia in freshwater is pH and temperature dependent, with more stringent guidelines applying at higher pH and higher temperature. The proposed threshold for Ammonia-N (Meadowbank and Baker) was conservatively derived using two discrete CCME guidelines corresponding to specific pH and temperature values. Note that the maximum pH among baseline data for Meadowbank/Wally/Baker is 8.66, while maximum temperatures in the lakes are around 16 to 18 degrees. The two CCME guidelines that span these maximum (i.e., worst-case) conditions are as follows: (1) total ammonia = 0.239 mg/L for pH = 8.5 and temperature = 15 degrees; and (2) total ammonia = 0.067 mg/L for pH = 9.0 and temperature = 20 degrees. The mid-point of these two values is 0.153 mg/L, which when converted from total ammonia to total ammonia as N is 0.126 mg/L.

Thus, the proposed threshold for ammonia-N is 0.126 mg/L. Application of this threshold provided trigger values of 0.065, 0.067, and 0.067 mg/L respectively for Meadowbank, Wally, and Baker (**Table 3**). Only at extreme pH and temperature would this trigger potentially exceed the CCME guideline. Whenever the trigger is exceeded, the concentrations of ammonia-N should be compared to the CCME guideline based on the specific pH and field temperature of each sample.

Total P -- The CCME does not specify a particular guideline for total phosphorus, but instead establishes a guidance framework for site-specific application. Under that framework, the specification for ultra-oligotrophic lakes is for total-P of <0.004 mg/L. The framework notes that up to a 50% increase in total-P over baseline is generally considered acceptable. Regardless, the 95th percentiles for Total-P exceeded 0.004 mg/L for both Meadowbank samples and Baker samples (**Table 3**). Consequently, the proposed lake-specific triggers were set equal to these 95th percentiles (Method B, **Table 3**).

pH -- The CCME guideline for pH in freshwater is a range from 6.5 to 9.0. Thus, for pH, there is both an upper threshold (9.0) and a lower threshold (6.5), with associated upper and lower triggers (**Table 3**). In the case of Meadowbank data, the lower trigger was based on Method B because the 5th percentile of the baseline data was equal to the lower threshold of 6.50 (**Table 3**).

TSS -- For water bodies with low natural TSS, the CCME guideline is a maximum increase of 25 mg/L over background for short periods (e.g., 24h) and a maximum increase of 5 mg/L over background for longer periods (e.g., 24h to 30 days). If we conservatively assume a background TSS of 0 mg/L, then thresholds of 25 mg/L and 5 mg/L would apply for short-term and long-term exposures, respectively. However, because sampling occurs only at most once per month, it will be unknown whether a given TSS measure is a short-term (< 24 h) or longer term (> 24 h) phenomenon. We therefore propose a TSS trigger based on the lower threshold of 5 mg/L, which thereby addresses both short and long durations. The resulting triggers, based on Method A, were 3.0 mg/L for all three systems (**Table 3**).

Table 1. Total metals: summary of trigger values for Meadowbank, Wally, and Baker stations.

Notes: For each variable, thresholds (guidelines) are shown if applicable (see text for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; Med = median if estimable; P95 = 95th percentile if estimable; M = method used to determine the trigger, where A = halfway from median (or DL if median not estimable) to threshold, B = 95th percentile, and C = 2*DL.

			Meadowbank						**Wally**						**Baker**					
Variable	Threshold	DL	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M
Aluminum (T)	0.1	0.003	204	169	0.007	0.014	0.054	A	34	23	0.006	0.011	0.053	A	31	30	0.011	0.023	0.056	A
Antimony (T)	0.02	0.0001	204	0	NA	NA	0.010	A	34	0	NA	NA	0.010	A	31	0	NA	NA	0.010	A
Arsenic (T)	0.005	0.0001	204	14	NA	NA	0.0026	A	34	14	0.00025	0.00029	0.0026	A	31	4	0.00015	NA	0.0026	A
Barium (T)	1.0	0.00005	204	79	0.0021	0.0030	0.50	A	34	14	0.0019	0.0030	0.50	A	31	14	0.0177	0.0196	0.51	A
Beryllium (T)	0.0053	0.0001	204	0	NA	NA	0.0027	A	34	0	NA	NA	0.0027	A	31	0	NA	NA	0.0027	A
Boron (T)	1.5	0.01	204	1	NA	NA	0.76	A	34	0	NA	NA	0.76	A	31	3	0.011	0.011	0.76	A
Cadmium (T)	0.00004	0.00001	204	10	NA	NA	0.000025	A	34	1	NA	NA	0.000025	A	31	0	NA	NA	0.000025	A
Chromium (T)	0.001	0.0001	204	14	0.00011	0.00046	0.00056	A	34	0	NA	NA	0.00055	A	31	2	NA	NA	0.00055	A
Copper (T)	0.002	0.0005	204	61	0.00047	0.00068	0.00124	A	34	16	0.00098	0.00129	0.00149	A	31	11	0.00049	0.00060	0.00125	A
Iron (T)	0.3	0.01	204	26	NA	NA	0.155	A	34	6	0.015	0.025	0.157	A	31	9	0.020	0.063	0.160	A
Lead (T)	0.001	0.00005	204	7	NA	NA	0.00053	A	34	2	NA	0.00015	0.00053	A	31	1	NA	NA	0.00053	A
Lithium (T)	0.096	0.0005	204	6	0.00042	0.00063	0.048	A	34	2	0.00085	NA	0.048	A	31	6	0.0010	0.0036	0.048	A
Manganese (T)	See text	0.00005	204	198	0.0013	0.0043	0.316	A	34	34	0.0014	0.0020	0.330	A	31	31	0.0024	0.0038	0.340	A
Mercury (T)	0.000026	0.00001	204	1	NA	NA	0.000018	A	34	0	NA	NA	0.000018	A	31	0	NA	NA	0.000018	A
Molybdenum (T)	0.073	0.00005	204	5	NA	NA	0.037	A	34	3	0.00013	0.00019	0.037	A	31	4	0.00008	NA	0.037	A
Nickel (T)	0.025	0.0005	204	8	0.0005	0.0007	0.013	A	34	0	NA	NA	0.013	A	31	0	NA	NA	0.013	A
Selenium (T)	0.001	0.0001	204	0	NA	NA	0.00055	A	34	0	NA	NA	0.00055	A	31	0	NA	NA	0.00055	A
Strontium (T)	0.049	0.0002	192	188	0.0068	0.0095	0.028	A	32	32	0.016	0.022	0.033	A	31	31	0.025	0.056	0.056	B
Thallium (T)	0.0008	0.00001	204	0	NA	NA	0.00041	A	34	0	NA	NA	0.00041	A	31	0	NA	NA	0.00041	A
Tin (T)		0.0001	204	2	NA	NA	0.0002	C	34	0	NA	NA	0.0002	C	31	0	NA	NA	0.0002	C
Titanium (T)	2.0	0.01	204	14	0.00016	0.00044	1.0	A	34	3	0.00013	0.00049	1.0	A	31	4	0.00038	NA	1.0	A
Uranium (T)	0.015	0.00001	204	20	0.00004	0.00006	0.0075	A	34	2	0.00004	NA	0.0075	A	31	4	0.00005	NA	0.0075	A
Vanadium (T)	0.006	0.001	204	0	NA	NA	0.0035	A	34	0	NA	NA	0.0035	A	31	0	NA	NA	0.0035	A
Zinc (T)	See text	0.003	204	4	NA	NA	0.0063	A	34	2	NA	NA	0.0106	A	31	0	NA	NA	0.0132	A

Table 2. Dissolved metals: summary of trigger values for Meadowbank, Wally, and Baker stations.

Notes: For each variable, thresholds (guidelines) are shown if applicable (see text for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; Med = median if estimable; P95 = 95th percentile if estimable; M = method used to determine the trigger, where A = halfway from median (or DL if median not estimable) to threshold, B = 95th percentile, and C = 2*DL.

			Meadowbank						**Wally**						**Baker**					
Variable	Threshold	DL	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M
Aluminum (D)	0.05	0.001	164	69	0.003	0.005	0.026	A	27	13	0.003	0.006	0.026	A	28	17	0.005	0.006	0.027	A
Antimony (D)	0.02	0.0001	164	0	NA	NA	0.010	A	27	0	NA	NA	0.010	A	28	0	NA	NA	0.010	A
Arsenic (D)	0.005	0.0001	164	12	NA	NA	0.0026	A	27	13	0.00024	0.00034	0.0026	A	28	6	0.00012	0.00024	0.0026	A
Barium (D)	1.0	0.00005	164	79	0.0020	0.0029	0.50	A	27	13	0.0018	0.0030	0.50	A	28	14	0.0178	0.0200	0.51	A
Beryllium (D)	0.0053	0.0001	164	0	NA	NA	0.0027	A	27	0	NA	NA	0.0027	A	28	0	NA	NA	0.0027	A
Boron (D)	1.5	0.01	164	0	NA	NA	0.76	A	27	0	NA	NA	0.76	A	28	0	NA	NA	0.76	A
Cadmium (D)	0.00004	0.00001	164	3	NA	NA	0.000025	A	27	0	NA	NA	0.000025	A	28	0	NA	NA	0.000025	A
Chromium (D)	0.001	0.0001	164	1	NA	NA	0.00055	A	27	0	NA	NA	0.00055	A	28	1	NA	NA	0.00055	A
Copper (D)	0.002	0.0002	164	77	0.00038	0.00049	0.00119	A	27	15	0.00087	0.00148	0.00148	B	28	13	0.00033	0.00044	0.00116	A
Iron (D)	0.3	0.01	164	0	NA	NA	0.155	A	27	0	NA	NA	0.155	A	28	1	NA	NA	0.155	A
Lead (D)	0.001	0.00005	164	3	NA	NA	0.00053	A	27	2	NA	0.00015	0.000525	A	28	0	NA	NA	0.000525	A
Lithium (D)	0.096	0.0005	164	2	NA	0.00053	0.048	A	27	2	0.00099	NA	0.048	A	28	4	0.0008	NA	0.048	A
Manganese (D)	See text	0.00005	164	114	0.0004	0.0029	0.315	A	27	22	0.0004	0.0015	0.330	A	28	24	0.0006	0.0019	0.339	A
Mercury (D)	0.000026	0.00001	153	2	NA	NA	0.000018	A	25	0	NA	NA	0.000018	A	26	0	NA	NA	0.000018	A
Molybdenum (D)	0.073	0.00005	164	17	0.00010	0.00018	0.037	A	27	8	0.00011	0.00019	0.037	A	28	3	0.00006	NA	0.037	A
Nickel (D)	0.025	0.0005	164	6	NA	NA	0.013	A	27	1	NA	NA	0.013	A	28	0	NA	NA	0.013	A
Selenium (D)	0.001	0.0001	164	0	NA	NA	0.00055	A	27	0	NA	NA	0.00055	A	28	0	NA	NA	0.00055	A
Strontium (D)	0.049	0.002	164	161	0.0069	0.0090	0.028	A	27	27	0.016	0.023	0.033	A	28	28	0.023	0.049	0.049	B
Thallium (D)	0.0008	0.00001	164	0	NA	NA	0.00041	A	27	0	NA	NA	0.00041	A	28	0	NA	NA	0.00041	A
Tin (D)		0.0001	164	0	NA	NA	0.0002	C	27	0	NA	NA	0.0002	C	28	0	NA	NA	0.0002	C
Titanium (D)	2.0	0.01	164	0	NA	NA	1.0	A	27	0	NA	NA	1.0	A	28	0	NA	NA	1.0	A
Uranium (D)	0.015	0.00001	164	20	0.00003	0.00005	0.0075	A	27	2	0.00004	NA	0.0075	A	28	4	0.00004	NA	0.0075	A
Vanadium (D)	0.006	0.001	164	0	NA	NA	0.0035	A	27	0	NA	NA	0.0035	A	28	0	NA	NA	0.0035	A
Zinc (D)	See text	0.001	164	6	NA	0.0021	0.0053	A	27	2	NA	NA	0.0096	A	28	2	NA	0.0028	0.0122	A

Table 3. Nutrients and conventional parameters: summary of trigger values for Meadowbank, Wally, and Baker stations.

Notes: For each variable, thresholds (guidelines) are shown if applicable (see text for discussion); DL = current detection limit; N = sample measurements; >DL = number of measurements above DL; Med = median if estimable; P95 = 95th percentile if estimable; M = method used to determine the trigger, where A = halfway from median (or DL if median not estimable) to threshold, B = 95th percentile, and C = 2*DL. **Red bolded** text indicates parameter values that are new for 2014 reporting (Azimuth, 2015).

			Meadowbank						**Wally**						**Baker**					
Variable	Threshold	DL	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M	N	>DL	Med	P95	Trigger	M
Ammonia-N	0.126	0.005	204	52	0.005	0.046	0.065	A	34	12	0.007	0.024	0.067	A	31	13	0.007	0.031	0.067	A
TKN		0.05	204	178	0.097	0.170	0.170	B	34	31	0.111	0.163	0.163	B	31	28	0.157	0.214	0.214	B
Nitrate-N	3.0	0.005	204	26	NA	0.025	1.503	A	34	2	NA	NA	1.503	A	31	26	0.014	0.030	1.507	A
Nitrite-N	0.06	0.001	204	6	NA	NA	0.031	A	34	2	NA	NA	0.031	A	31	2	NA	NA	0.031	A
Ortho-phosphate		0.001	192	10	NA	0.0010	0.0020	C	34	3	NA	0.0010	0.0020	C	31	5	0.0007	0.0013	0.0020	C
T. phosphorous	0.004	0.002	192	84	0.0019	0.0060	0.0060	B	34	21	0.0028	0.0067	0.0067	B	31	23	0.0036	0.0096	0.0096	B
TOC		0.5	204	204	1.74	2.79	2.79	B	34	34	2.18	4.11	4.11	B	31	31	3.16	4.25	4.25	B
DOC		0.5	204	204	1.70	2.60	2.60	B	34	34	2.20	3.21	3.21	B	31	31	3.17	4.05	4.05	B
Reactive silica		0.5	185	56	0.28	0.44	1.00	C	32	14	0.74	1.08	1.08	B	28	10	0.31	0.42	1.00	C
Bicarb. alkalinity		2.0	192	192	5.2	8.6	8.6	B	34	34	10.0	17.8	17.8	B	31	31	9.3	10.6	10.6	B
Chloride	120	0.1	204	141	0.550	0.809	60.3	A	34	15	0.469	0.639	60.2	A	31	31	24.4	95.7	95.7	B
Carb. alkalinity		2.0	192	0	NA	NA	4.0	C	34	0	NA	NA	4.0	C	31	0	NA	NA	4.0	C
Conductivity		2.0	204	204	15.2	23.5	23.5	B	34	34	28.7	36.6	36.6	B	31	31	110.0	494.5	494.5	B
Hardness		0.5	204	204	5.7	8.5	8.5	B	34	34	12.2	16.7	16.7	B	31	31	16.5	41.2	41.2	B
Calcium		0.5	204	204	1.30	2.15	2.15	B	34	34	3.34	4.88	4.88	B	31	31	3.02	4.50	4.50	B
Potassium		0.1	204	79	0.37	0.50	0.50	B	34	14	0.37	0.59	0.59	B	31	20	0.93	2.43	2.43	B
Magnesium		0.1	204	204	0.64	0.83	0.83	B	34	34	0.96	1.36	1.36	B	31	31	2.61	7.44	7.44	B
Sodium		0.05	204	79	0.55	0.98	0.98	B	34	14	0.48	0.72	0.72	B	31	31	12.1	54.0	54.0	B
Sulphate	128	0.5	204	204	1.42	2.83	64.7	A	34	34	2.34	3.38	65.2	A	31	31	3.84	13.80	65.9	A
pH **Field** (Upper)	**9.0**	**0.1**	**174**	**174**	**7.24**	**8.25**	**8.25**	**B**	**32**	**32**	**7.67**	**8.26**	**8.34**	**A**	**26**	**26**	**7.41**	**8.32**	**8.32**	**B**
pH **Field** (Lower)	**6.5**	**0.1**	**174**	**174**	**7.24**	**6.30**[a]	**6.30**	**B**	**32**	**32**	**7.67**	**6.54**[a]	**6.54**	**B**	**26**	**26**	**7.41**	**6.50**[a]	**6.50**	**B**
pH Lab (Upper)	9.0	0.1	204	204	6.89	7.27	7.94	A	34	34	7.35	7.44	8.17	A	31	31	7.21	7.66	8.11	A
pH Lab (Lower)	6.5	0.1	204	204	6.89	6.50[a]	6.50	B	34	34	7.35	7.00[a]	**6.92**	A	31	31	7.21	6.99[a]	**6.86**	A
Total Alkalinity		2.0	192	192	5.20	8.55	8.55	B	34	34	10.0	17.8	17.8	B	31	31	9.3	10.6	10.6	B
TDS		3.0	204	134	11.0	18.0	18.0	B	34	34	18.0	25.3	25.3	B	31	31	64.0	208.0	208.0	B
TSS	5.0	1.0	204	9	NA	NA	3.00	A	34	1	NA	NA	3.00	A	31	2	NA	NA	3.00	A

[a] For pH (Lower), the 5th percentile is reported.

Table 4. Summary of thresholds for water variables.

Variable	Source	Description of guidelines
t-Aluminum (Al)	CCME	The CCME guideline for t-Al in water is 0.005 mg/L when pH < 6.5, and 0.1 mg/L when pH ≥ 6.5. See text for details.
t-Arsenic (As) **d-Arsenic	CCME	The CCME water quality guideline (aquatic life) for t-As is 0.005 mg/L.
t-Boron (B) **d-Boron	BC MOE	There is no CCME guideline for t-B. However, the BC Ministry of Environment (BC MOE, www.env.gov.bc.ca) guideline for freshwater aquatic life is 1.2 mg/L.
t-Cadmium (Cd) **d-Cadmium	CCME	The hardness-dependent CCME guideline for t-Cd (mg/L) is 0.00004 mg/L when hardness > 0 to < 17 mg/L $CaCO_3$ and is $0.001*10^{0.83*\log(H)-2.46}$ where H = hardness (mg/L $CaCO_3$) when hardness is >= 17 to <= 280 mg/L $CaCO_3$. For hardness > 280 mg/L $CaCO_3$, the guideline is 0.00037 mg/L.
t-Chromium (Cr) **d-Chromium	CCME	The CCME guideline for hexavalent chromium (the most common form in surface waters) is 0.001 mg/L.
t-Copper (Cu) **d-Copper	CCME	The CCME guideline for t-Cu is 0.002 mg/L for hardness < 82 mg/L $CaCO_3$.
t-Iron (Fe) **d-Iron	CCME	The CCME guideline for t-Fe is 0.3 mg/L.
t-Lead (Pb) **d-Lead	CCME	The CCME guideline for t-Pb is 0.001 mg/L for hardness < 60 mg/L $CaCO_3$.
t-Manganese (Mn) **d-Manganese	BC MOE	There is no CCME guideline for t-Mn in water. The hardness-dependent BC MOE guideline for t-Mn in mg/L is 0.0044*H + 0.605, where H = hardness (mg/L $CaCO_3$). See text for details.
t-Mercury (Hg) **d-Mercury	CCME	The CCME guideline for total inorganic mercury is 26 ng/L (0.00026 mg/L).
t-Molybdenum (Mo) **d-Molybdenum	CCME	The CCME guideline for t-Mo in water is 0.073 mg/L.
t-Nickel (Ni) **d-Nickel	CCME	The CCME guideline for t-Ni is 0.025 mg/L for hardness < 60 mg/L $CaCO_3$.
t-Selenium (Se) **d-Selenium	CCME	The CCME guideline for t-Se in water is 0.001 mg/L.
t-Thallium (Tl) **d-Thallium	CCME	The CCME water quality guideline for t-Tl is 0.0008 mg/L.
t-Zinc (Zn) **d-Zinc	CCME Ekati	The CCME water quality guideline for t-Zn is 0.030 mg/L. However, this guideline does not take into account hardness, and zinc toxicity is known to be hardness-dependent. An assessment for Ekati by EVS (2004) compiled data on species applicable to oligotrophic systems with low hardness, and developed a chronic benchmark for t-Zn that was

		hardness dependent. See text for details.
d-Aluminum (Al)	BC MOE	A pH-dependent water quality guideline for d-Al (mg/L) has been developed by BC MOE for protection of freshwater aquatic life when pH <6.5 as follows: $d\text{-}Al = e^{(1.6-3.327*pH + 0.402*K)}$ where $K = pH^2$. For pH >= 6.5 the guideline is 0.05 mg/L See text for details.
Ammonia-N	CCME	The CCME guidelines for total ammonia in freshwater are pH and temperature dependent, with more stringent guidelines applying at higher pH and higher temperature. See text for details.
Nitrate-N	CCME	The CCME guideline for NO3-N is 2.9 mg/L.
Nitrite-N	CCME	The CCME guideline for nitrite-N is 0.06 mg/L.
t-Phosphorous (P)	CCME	The CCME does not specify a particular guideline for t-P, but instead establishes a guidance framework for site-specific application. See text for details.
pH	CCME	The CCME guideline for pH is a range from 6.5 to 9.0. See text for details.
TSS	CCME	For water bodies with low natural TSS, the CCME guideline is a maximum increase of 25 mg/L over background for short periods (e.g., 24h) and 5 mg/L for longer periods (e.g., 24h to 30 days). See text for details.

****** where thresholds for total metals were developed, those thresholds were also applied to dissolved metal parameters.

AGNICO EAGLE

MEADOWBANK GOLD MINE

2015 WATER MANAGEMENT REPORT AND PLAN

OCTOBER 2015

VERSION 03

EXECUTIVE SUMMARY

Agnico-Eagle Mines Ltd. Meadowbank Division (AEM) is operating the Meadowbank Gold Mine (the Mine), located on Inuit-owned surface lands in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake, Nunavut. The mine is subject to the terms and conditions of both the Project Certificate issued in accordance with the Nunavut Land Claims Agreement Article 12.5.12 on December 30, 2006, and the Nunavut Water Board Water Licence No. 2AM-MEA1525 issued on July 23, 2015.

This report presents an updated version of the Water Management Plan 2014 that provides a revised site-wide water balance. The revised water balance will determine the demand and storage requirements of water over the life of the mine. The storage strategies and required transfers will be discussed at large. Certain concepts within the water balance, including pit flooding, remain at the conceptual stage for now and will be further detailed in the Final Mine Closure and Reclamation Plan to be submitted one year prior to final closure in accordance with the current Type A Water License.

The necessity of this particular water management update follows changes in the observed natural pit water inflows, updated tailings deposition parameters, mine and milling life schedule and production rate, tailings management and pit backfilling strategies.

Recommendations and requirements concerning the water use and management, the water balance and the water quality modelling and outlined in the *document Water License: 2AM-MEA1525 Reasons for Decision Including Record of Proceedings* from the Nunavut Water Board will be included in the next version of the Meadowbank Water Management Plan Report which will be submitted with the Meadowbank Annual Report 2015 (March 31, 2016). The Water Management Plan will be updated on a yearly basis as required by the Nunavut Water Board Water Licence 2AM-MEA1525.This will include an updated Water Quality modelling forecast yearly. AEM conducts this modelling to determine if treatment prior to transfer of the South Cell reclaim water would require treatment, if treatment would be achievable in situ after transfer or if no treatment is necessary. Prior to transfer of main volume of South Cell water the model forecasts will be consulted and a decision will be made. However, it is important to note that AEM will not breach the dikes until the water quality meets CCME Guidelines for the Protection of Aquatic Life. Also,water quality concentrations for parameters of concern that are not included in the CCME guidelines will be similar to or within background concentrations of those parameters.

DOCUMENT CONTROL

Version	Date (YM)	Section	Page	Revision
1	March 2014	ALL	-	Revision for the 2012 Water Management Plan (by SNC) according to the updated Life of Mine and water management strategies
2	March 2015	ALL	-	Revision for the 2013 Water Management Plan (by AEM) according to the updated Life of Mine and water management strategies
3	October 2015	ALL	-	Updated items mentioned by NWB in the "Reasons for decision including record of proceedings" document.

Prepared By:

Julie Belanger
Engineering and Environmental Department

Approved by:

Kevin Buck
Engineering and Environmental Department

Table of Contents

SECTION 1.0 - INTRODUCTION 8

SECTION 2.0 - BACKGROUND INFORMATION 9

2.1 Site Conditions 9

2.1.1 Climate 10

2.1.2 Faults 11

2.1.3 Permafrost 12

2.1.4 Hydrology 12

2.2 Mining Operation Description 13

2.2.1 Portage Pit Area 14

2.2.2 Goose Pit Area 15

2.2.3 Vault Pit Area 16

2.3 Life Of Mine Description 17

2.3.1 Changes from the Water Management Plan 2013 18

SECTION 3.0 - WATER MANAGEMENT PLAN AND WATER BALANCE 19

3.1 General Water Management Strategy 19

3.1.1 Fresh Water from Third Portage Lake 20

3.1.2 Reclaim Tailings Water 22

3.1.3 Mill 24

3.1.4 North Cell 25

3.1.5 South Cell 26

3.1.6 Portage Pit 26

3.1.7 Goose Pit 26
3.1.8 Water Transfers 27
3.1.9 Seepage Collection Systems 31
3.2 Pit Reflooding 36
3.2.1 Goose pit reflooding 38
3.2.2 Portage pit reflooding 40
3.2.3 Vault pit reflooding 41
3.3 Water Management Structures 42

SECTION 4.0 - MEADOWBANK WATER QUALITY FORECASTING UPDATE 42

SECTION 5.0 - 2014 INTEGRATED DEPOSITION PLAN 44

SECTION 6.0 - CONCLUSION 45

SECTION 7.0 - RECOMMENDATIONS 47

SECTION 8.0 - REFERENCES 48

APPENDIX A – WATER BALANCE 49

APPENDIX B – GENERAL WATER MOVEMENT 64

APPENDIX C – 2014 MEADOWBANK WATER QUALITY FORECASTING UPDATE 69

APPENDIX D – 2015 FRESHET ACTION PLAN 119

APPENDIX E – 2014 AMMONIA MANAGEMENT PLAN 166

LIST OF TABLES

Table 2.1: Estimated average monthly climate data – Baker Lake 10

Table 2.2: Total annual precipitation for varying return periods 12

Table 2.3: Current official LOM figures – Processed ore tonnages 18

Table 3.1: 2015 Targetted water hourly consumption per month 21

Table 3.2: Yearly water consumption summary 22

Table 3.3: Monthly average ore moisture content observed and forecasted at the mill 25

Table 3.4: TSF water transfers 28

Table 3. 5: Wally Lake annual discharge 30

Table 3.6: Mill Seepage 2014 pumped volumes 33

Table 3.7: ST-16 RFS Seepage 2014 pumped volumes 34

Table 3.8: Mill Seepage 2014 pumped volumes 35

Table 3.9: Pit flooding profile 37

LIST OF FIGURES

Figure 2.1: Portage Pit area map 9
Figure 2.2: Portage Pit area map 11
Figure 2.3: Baker Lake A meteorological IDF curves 13
Figure 2.4: Portage Pit area map 15
Figure 2.5: Goose Pit area map 16
Figure 2.6: Vault Pit area map 17
Figure 3.1: Flow to the mill 22
Figure 3.2: North Cell TSF – Reclaim water volume, elevation and transfer 23
Figure 3.3: South TSF - Reclaim water volume, elevation and transfer 24
Figure 3.4: Vault Attenuation Pond 29
Figure 3.5: Mill Seepage Area 32
Figure 3.6: Distribution of TPL elevation surveyed data 36
Figure 3.7: Goose pit flooding 39
Figure 3.8: Portage pit flooding 40
Figure 3.9: Vault and Phase pits flooding 41

Section 1.0 - INTRODUCTION

Agnico-Eagle Mines Ltd. (AEM) has been operating its Meadowbank Gold Mine since 2008, officially beginning production in 2010. The mine is located approximately 70km north of the Hamlet of Baker Lake, Nunavut. The mine is subject to the terms and conditions of both the Project Certificate issued in accordance with the Nunavut Land Claims Agreement Article 12.5.12 on December 30, 2006, and the Nunavut Water Board Water Licence No. 2AM-MEA1525 issued on July 23rd, 2015.

This report presents an updated version of the Water Management Plan 2014 and provides a revised site-wide water balance that determines the demand and storage requirements of water over the life of the mine (LOM). The storage strategies and required transfers will be discussed at large. Certain concepts within the water balance, including pit flooding, remain at the conceptual stage for now and will be further detailed in the Final Mine Closure and Reclamation Plan which is to be submitted one year prior to mine closure in accordance with the Type A Water License.

The necessity of this particular water management update follows changes in the observed natural pit water inflows, updated tailings deposition parameters, mine and milling life schedule and production rate, tailings management and pit backfilling strategies.

The Vault data presented in this report is derived from the actual dewatering process that was undertaken in 2013 and 2014. Runoff values and pit inflows for the Vault area were determined from the SNC Lavalin Water Management Plan 2012 (SNC, 2013) until runoff values can be verified and revised with field observations.

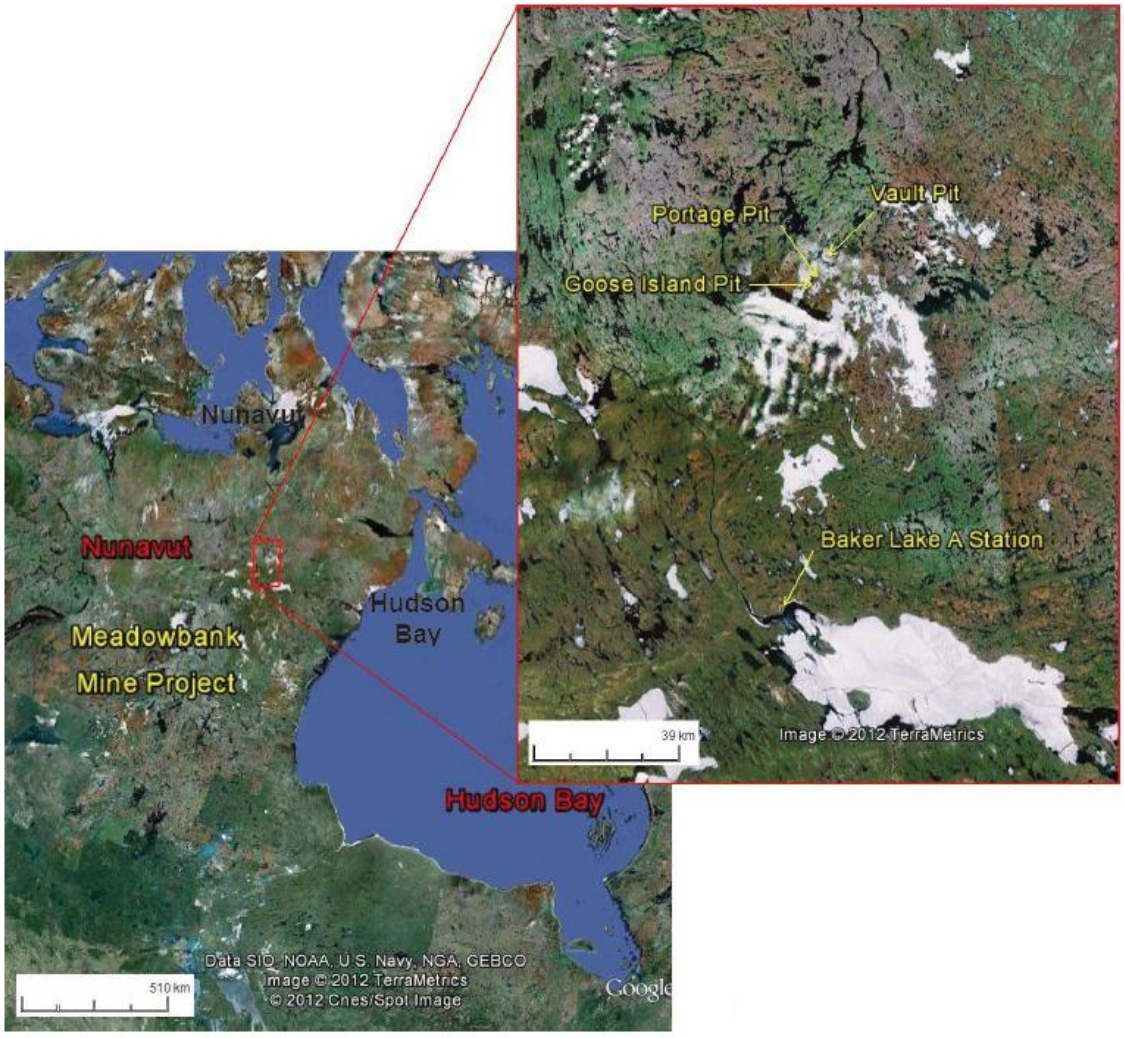
Recommendations and requirements concerning the water use and management, the water balance and the water quality modelling and outlined in the *document Water License: 2AM-MEA1525 Reasons for Decision Including Record of Proceedings* from the Nunavut Water Board will be included in the next version of the Meadowbank Water Management Plan Report which will be submitted with the Meadowbank Annual Report 2015 (March 31, 2016). The Water Management Plan will be updated on a yearly basis as required by the Nunavut Water Board Water Licence 2AM-MEA1525. This will include an updated Water Quality modelling forecast yearly. AEM conducts this modelling to determine if treatment prior to transfer of the South Cell reclaim water would require treatment, if treatment would be achievable in situ after transfer or if no treatment is necessary. Prior to transfer of main volume of South Cell water the model forecasts will be consulted and a decision will be made. However, it is important to note that AEM will not breach the dikes until the water quality meets CCME Guidelines for the Protection of Aquatic Life.

Section 2.0 - BACKGROUND INFORMATION

2.1 SITE CONDITIONS

The location of the Meadowbank mine site is shown below in Figure 2.1. A close-up is also provided to show the location of the Baker Lake A Station used to obtain meteorological data.

Figure 2.1: Portage Pit area map



Source: Google Earth Pro, 2012

2.1.1 Climate

The Meadowbank region is located within a low Arctic ecoclimate described as one of the coldest and driest regions of Canada. Arctic winter conditions occur from October through May, with temperatures ranging from +5°C to -40°C. Summer temperatures range from -5°C to +25°C with isolated rainfall increasing through September (Table 2.1).

Table 2.1: Estimated average monthly climate data – Baker Lake

Month	Max. Air Temp. (°C)	Min. Air Temp. (°C)	Rainfall (mm)	Snowfall (mm)	Total Precip. (mm)	Lake Evap. (mm)	Min. Relative Humidity (%)	Max. Relative Humidity (%)	Wind Speed (km/h)	Soil Temp. (°C)
January	-29.1	-35.5	0	6.9	6.9	0	67.1	75.9	16.3	-25.5
February	-27.8	-35.2	0	6.0	6.1	0	66.6	76.5	16.0	-28.1
March	-22.3	-30.5	0.0	9.2	9.2	0	68.4	81.4	16.9	-24.9
April	-13.3	-22.5	0.4	13.6	14.0	0	71.3	90.1	17.3	-18.1
May	-3.1	-9.9	5.2	7.7	12.8	0	75.7	97.2	18.9	-8.0
June	7.6	0.0	18.6	3.1	21.7	8.8	62.6	97.2	16.4	2.0
July	16.8	7.2	38.6	0.0	38.6	99.2	47.5	94.3	15.1	10.5
August	13.3	6.4	42.8	0.6	43.4	100.4	59.2	97.7	18.4	9.3
September	5.7	0.9	35.2	6.7	41.9	39.5	70.8	98.6	19.3	3.6
October	-5.0	-10.6	6.5	22.6	29.1	0.1	83.1	97.4	21.4	-2.8
November	-14.8	-22.0	0.2	16.2	16.4	0	80.6	91.1	17.9	-11.7
December	-23.3	-29.9	0	9.4	9.5	0	73.3	82.7	17.7	-19.9

Note: Data from Baker Lake A station is available from 1946 to 2011. During this period, the data quality is good, with the exception of years 1946 to 1949, and 1993 which were removed from the compilation.

The long-term mean annual air temperature for Meadowbank is estimated to be approximately 11.1°C. Air temperatures in the Meadowbank area are, on average, about 0.6°C cooler than Baker Lake air temperatures, and extreme temperatures tend to be larger in magnitude. This climatic difference is thought to be the effect of a moderating maritime influence at Baker Lake.

The prevailing winds at Meadowbank for both the winter and summer months are from the northwest. A maximum daily wind gust of 93 km/h was recorded on September 1, 2009. Light to moderate snowfall is accompanied by variable winds up to 70 km/h, creating large, deep drifts and occasional whiteout conditions. Skies tend to be more overcast in winter than in summer.

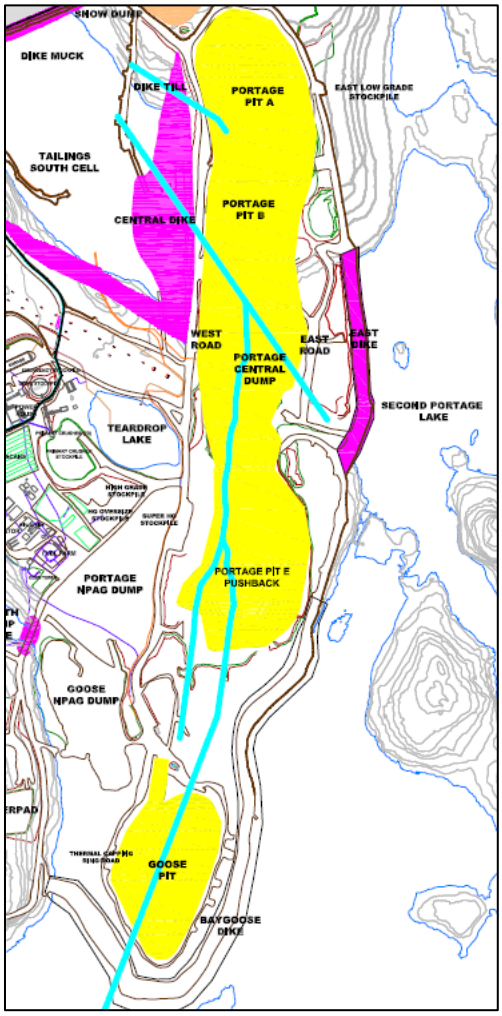
The Table 2.1 presents monthly rainfall, snowfall and total precipitation values for the mine site. August is the wettest month, with a total precipitation of 43.4 mm, and February is the driest

month, with a total precipitation of 6.1 mm. During an average year the total precipitation is 249.6 mm, split between 147.5 mm of rainfall and 102.1 mm of snowfall precipitation.

2.1.2 Faults

As shown in Figure 2.2 by clear blue lines, two main faults are inferred in the Portage deposit area and were included in the groundwater model (Golder, 2011) used to estimate groundwater inflows and brackish water upwelling to the pits during mine life. These are the Bay Zone Fault and the Second Portage Fault.The Second Portage fault trends to the northwest and is expected to be under the Central Dike and the Tailings Storage Facilities (TSF), roughly parallel to the orientation of Second Portage Lake. Analysis conducted during the design of the Central Dike showed little seepage potential. To date Central Dike has been completed to elevation 132m.

Figure 2.2: Portage Pit area map



2.1.3 Permafrost

The Meadowbank Gold Mine is located in the area of continuous permafrost. Lake ice thicknesses of between 1.5 m and 2.5 m have been encountered during geotechnical investigations in mid to late spring. Taliks (areas of permanently unfrozen ground) are expected where water depth is greater than about 2 to 2.5 m. Based on thermal studies and measurements of ground temperatures (Golder, 2003), the depth of permafrost at site is estimated to be in the order of 450 to 550 m, depending on proximity to lakes. The depth of the active layer ranges based on depth of overburden, vegetation and organics, proximity to lakes, and aspect is about 1 to 1.5 m

Based on ground conductivity surveys and compilation of regional data, the ground ice content is expected to be low. Locally on land, ice lenses and ice wedges are present, as indicated by ground conductivity, and by permafrost features such as frost mounds. These areas of local ground ice are generally associated with low-lying areas of poor drainage.

A thermal monitoring plan, which meets the requirement of the Water Licence, is presented in Section 8 of this document.

2.1.4 Hydrology

As shown above in Table 2.1, the Baker Lake A meteorological station was used to tabulate the monthly precipitation data. Using this data SNC-Lavalin completed a Log-Pearson 3 probility distribution to determine the annual precipitation for different return periods. The results of this statistical analysis can be seen in Table 2.2.

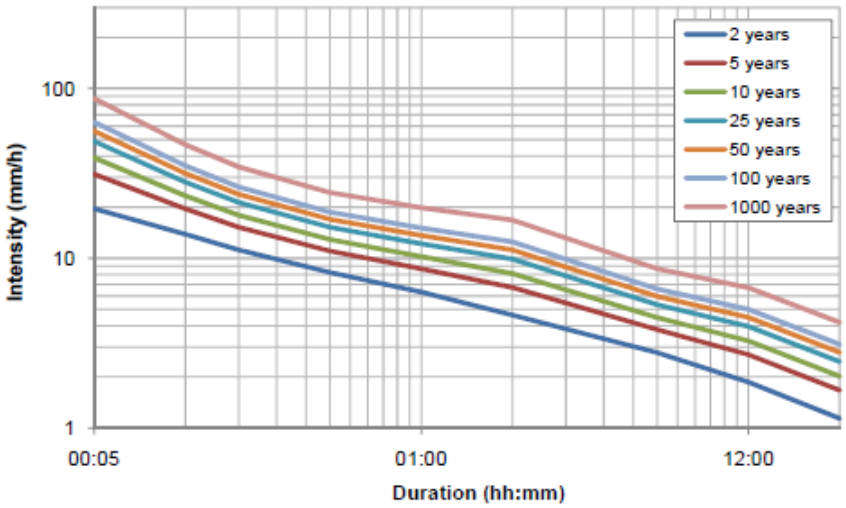
Table 2.2: Total annual precipitation for varying return periods

Return Period (years)	Precipitation (mm)
2	246
5	295
10	322
20	345
100	391

Source: SNC-Lavalin Water Management Plan 2012

Intensity duration frequency curves (IDF), previously presented by SNC in the Water Management Plan 2012 (SNC, 2013), are seen below in Figure 2.3. These curves prepared by Environment Canada from the Baker Lake A meteorological station, show the IDF curves for precipitations of short duration (5min-24hrs) based on data between 1987 and 2006.

Figure 2.3: Baker Lake A meteorological IDF curves



Source: SNC-Lavalin Water Management Plan 2012

The freshet (spring period) will vary from year to year however it has been observed that the winter snow accumulation (October to May) will begin to melt at the beginning June and continue throughout the month.

2.2 MINING OPERATION DESCRIPTION

The Meadowbank Gold Mine consists of several gold-bearing deposits within reasonably close proximity to one another. The three main deposits are: Vault (including Phaser), Portage (South, Center and North Portage deposits), and Goose.

The South Portage deposit is located on a peninsula, and extends northward under 2PL and southward under Third Portage Lake (3PL). The North Portage deposit is located on the northern shore of 2PL. The South, Center and North Portage deposits is mined as a single pit, termed the Portage Pit, which extends approximately 2 km in a north-south direction. The Goose deposit lies approximately 1 km to the south of the Portage deposit, and beneath 3PL. The Vault deposit is located adjacent to Vault Lake, approximately 6 km North of the Portage deposits. A series of dewatering dikes (East, West Channel, Bay-Goose, South Camp and Vault) are required to isolate the mining activities from the lakes. Additional dikes (the Central Dike, Stormwater Dike and Saddle Dams) are required to manage tailings within the dewatered 2PL Arm. East Dike, West Channel, Bay-Goose, South Camp and Stormwater Dikes, Saddle Dam 1 and Saddle Dam 2 were all constructed within the past 5 years. The dikes were and will be constructed primarily using materials produced on site.

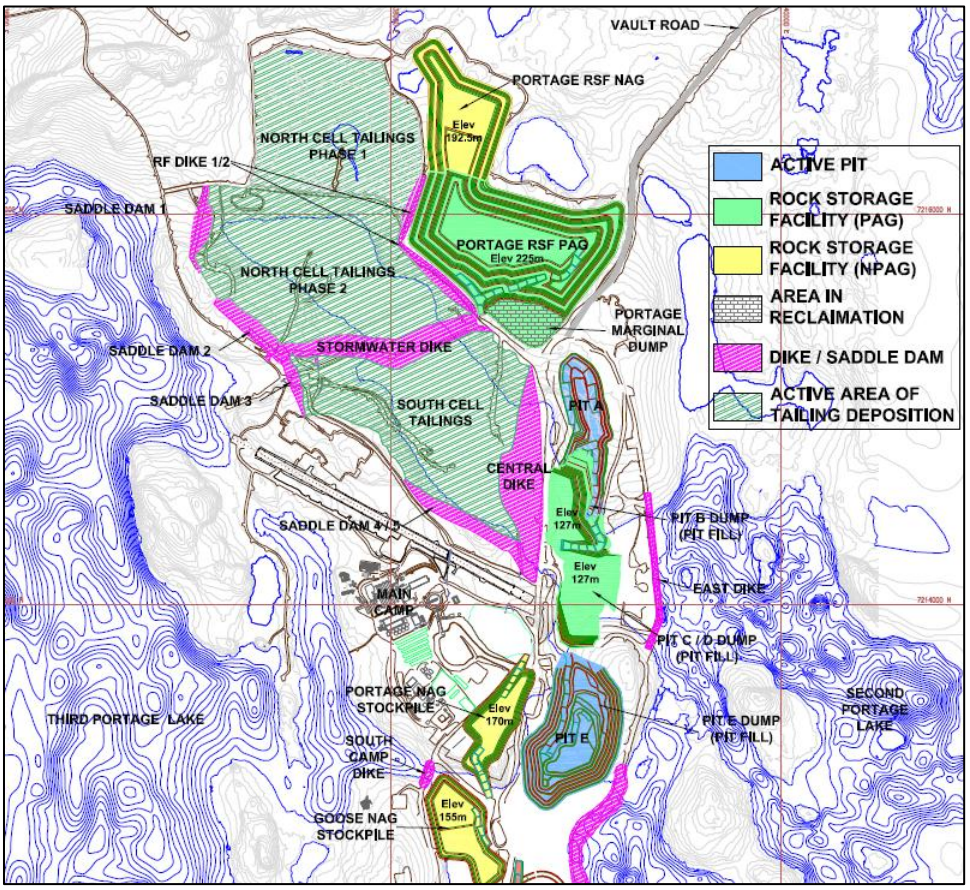
Mining of Portage pit began in early 2010 is conducted via truck-and-shovel open pit operation under the terms established by the Water License. Any modifications to the dewatering process, LOM, TSF and any other aspect associated to the water management must be followed with a yearly update of the Meadowbank Water Management plan and water balance.

2.2.1 Portage Pit Area

The Portage area located between the 3PL and 2PL contains most of the infrastructure of the Meadowbank mine site including but not limited to the Rock Storage Facility (RSF), North and South Tailings Storage Facilities (NC & SC TSF), mill and the Stormwater Management Pond. The East Dike was constructed to isolate the North portion of the Portage Pit from the 2PL. Subsequent renaming of the pits led to the new nomenclature for each pit (A, B, C, D and E). Mining in Pits B, C, D are now completed and are currently subject to pit infilling operations. See Figure 2.4 below for the current Portage Pit and surrounding infrastructure.

In 2014 and likely continuing through 2015, the majority of the water entering Portage Pit has been observed to be coming from the East Dike wall, due to seepage through the East Dike from Second Portage Lake (2PL). This is controlled via two seepage collection points. From the collection points the water is pumped to a common pipe and discharged back into 2PL. The discharge is subject to MMER and Water License effluent criteria. The water is discharged through a diffuser located in 2PL. If the seepage does not meet criteria (mainly related to TSS) the pumping is redirected toward the Portage Pit, specifically in the Portage Central Waste Rock area, where the water flows in the backfill toward Pit B and Pit E. If necessary the water is pumped to the South Cell Reclaim Pond. Another major source of pit water was observed in the bottom benches of Pit C and D. These two pits are located in an inferred talik area and also cross a regional fault (Golder, 2009). There are several areas in these pits which are not in permafrost which infers a talik. The water is likely a combination of ground and surface waters. AEM is currently monitoring this water quality in accordance with the Water License. Pits A, B and E are located in the permafrost and a minimal amount of water has been observed historically. All water pumped from the Portage Pits is directed to the now operational South Cell TSF (formerly the Portage Attenuation Pond). During closure the East Dike seepage and any water associated with Pit C and D will form part of the pit reflooding.

Figure 2.4: Portage Pit area map



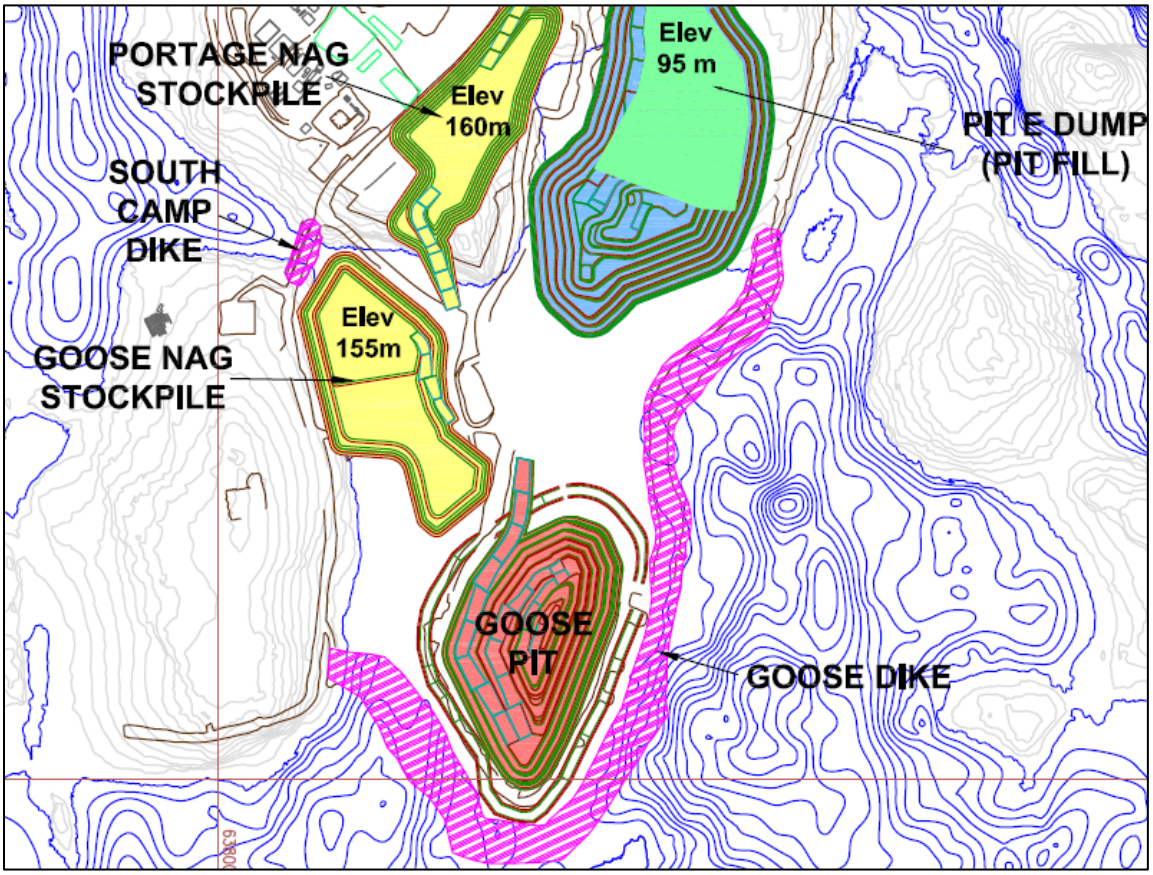
2.2.2 Goose Pit Area

The Goose Pit is under 3PL which required the construction of the Goose Dike to isolate the lake from the mining area. Mining in Goose pit commenced in 2012 and is expected to be completed by the end of March 2015. After mining is complete Goose Pit will be an attenuation pond while it is being re-flooded as part of the final closure. The Goose Pit area and surrounding infrastructure are illustrated below in Figure 2.5.

The majority of the water entering Goose Pit has been observed coming from the South and West wall adjacent to the Goose dike due to natural inflow from the fractured quartzite rock formation. No major water inflow is observed on the Eastern wall associated with iron formation with small volcanic lenses. Between the quartzite and iron formation there is a large band of ultramafic rock (soapstone). Most of this pit is located in a talik zone which explains the water in flow. Areas of the pit bottom are not in permafrost which infers a talik area. The water is managed with a system of sumps and trenches along the pit ramp, on the 5109 catch bench and

on the working elevation. All water pumped from the Goose Pit is directed to the South Cell Reclaim pond. Once mining is completed, the inflow will be allowed to collect in pit as part of the natural reflooding process. Field observations reveal that as the pit gets deeper, inflows are increasing due to a higher hydraulic gradient. AEM will utilize some of this inflow water in 2016 to supplement the South Cell TSF reclaim pond.

Figure 2.5: Goose Pit area map



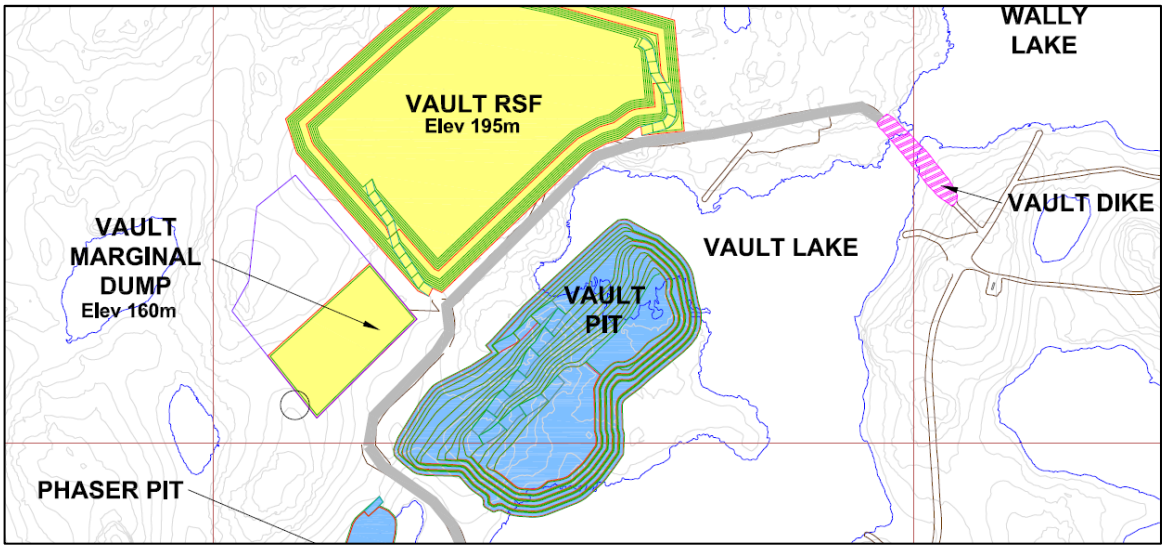
2.2.3 Vault Pit Area

The Vault Pit area contains its own independent infrastructure including but not limited to the Vault RSF, ore and marginal pads, Vault dike, Vault pit, Vault attenuation pond, service building and emergency shelter. The Vault Pit, which is located under the former Vault Lake required the construction of Vault dike in order to isolate the mining area from Wally Lake. Dewatering was undertaken in 2013 and 2014. This allowed for mining of Vault Pit and the creation of the Vault Attenuation Pond (ATP). The Vault pit began pre-mining operations in 2013 with active mining

starting in 2014. Mining is expected to be completed by the end of 2017. Figure 2.6 illustrates the Vault Pit area and surrounding infrastructure.

The majority of the water migrating into Vault Pit has been observed to be runoff from the surrounding area during the freshet period. No major water inflow has been observed to date originating from the pit walls. However, occurences of small pressurized isolated pockets of water are sometimes found while drilling. The water is managed with a system of sumps and trenches along the pit crest, the main ramp and on the working bench. All water pumped from the Vault Pit is directed to the Vault Attenuation Pond (ATP). The water is subsequently treated for total suspended solids removal (TSS) during summer months (if necessary) and discharged into Wally Lake in accordance with the Water License and the MMER.

Figure 2.6: Vault Pit area map



2.3 LIFE OF MINE DESCRIPTION

The current life-of-mine (LOM) has been updated with the current mining surfaces, operational fleet, stockpile situation and milling forecasts. An update to the pit designs has caused an expansion to Phase 3 of Portage Pit E. The specifics of the expected monthly milling tonnage is summarized in Table 2.3 seen below.

Table 2.3: Current official LOM figures – Processed ore tonnages

	2015	2016	2017
January	361 119	349 618	341 992
February	319 648	327 062	308 896
March	318 618	349 618	341 992
Q1	***999,385***	***1,026,298***	***992,880***
April	346 230	335 790	330 960
May	320 509	346 983	341 992
June	350 160	335 790	330 960
Q2	***1,016,899***	***1,018,563***	***1,003,912***
July	357 182	343 139	350 300
August	320 416	343 139	350 300
September	351 840	332 070	100 324
Q3	***1,029,438***	***1,018,348***	***800,924***
October	360 406	346 053	-
November	318 060	334 890	-
December	367 598	346 053	-
Q4	***1,046,064***	***1,026,996***	-
Total	***4,091,786***	***4,090,205***	***2,797,716***

2.3.1 Changes from the Water Management Plan 2013

As previously stated, updates to the LOM will lead to additional adjustments of the water management plan. Changes in the LOM plan that affect water management include but are not limited to:

- Goose and Vault Pit modifications;
- Updated truck mining fleet;
- Updated stockpile status;
- Modification to the Central waste rock storage (pit) design and overall volume.

In 2014 the above mentioned modifications added two months to the tailings storage requirements as well as slightly affecting the pit flooding curves. In addition to the changes in the LOM, many other revisions/modifications were made to the water balance in 2014- 2015 that lead to this update. These include:

- Fresh water consumption revision;
- Total daily mill water requirements;
- Updated tailings deposition plan affecting the North Cell and South Cell deposition calendar;
- Pit water inflow revision based on observed flowmeter data;
- 3PL elevation change affecting reflooding requirements;
- Dewatering of Phaser Lake – when approved by regulatory agencies;
- Updating the seepage section;
- Changes in tailings dry density as observed through bathymetric analysis.

Further details of the modifications/revisions and their effects on the overall water management strategy will be provided in subsequent sections of the Plan.

Section 3.0 - WATER MANAGEMENT PLAN AND WATER BALANCE

3.1 GENERAL WATER MANAGEMENT STRATEGY

At Meadowbank, four major sources of inflow water are considered in the site water management system on site: freshwater pumped from Third Portage Lake, natural pit groundwater inflow, seepage inflow from the East Dike and freshet water. This water is utilized and removed from the inflow (outflow) by the following means: water treatment plant effluent from the attenuations ponds (former Portage ATP (now South Cell TSF – no longer an outflow source) and Vault Lake ATP), water trapped in the capillary voids of the tailings fraction at the TSF's, East Dike seepage discharge into Second Portage Lake and water trapped within the in-pit central waste rock storage area voids.

The complimentary water balance is subdivided into the following headings: Fresh Water from Third Portage, Reclaim Tailings Water to the Mill from the North and South Cell TSF's, Portage Pit, Goose Pit sumps Water Transfers, Model Parameters, East Dike Seepage pumped to Second Portage Lake, Vault Pit sumps water transfer to Vault ATP, Vault ATP discharge to Wally Lake and Phaser Lake (once approved). The following sections will discuss each item and their inherent parameters.

The Water Balance is presented in Appendix A of this report.

As per the recommendations and requirements concerning the water balance outlined in the document Water License: *2AM-MEA1525 Reasons for Decision Including Record of Proceedings* from the Nunavut Water Board as per the Water License 2AM-MEA1525 (Part E, Item 7), the Water Management Plan will be updated on an annual basis. The Water Management Plan will include a yearly updated water balance according to the water management strategy. The updated water balance will be presented in the next version of the Meadowbank Water Management Plan Report to be presented with the Meadowbank Annual Report 2015 (Macrh 31, 2016).

3.1.1 Fresh Water from Third Portage Lake

Fresh water from Third Portage Lake is pumped utilizing a fresh water barge in order to service the camp, mill, maintenance shop and all other fresh water users at Meadowbank. The amount pumped from the barge is tracked and reported in the water balance and as a requirement of the Type A Water License. The two main consumers of fresh water are the mill with an average of 91,531 m^3/month in 2014 (expected average 82,540m^3/month in 2015) and the camp that averaged 2890m^3/month in 2014.

The freshwater going to the mill is used in the milling process and will be discharged with the tailings as a slurry. Once in the TSF the total water volume is comprised of 40% free reclaim water (recycled back to the mill as process water) 30% entrapped within the capillary void space of the tailings and a further 30% is entrapped within the TSF as ice (60% total entrapped in TSF). The water entrapment within the TSF represents annual averages as the ice entrapment during the summer months would fall to zero, while in winter months it could reach close to 80% (according to the July 2014 bathymetric analysis).

The fresh water used in the camp includes laundry facilities, cleaning, cooking and drinking water consumption. The majority of the camp fresh water is returned as sewage treatment effluent to the Stormwater Management Pond which ultimately gets transferred to the active TSF (currently the South Cell) and later in the mine closure period to Portage pit during the reflooding operation.

The total expected fresh water utilization planned for 2015 to mine closure varies from 90-150m^3/hr during mill operation, and drops gradually during closure to 4m^3/hr once the mill has closed (represents water used by the camp only, does not include pit reflooding). The variation seen in the fresh water consumption during the mill operation is calculated to prevent a water deficit in our TSF and allows for adequate reclaim volumes. During the summer months,

90m^3/hr is targeted, meanwhile, during the winter months up to 150m^3/hr is required in order to maintain an adequate reclaim water volume in the TSF as seen in Table 3.1. The ice cover during the winter months on the reclaim pond will vary between 0.0-1.8m in thickness which may represent up to 80% of the total reclaim water volume. For this reason, the water balance is completed hand in hand with the tailings deposition plan.

In 2014 AEM used 1,098,373 m^3 of freshwater. Table 3.1 and 3.2 summarize and project the water consumption until the end of the mine life. More details are included in the water balance presented in Appendix 1.

Adjustments at the mill and in the water management strategies has led to adjusted fresh water consumption. As of 2018 when the mill is scheduled to cease production freshwater use will be limited to pit reflooding as per the Interim Closure Plan (Golder, 2014) and for camp use. Figure 3.1 presents the 2015 mill water consumption per month and yearly values are summarized in Table 3.2. Refer to Section 3.3 for the pit reflooding activities description and freshwater needs.

Table 3.1: 2015 Targeted water hourly consumption per month

Month	Fresh Water Flow (m^3/h)	Reclaim Water Flow (m^3/h)	Total Water Flow (m^3/h)
January	150	260	410
February	150	260	410
March	150	260	410
April	150	260	410
May	90	320	410
June	90	320	410
July	90	320	410
August	90	320	410
September	90	320	410
October	90	320	410
November	110	300	410
December	110	300	410
Average	**113**	**29**	**410**

Figure 3.1: Flow to the mill

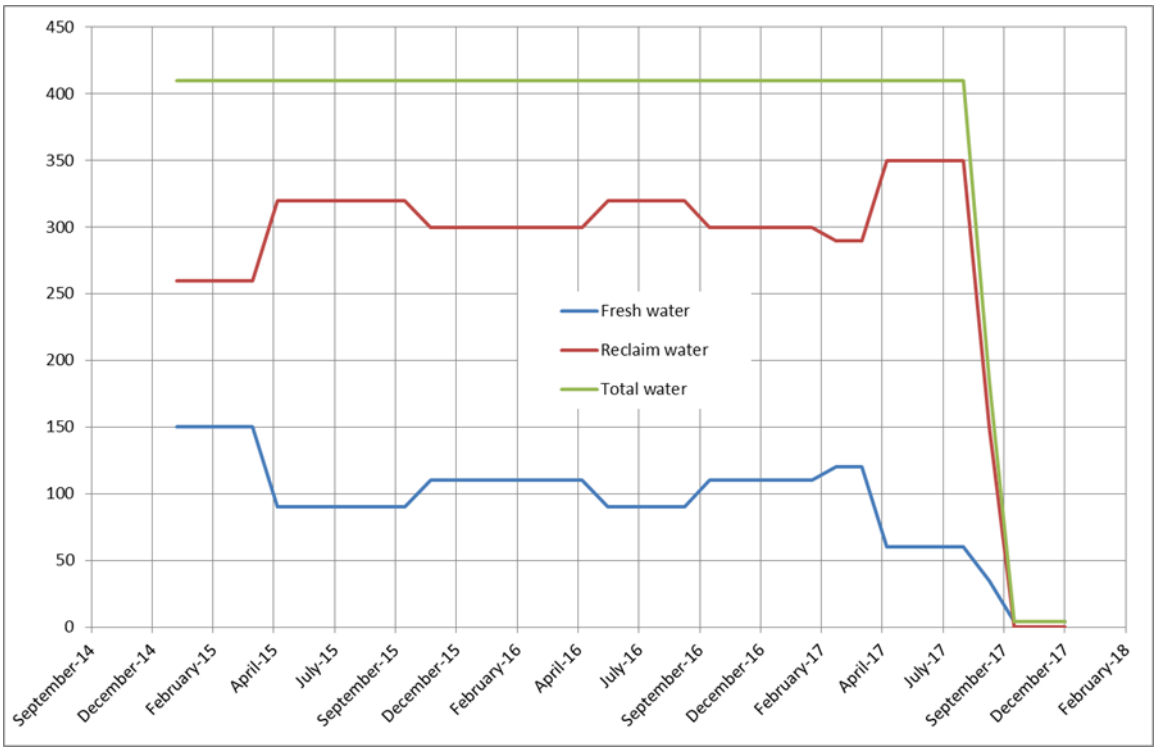


Table 3.2: Yearly water consumption summary

Year	Fresh Water Flow (m^3/h)	Total Fresh Water (m^3)	Reclaim Water Flow (m^3/h)	Total Reclaim Water (m^3)
2013	181	1,587,409	261	2,286,400
2014	125	1,098,373	279	2,447,002
2015	113	990,480	297	2,601,120
2016	103	907,680	307	2,693,760
2017	62	542,561	228	1,990,560
2018-2025	4	34,675	0	0

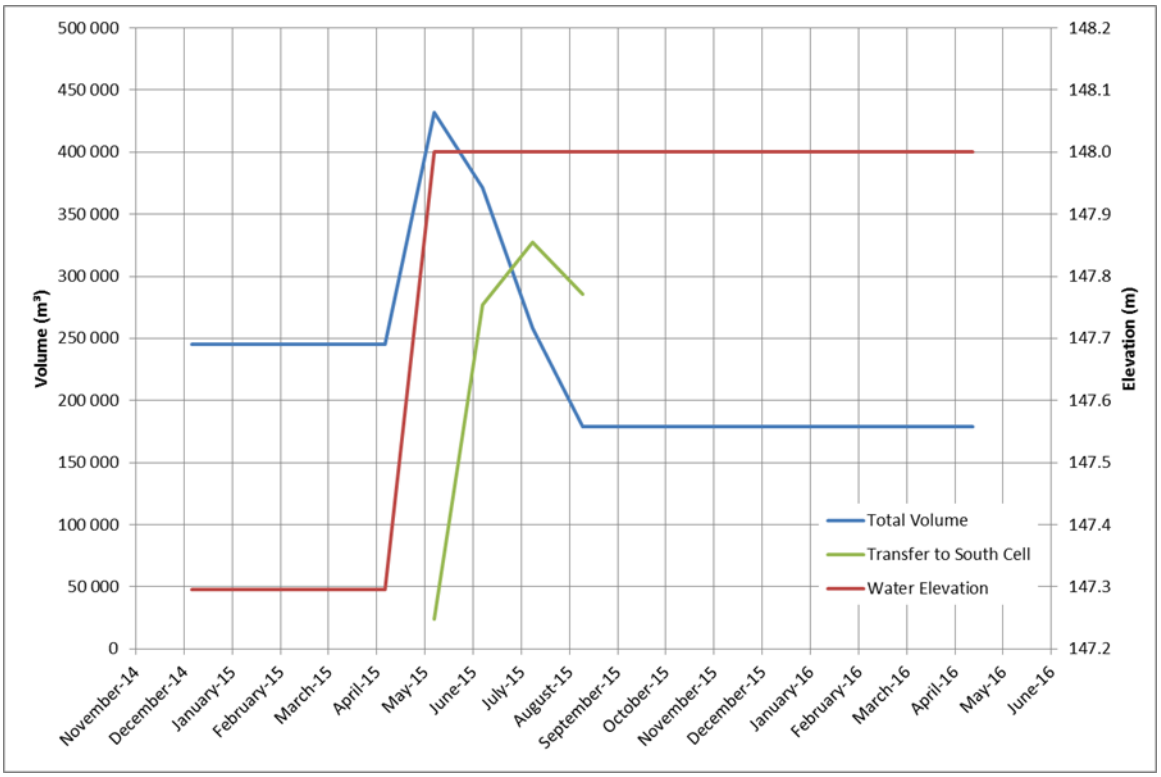
3.1.2 Reclaim Tailings Water

Reclaim tailings water represents the water reclaimed from the TSF during mill operation (North and South Cell reclaim ponds). Currently, the pumping system utilizes a mobile pumphouse on skids which retreats on a road as the water level rises in the South Cell TSF. The suction line is

laid down on the ice sheet and extended as needed according to the pump moves. A summary of the reclaim water sent to the mill on an annual basis can be seen in Table 3.2.

Figure 3.2 represents the water management in the North Cell TSF until the end of its operation. As seen in the water balance spreadsheet presented in appendix A, at this time, the reclaim water originates from the active South Cell TSF except from June to October 2015 when Tailings will be deposited in the North Cell for closure. During this time the associated water that accumulates due to the deposition will be transferred to the reclaim pond in the South Cell. The reclaim pumping system now installed in the South Cell will continue to supply the mill with reclaim water. The objective of this plan is to maintain 2.0 m of freeboard in the North Cell TSF and to continue providing the mill with the expected volume of reclaim water.

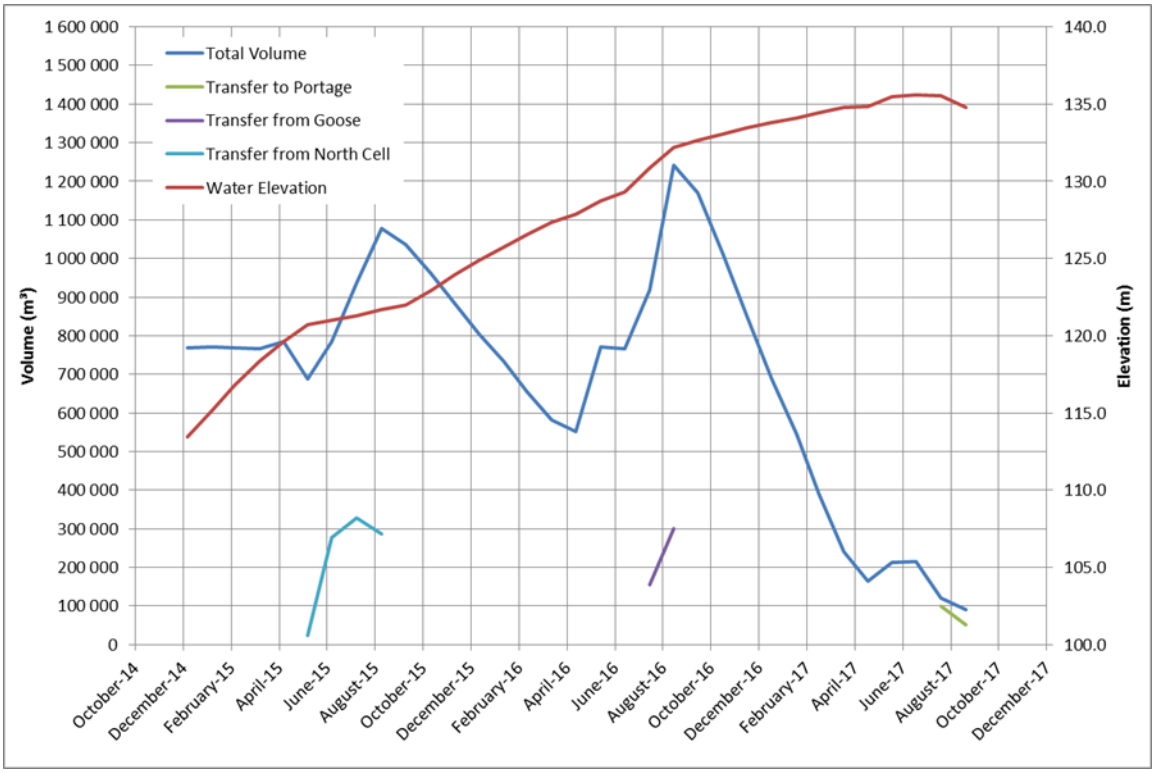
Figure 3.2: North Cell TSF – Reclaim water volume, elevation and transfer



The South Cell TSF water management is based on same principles as the North Cell. Figure 2.9 shows the projected water elevation and volume from Dec, 2014 through to mine closure in Q3, 2017. The freshet periods of 2015 and 2016 are represented by two peaks on the volume curve. After summer 2016, the reclaim water volume will decrease slowly until the deposition is completed. All water transfers as per the water management plan and water balance are also included in the graph. Some water will need to be transferred to the Portage pit at the end of

the deposition (cessation of mine mill operation) to properly dewater the tailings pond for closure capping. This water is included in the reflooding process.

Figure 3.3: South TSF - Reclaim water volume, elevation and transfer



3.1.3 Mill

The LOM figures depicted in Table 2.3 were used to calculate the monthly mill throughput. Based on this, AEM has determined the historical average ore moisture content associated with the mill feed which represents this source of water within the water balance. Table 3.3 illustrates the average moisture content over time until closure. The forecasted average moisture content for 2015-2017 is the average of the measured volume of 2013 and 2014. The moisture content calculation is also an important factor used to calculate tailings storage capacities.

Table 3.3: Monthly average ore moisture content observed and forecasted at the mill

Month	Observed Average Ore Moisture Content (%)		
	2013	2014	2015-2017
January	1.25%	0.93%	0.98%
February	1.37%	0.80%	1.53%
March	1.48%	0.58%	0.92%
April	1.16%	0.77%	1.09%
May	0.95%	0.86%	1.08%
June	1.00%	0.88%	0.99%
July	0.74%	0.69%	1.30%
August	0.65%	0.91%	0.98%
September	1.05%	1.05%	0.89%
October	0.92%	1.40%	0.99%
November	0.82%	1.39%	0.72%
December	1.55%	1.30%	0.93%
Average	**1.08%**	**0.97%**	**1.03%**

3.1.4 North Cell

The North Cell TSF has been in operation since January 2010. Deposition ceased temporarily in November, 2014 and the South Cell TSF became operational. Tailings deposition will commence again from June, 2015 to October, 2015 as part of the closure of the North Cell (fill to final design elevation). Closure and capping of the North Cell TSF will occur progressively.This is anticipated to commence in 2015. As per the design specifications and regulatory requirements, the level of the North (and South) cell reclaim pond must maintain a two meter freeboard with the surrounding structures, which is 148.0m elevation for the North Cell.

As seen in the water balance presented in appendix A, no tailings will be deposited in the North Cell during the winter 2015 (October 2014 - June 2015) due to the difficulty of operating the TSF during the winter months. The thick ice cover that will occur at the current level (nearly full) will dramatically reduce the amount of free water which may render the pumping of the reclaim water to the South Cell impossible.

3.1.5 South Cell

The South Cell area was, prior to the November, 2014 commencement of tailings deposition, a mine site attenuation pond (known as the Portage Attenuation Pond). The attenuation pond was designed to contain mine contact water as well as freshet runoff and was discharged to Third Portage Lake in accordance with the Water License and MMER. In the summer 2014, 190,882m^3 was treated for TSS removal via the Water Treatment Plant (WTP) and discharged in Third Portage Lake. This differs from the 1,041,000 m^3 initially planned as it was determined that a higher volume of water was required in the South Cell at the start of tailings deposition in November 2014 to ensure adequate reclaim volumes for the mill. No other discharge is planned via the Portage WTP through the mine life since all the water collected in the Goose and Portage pits will remain as part of the reflooding process or added to the reclaim pond if extra water is required for reclaiming. The South Cell TSF commenced operation in November 2014 and will be receiving tailings from the mill until October 2017. Closure and capping will be finalized during the closure process.

As seen in the water balance and the tailings deposition plan (AEM, 2014), no tailings will be deposited in the South Cell during the summer 2015 (June 2015 – October 2015) in order to finalize deposition in the North Cell. The water transfers, that will be discussed later, and water management strategies within the water balance reflect the latest tailings deposition plan.

3.1.6 Portage Pit

The Portage pit incorporates all sub-pits (A, B, C, D & E) and their associated pushback areas. Currently, Portage pit contains a Central waste rock storage area which extends from Pit C to D with a second section located in Pit B. The Portage pit natural inflow has been revised from the 2012 SNC Water Management Plan (SNC, 2013) with measured on site data from 2013 and 2014. The majority of the inflow originates from the bottom benches of Pit C and D. Since these areas are now backfilled, a reduction of water inflow has occurred. It is anticipated that additional inflow could occur at the bottom of Pit A and E. Until pit reflooding operations commence in 2018, all water pumped from the Portage pit area is sent to the South Cell to supplement reclaim water. Once reflooding starts the pumping system will be decommissioned and replaced by the infrastructure required for the pit reflooding. Refer to Section 3.2 for the pit reflooding activities description.

3.1.7 Goose Pit

Mining in the Goose Pit is scheduled to be completed at the beginning of 2015 as per the current Mine Plan. The inflow values have been revised from the 2012 SNC Water Management Plan (SNC, 2013). Observations in 2014 indicate a difference in the data. Namely, it was

observed that the pit inflow slows down during the winter due to the freezing of the pit walls. However a large amount of ice has been building on the walls and is subsequently removed on a recurring basis (for safety reasons). The volume of ice is significant and is not measured. The values for the 2015 Goose pit inflow have been adjusted based on the 2013-2014 pumping values. When referring back to the initial estimates originating from the 2012 SNC Water Management Plan (SNC, 2013), an increase was observed in the water inflow during the mining of the bottom benches of Goose. The water pumped from Goose is sent to the South Cell during the mining process. Once mining of this pit has been completed, the inflow will be allowed to collect in the pit as part of the reflooding process. In 2016, around 454,237m^3 of this inflow water will be transferred to the South Cell for optimal tailing deposition and reclaim pond operation. AEM has determined that some inflow may be the result of a low volume seep from the 3PL through the Bay Goose Dike. This inflow was collected in 2014 by a sump system at an average total (including groundwater infiltration) monthly flow rate of 24,781m^3. The inflow is not a large volume and is expected to continue after mining ceases in April 2015 after which it will be part of the natural reflooding process of Goose Pit. It is understood that AEM will continue to monitor the flow rate during this natural reflooding process through the filling rate of the pit. Refer to Section 3.2 for the pit reflooding activities description.

3.1.8 Water Transfers

Water transfers from various locations around the site are required to reduce freshwater consumption, optimize the water balance and maintain the good working order of the different facilities around the mine site. They are also required to prevent off site environmental impacts.

3.1.8.1 TSF Water Transfers

In order to optimize the tailings deposition sequence, maintaining an adequate reclaim pond (operating volume, dike structure protection and water quality) and closure of each cell, water transfers within the tailing storage facilities and pits are required throughout their operating life. As seen in Table 3.4, water transfers from the South Cell attenuation pond to the North Cell TSF was required in 2013. Also, additional water from the Stormwater Management Pond (SMP) was transferred to the North Cell TSF in 2014. Both transfers were undertaken in order to maintain adequate reclaim pond levels. Regular transfers from SMP take place twice yearly from 2015 and ending in 2017. These transfers ensure there is always capacity in the pond to contain freshet water as well as the on site Sewage Treatment Plant effluent. Once the TSF's are closed any additional transfers from SMP will be directed to the Portage pit until camp closure in 2024. In 2015 and 2016, water transfers from the North Cell towards the South Cell are required for

adequate operation and closure of the North Cell. In 2016, 2017 and 2018, water transfers from the South Cell (SC) to the pits (Goose and Portage) are undertaken to close this TSF.

The diversion ditches located around the North Tailings Cell are designed to collect the non-contact water runoff from the surrounding water shed. The ditches are divided in two sections – the west and east sections, to divert non-contact water respectively to the Third Portage Lake and to NP1 Lake. On the west end of the diversion ditches, an interception sump was constructed in March 2014 and will be completed in 2015. The interception sump has been put in place mainly to control the water quality, in term of total suspended solids. The interception sump aims to collect runoff water from the west section of the diversion ditches and to retain it until the total suspended solids have reached the criteria allowing discharge to the environment. Some of the water in the interception sump was also transferred to the North Cell TSF, in order to maintain an adequate water level in the sump. As-built drawings of the interception sump will be completed in 2015 when the structure will be fully finalized. The current volume is approximately 3000 m^3.

Table 3.4: TSF water transfers

Year	TSF Water Transfers							
	SC to NC (m^3)	NC to SC (m^3)	SC to WTP (m^3)	SWM to NC (m^3)	SWM to SC (m^3)	SWM to Portage (m^3)	SC to Portage (m^3)	Goose to SC (m^3)
2013	507,144	0	485,018	0	0	0	0	0
2014	0	0	190,882	36,584	0	0	0	0
2015	0	913,416	0	0	34,675	0	0	0
2016	0	178,994	0	0	34,770	0	0	454,237
2017	0	0	0	0	34,675	0	150,000	0
2018-2024	0	0	0	0	0	34,675	89,294	0
Total	**507,144**	**1,092,410**	**675,900**	**36,584**	**104,120**	**34,675**	**239,294**	**454,237**

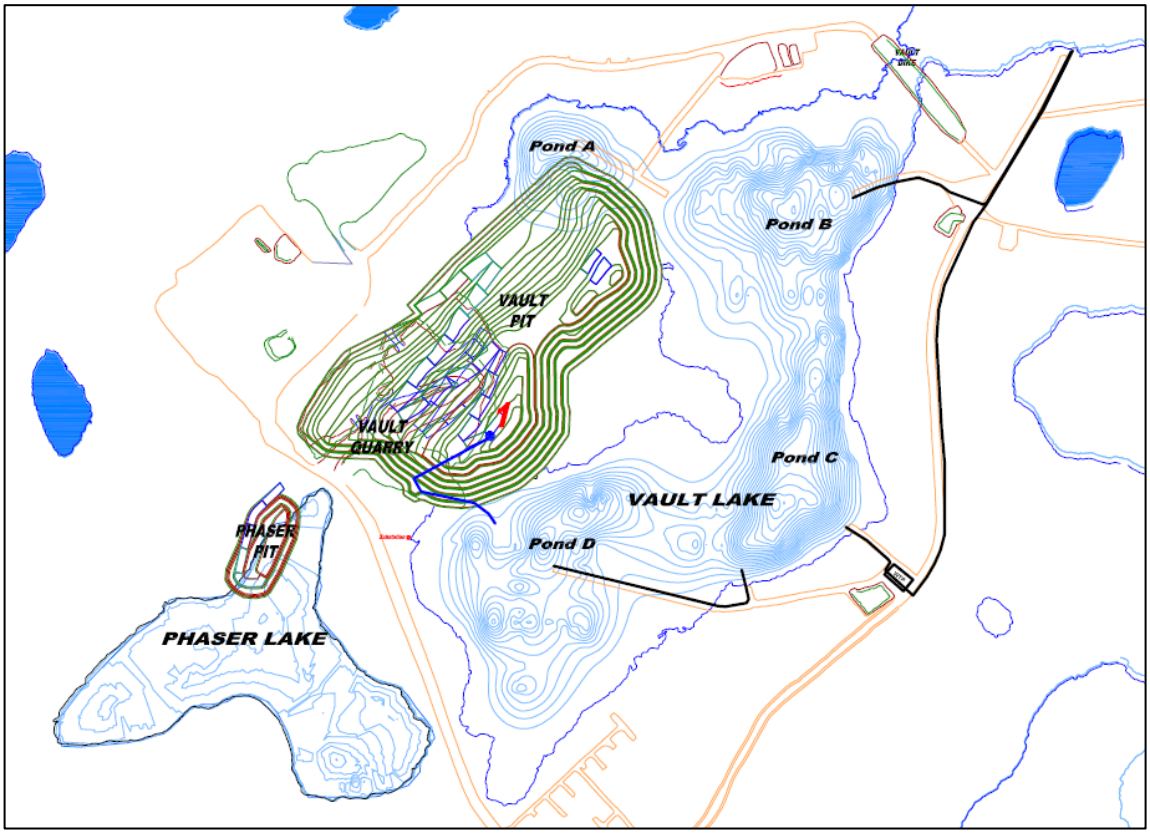
3.1.8.2 Portage Water Treatment Plant

In 2014, the Portage water treatment plant (WTP) was used to treat water from the Portage Attenuation Pond, before tailings were deposited in November 2014 (and then became the South Cell TSF), and discharged to Third Portage Lake. The necessity of this treatment is guided by the deposition plan of the South Cell which has optimized the starting volume of the pond. Treatment requirements were minimized in 2014; a total of 485,018 m^3 of water, instead of the 1,041,000m^3 planned, was discharged. There will be no further planned discharge from the WTP at this site to 2PL.

3.1.8.3 Vault Treatment Plant

In 2013, the dewatering of Vault Lake began. During 2013 a total of 2,315,483m^3 was discharged to Wally Lake. In 2014, an additional 329,101m^3 was discharged to Wally Lake. The Vault WTP was not required last year to remove TSS as the water met discharge criteria stated in the Water Licence as well as MMER criteria. The Vault Lake is divided into 4 different zones, see figure 3.4, and has now become the Vault Attenuation Pond as Vault pit contact water and runoff from the Vault RSF area is pumped to the pond.

Figure 3.4: Vault Attenuation Pond



AEM currently is in the Type A Water License renewal process. As part of the process a proposal to dewater Phaser Lake and mine an area of this basin was submitted to the Nunavut Impact Review Board (NIRB) in 2014. Although the Water License Renewal is proceeding with the Nunavut Water Board the Phaser proposal is still being reviewed by NIRB. Once the NIRB process is complete AEM will apply to the NWB for an amendment to the renewed Type A Water License. The mining of the proposed Phaser pit is considered a small project by AEM and amounts to only an additional mining life of approximately 30 days. Nonetheless AEM has included estimated water volumes associated with the dewatering of Phaser Lake in this Plan. See Table 3.5 and Sec 3.1.8.3 below. Details of the proposed Phaser Lake dewatering are presented in this section.

Table 3. 5: Wally Lake annual discharge

Year	Vault Dewatering (m^3)	Phaser Dewatering (m^3)	Wally Lake Annual Discharge (m^3)
2013	2,315,483	0	2,315,483
2014	329,101	0	329,101
2015	446,426	0	446,426
2016	472,773	405,665	878,438
2017	435,839	0	435,839
Total	**4,407,376**	**405,665**	**4,407,376**

3.1.8.3 Phaser Lake dewatering (Proposed)

Phaser Lake is a small, shallow lake located south of Vault lake beside the Vault haul road, as shown on figure 3.4. In the current version of the Life of Mine (LOM), Phaser pit is proposed to be mined in 2017 near the end of the mine operations. Upon receiving approval from the NWB and other regulators (NIRB, DFO) AEM will proceed to dewater Phaser Lake to allow mining the Phaser pit. This is considered a small mining project as the mining activity is anticipated to last approximately 30 days. Fish out procedures would occur prior to dewatering in accordance with DFO requirements. As per Table 3.5 above a volume of 405,665 m^3 of water will be pumped to the adjacent Vault Lake ATP. This will then be discharged from the Vault ATP to Wally Lake via the WTP in accordance with the Water License and the MMER.

3.1.8.3 Stormwater Management Pond

The Stormwater Management Pond is a small shallow and fishless, water body that can be seen in Figure 2.2 adjacent to Portage Pit. Treated sewage effluent is discharged to this lake before

being transferred to the active TSF (South Cell). The pond also collects freshet flows within its catchment area. The pond water is transferred two times per year during the warmer months – once in the spring and once in the fall with the total flow volume being 34,675m^3. This represents less than 1% of the total inflow to the TSF.

3.1.9 Seepage Collection Systems

3.1.9.1 Mill Seepage Collection system

In November 2013, AEM observed seepage discharging West of the access road in front of the Assay lab shown on figure 3.5. After an investigation which included initial sampling and monitoring, contaminants, namely cyanide and copper were identified. The source was leaking internal containment structures within the mill. Third Portage Lake (3PL), approximately 200 m to the west, was identified as a possible sensitive receptor. Remedial measures were undertaken immediately and this included construction of an impermeable interception/collection trench downstream of the seepage flow path. A comprehensive monitoring network and plan was implemented which included installation of monitoring wells, a recovery well (MW 203) and a sampling program (including Third Portage Lake). To date no contaminants have been detected in 3PL. Repairs (sealing) were completed within the mill (containment structures) in 2014 to eliminate the source of contaminants. Seepage collected in the trench and recovery well is pumped back to the mill to be used as process water (much the same as reclaim water from the TSF's). The pumping occurs in the warmer months from the trench beginning when freshet commences. The recovery well is pumped year round. No flow of water has been detected during winter months in the trench. (See Freshet Action Plan – Appendix D) Table 3.6 shows the pumped volumes for 2014. AEM anticipates that the flow to the trench will decrease in 2015 as the source area has been repaired and the recovery well will have been pumping during the 2015 winter season.

Figure 3.5: Mill Seepage Area

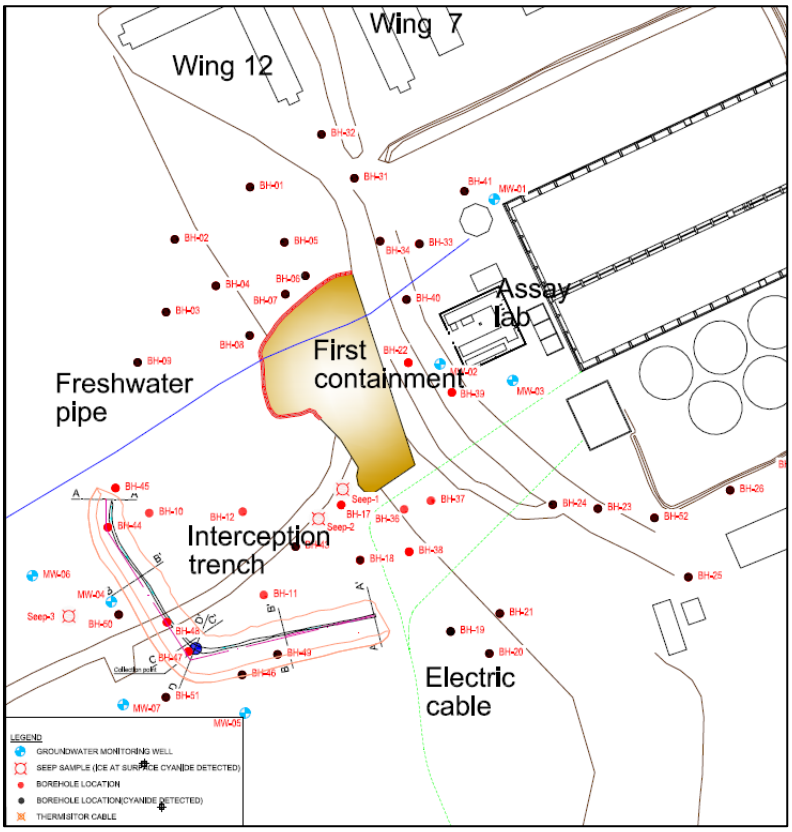


Table 3.6: Mill Seepage 2014 pumped volumes

Month	2014 Mill seepage pumped volumes back to the mill (m^3)
January	0
February	0
March	0
April	0
May	2,450
June	1,935
July	1,158
August	3,979
September	2,420
October	1,043
November	842
December	871
Total	**14,698**

3.1.9.2 ST-16 RSF Seepage management

Refer to the Freshet Action Plan (Appendix D) for the history, long term monitoring plan and remedial actions for this seepage location. A pumping system was installed and was operational during the 2014 freshet period and through the warmer months – May – Sept, 2014. Contaminated seepage was monitored in accordance with the Freshet Action Plan and was pumped back to the North Cell TSF. Other actions continued to prevent any reclaim water in the North Cell from migrating through the Portage Rock Storage Facility to the ST-16 location. These actions included the construction of a filter along RF-1 and RF-2 – see Table 3.7 for 2014 monthly flow volumes. AEM expects seepage flow to diminish yearly until closure as the reclaim water in the North Cell will have been transferred to the South Cell TSF in 2015. In addition capping of the North Cell is anticipated to commence in 2015. These actions will diminish the water source that contributes to the seepage. Finally, the thermal monitoring network shows that the tailings and RSF are continuing to freeze further restricting any seepage flow.

Table 3.7: ST-16 RFS Seepage 2014 pumped volumes

Month	2014 RSF seepage pumped volumes back to NC TSF (m^3)
January	0
February	0
March	0
April	0
May	14 591
June	9 294
July	3 810
August	3 386
September	1 088
October	0
November	0
December	0
Total	**32,169**

3.1.9.3 East Dike Seepage Collection

As previously stated, the East Dike Seepage Collection system, collects seepage originating from Second Portage Lake (2PL). Seepage from 2PL traverses through the East Dike in two discrete locations and is collected and discharged back , as a combined flow, through a diffuser, to 2PL (in accordance with the Water License and the MMER). Once mining of South Portage pit area is completed, the East Dike seepage will remain in the Portage pit as part of the pit reflooding operations (closure plan). The monthly flow observed from the table 3.8 indicates the 2014 monthly volume discharged to 2PL. If water quality does not meet license or MMER criteria it is pumped to mine out areas of the Portage pit.The total volume returned to Second Portage Lake in 2014 was 143,636 m^3.

Table 3.8: Mill Seepage 2014 pumped volumes

Month	2014 RSF seepage pumped volumes back to NC TSF (m^3)
January	11 779
February	12 729
March	12 971
April	10 736
May	528
June	0
July	1 716
August	22 049
September	19 914
October	17 880
November	16 453
December	16 881
Total	**143,636**

3.1.9.4 Central Dike Seepage

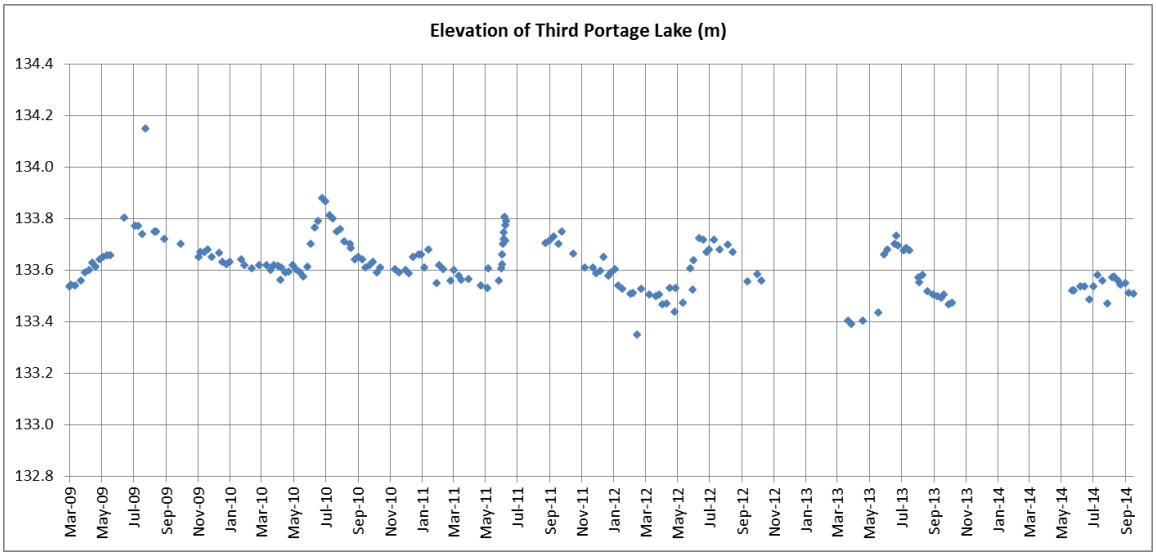
Once tailings deposition started in the South Cell – November 22th, 2014 – daily inspections of the downstream toe of Central Dike have been included in the geotechnical inspection program. A small volume of water against the downstream toe of Central Dike was noticed at that time. This water in contained between the West road and the Central Dike downstream toe. Piezometers, thermistors and a ground water well are used to monitor the dike integrity, the foundation temperatures and the piezometric levels witin the structures and its foundation.

The design of the central dike and the arrangement of instrumentation have taken into account the possibility of rock infiltration throught the talik or faults. The Central dike remains stable despite this minor infiltration. At this time it is difficult to conclude on the source of this seepage. AEM will continue to conduct regular inspection and sampling to monitor the flow and the water quality at this location during the open water months in 2015. It is anticipated at this time that a pumping station will be installed in 2015 to pump the water back to the South Cell TSF during summer season.

3.2 PIT REFLOODING

The volumes of water needed for pit reflooding, which is part of the overall closure plan, is dependent on the water elevation of TPL. The Goose dike can only be breached when the level of the reflooded pit reaches the same elevation as TPL. According to TPL elevation data from 2013 – 2014 this elevation would be 133.6 melv. Figures 2.7 indicates the elevation data recorded since 2009.

Figure 3.6: Distribution of TPL elevation surveyed data



The current flooding technique proposed for Portage and Goose Pits is to use a combination of Canadian dewatering pumps and syphons to achieve the pumping rates prescribed by the water balance and the Water Liscense. Details of the reflooding system will be available in the Final Reclamation and Closure Plan to be issued one year prior to closure. A total of 37.6Mm^3 will need to be transferred form 3rd Portage Lake to accomplish the required pit reflooding for Portage and Goose Pits. The current mining plan shows that the Goose pit mining will be completed in the first quarter of 2015 at which point Goose pit flooding may commence. Mining will cease in the Portage pit around the end of 2017. Pit reflooding of the Portage pit will start in 2018. At water elevation 131.0m both Portage and Goose pit will join to become one waterbody. Reflooding will continue to the natural Third Portage lake water elevation at approximately elevation 133.6. At this level the dikes can be breached; however this is dependent on pit water quality. The current objective is to ensure the water meets CCME Guidelines for the Protection of Aquatic Organisms (CCME) before the dike is breached. The entire flooding sequence should be completed by the beginning of 2025.

The operation of the TSF facilities will lead to the need to discharge 239,294m³ of reclaim water by the end of the mine life. The 2012 Water Management Plan (SNC, 2012) suggested that this reclaim water quantity be pumped in equal volumes to Goose and Portage pits which coincides with the reflooding operation (Goose 2015 – 2025, Portage 2018 – 2025). Due to operational constraints and date of availability for water storage, the current water management plan is to transfer the total amount of reclaim water (South Cell TSF - 239,294 m3) to the Portage pit in 2018. The treatment requirements of the reclaim water will be determined as per Meadowbank Water Quality Forecasting Update Technical Note rev. 00 completed by SNC (Feb, 2015 – See Appendix C). This document predicts that copper and selenium may require treatment to reach CCME criteria. Treatment may be conducted either as the water is discharged, by a water treatment unit, to the South Cell or after (Batch treatment). A final decision has not been made at this time, however AEM is committed to update this forecasted model on a yearly basis until, and possibly after, the closure of mine operations. The water split between Portage and Goose could also be revised in the future depending on mining plan updates and water balance changes.

To obtain a water elevation of 133.6m will require a total of 45Mm^3 of water. As previously stated, 37.6Mm^3 originates from 3rd Portage Lake, and the 7.3Mm^3 balance will be made up from the natural pit water inflow including runoff and precipitation combined with reclaim water. Please refer to Table 3.9 for the reflooding sequence per year for all pits.

Table 3.9: Pit flooding profile

Pit Flooding profile				
Year	Volumes pumped from 3rd Portage lakes		Volumes pumped from Wally lake	
	To Portage pit (m^3)	To Goose pit (m^3)	To Vault pit (m^3)	To Phaser pit (m^3)
2016	0	1,200,000	0	0
2017	0	4,520,000	0	0
2018	4,520,000	360,000	4,182,604	0
2019	4,520,000	360,000	4,182,604	0
2020	4,520,000	360,000	4,182,604	0
2021	4,520,000	0	4,182,604	0
2022	4,520,000	0	2,161,226	0
2023	4,520,000	0	0	571,007
2024	3,638,634	0	0	0
Total	**30,758,634**	**6,800,000**	**18,891,642**	**571,007**

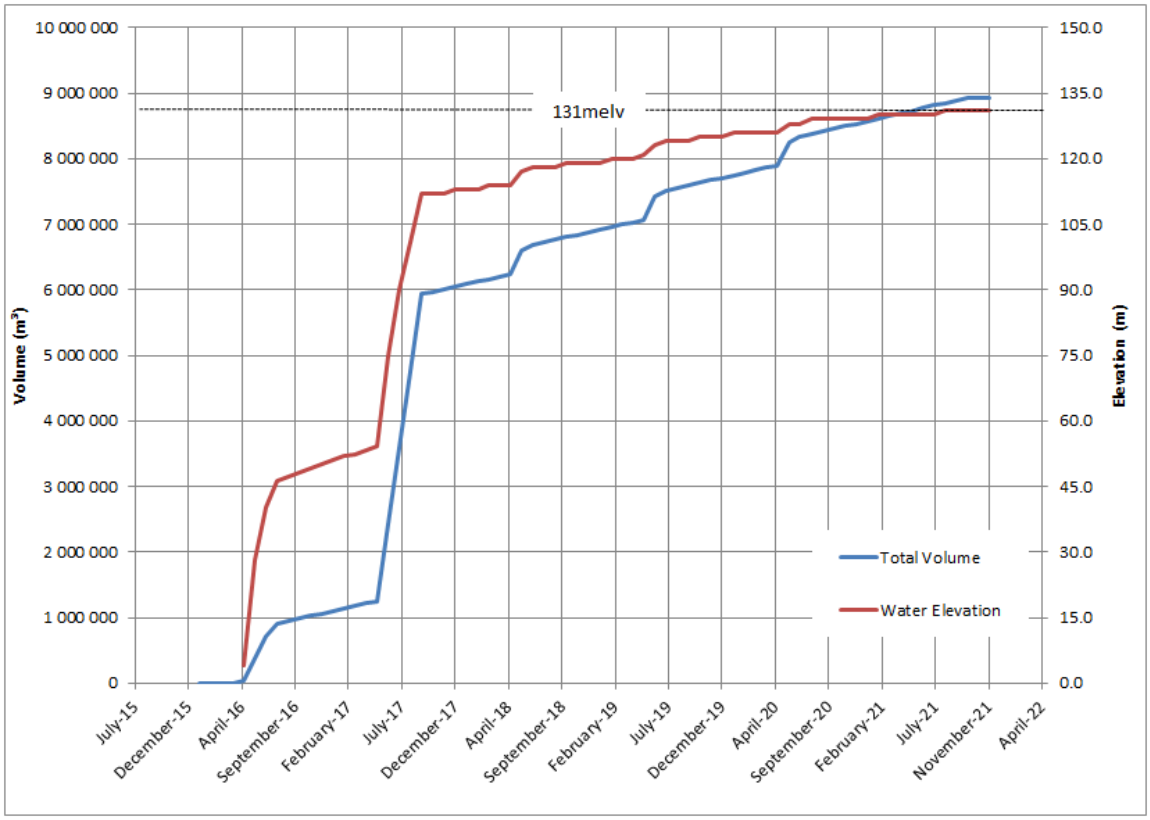
As mentioned in the *document Water License: 2AM-MEA1525 Reasons for Decision Including Record of Proceedings* from the Nunavut Water Board and as prescribed in the Nunavut Water Board Water Licence No. 2AM-MEA1525 issued on July 23rd, 2015 (Part E, Conditions 1 and 2), the use of water from Third Portage Lake, for all purposes, including reflooding of the pits, shall not exceed a total 2,350,000 m^3 per year from the Licence approval date to December 31 2017, followed by a maximum 4,935,000 m^3 starting in 2018 through to the expiry of the Licence 2AM-MEA1525. The use of water from Wally Lake shall not exceed a total 4,185,000 m^3 per year starting in 2018 through the expiry of the Licence 2AM-MEA1525. As per the recommendations and requirements concerning the water use, the Meadowbank Water Management Plan will be updated on an annual basis. The Water Management Plan will include a pit reflooding strategy meeting the requirements outlined in the the Nunavut Water Board Water Licence No. 2AM-MEA1525. The updated pit reflooding strategy and yearly water usage will be presented in the in the next version of the Meadowbank Water Management Plan Report to be presented with the Meadowbank Annual Report 2015, to be issued in March 2016.

AEM will provide at least 30 day notice to the Nunavut Water Board and Inspector prior to starting the re-flooding of each pit.

3.2.1 Goose pit reflooding

Goose pit reflooding will take approximately 5 years and will start in 2015 by allowing the annual inflow volume (runoff, groundwater, precipitation and possible Bay Goose dike seepage) of 468,000m^3 to remain within the pit. In 2016, transfer from TPL to Goose pit will start until elevation 131.0m is reached in 2021. Once elevation 131.0m is reached the Goose water will join the Portage pit water to form one water body. Figure 3.6 represents the Goose pit flooding curve. Once Portage joins Goose's elevation early 2024, an additional 3,638,634Mm^3 will be added that summer to complete the reflooding process to elevation 133.6m. The Goose and South Camp dikes will then be breached provided water quality meets CCME criteria. Refer to Section 4 for the pit water quality forecast model.

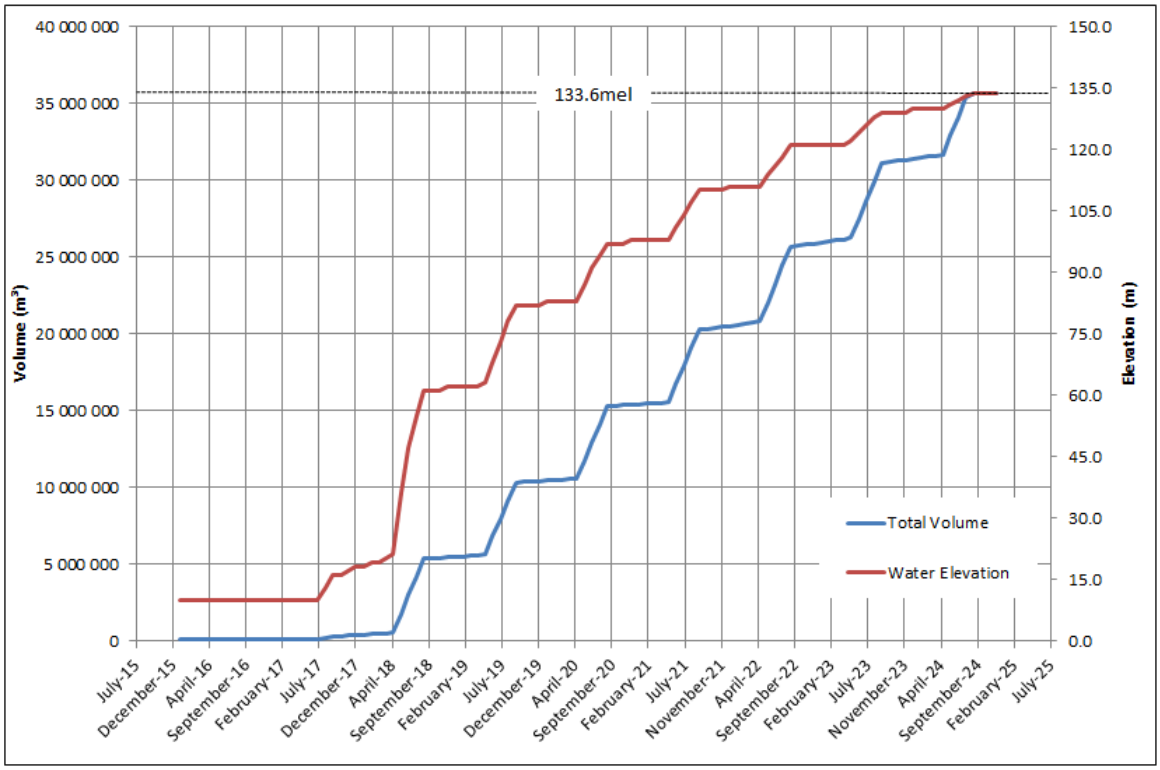
Figure 3.7: Goose pit flooding



3.2.2 Portage pit reflooding

Portage pit reflooding will begin in 2018 with an annual 4.52Mm³ transfer from 3rd Portage to the Portage pit until 2023. In 2024, an additional 3.6Mm^3 will be required to complete the total reflooding of both pits to elevation 133.6m. See Figure 3.7 to view the pump reflooding curve. Refer to Section 4 for the pit water quality forecast model.

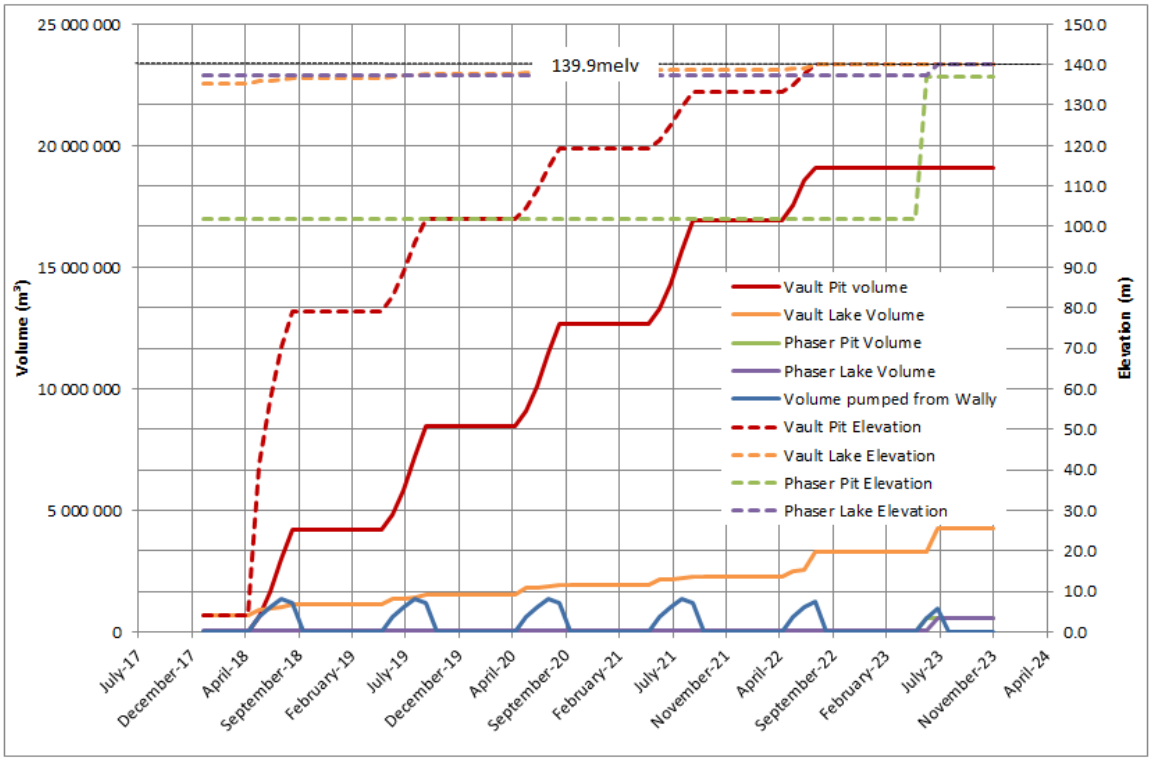
Figure 3.8: Portage pit flooding



3.2.3 Vault pit reflooding

The Vault pit area is composed of many basins in the former lake and different pit elevations that are all linked togheter. The reflooding of Vault and Phaser (once approved) is more complex and requires water transfers from basin to basin. Reflooding of the Vault area will commence in 2018 and will continue for 5 years to 2022. The flooding curves for the Vault area are represented in figure 3.9. The final elevation of the reflooding will be 139.9m (natural Wally Lake water level) for Phaser and Vault Lake. At this point the Vault dike will be breached provided the water meets CCME criteria. Refer to Table 3.9 for the yearly volumes required to complete the reflooding process. The reflooding includes app 480,246m³ yearly from inflow water (freshet, precipitation, groundwater inflow). Refer to Section 4 for the pit water quality forecast model.

Figure 3.9: Vault and Phase pits flooding



3.3 WATER MANAGEMENT STRUCTURES

As per the recommendations and requirements outlined in the document *Water License: 2AM-MEA1525 Reasons for Decision Including Record of Proceedings* from the Nunavut Water Board and as per the Water License 2AM-MEA1525 (Part E, condition 10), the next version of the Meadowbank Water Management Plan Report to be presented with the Meadowbank Annual Report 2015, in March 2016, will include records of inspections of all water management structures during periods of flow.

Section 4.0 - MEADOWBANK WATER QUALITY FORECASTING UPDATE

This report was prepared by SNC Lavallin (Feb, 2015). This is a continuation of a series of yearly water quality modelling forecast reports that commenced in 2012 and will continue until mine closure. The purpose is to identify contaminants of concern and determine if water treatment will be required on site during closure activities – primarily, but not limited to, the pit reflooding process. Each yearly update builds on the previous year as new monitoring data is added at the site. Two contaminants of concern were identified in the 2015 report, Copper and Selenium. These are identified as possibly requiring treatment for removal during or after the pit reflooding process.These contaminants are present in the TSF reclaim water. This report is attached as Appendix C and AEM is committed to implementing the recommendations provided in 2015 and beyond. These are:

- In addition to the current set of chemical analyses, regular (at least monthly) monitoring of all inflows and outflows of the North and South Cells TSF Reclaim Pond for cyanide, total and dissolved copper, total and dissolved iron, ammonia, nitrate chloride and selenium should be undertaken.
- Implement a water sampling and analysis program once reclamation of the North Cell TSF commences to confirm copper equilibrium concentrations, as well as other parameters, once no Mill Effluent is added into the TSF Reclaim Pond. This could be carried between the months of December 2014 to May 2015 while no tailings are being deposited in the North Cell TSF.
- Regular analysis are also required of the Mill Effluent water discharged to the TSF in order to better monitor the changes in cyanide, copper, iron, ammonia, nitrate, chloride and selenium concentrations. Samples should be taken at least once a quarter.
- Once transfer begins to the Portage Pit (August 2017), regular (at least monthly) monitoring of all outflows of the TSF Reclaim Pond for all parameters should be undertaken.

- Sample and analyze the North and South Cell TSF Reclaim Pond at different depths and locations to determine if there is a concentration gradient in the Reclaim Pond.
- Continued monitoring of the water in the South Cell TSF Reclaim Pond in 2015 on a regular basis to monitor the evolution of the parameters of concern listed in section 2.2.1. It is understood that this recommendation is required as per the water license.
- In order to validate the assumption of a well mixed system in Portage and Goose Pits, it is recommended to sample and analyze the water at different depths before, during and after the pit is filled with water from South Cell TSF and/or Third Portage Lake. Furthermore, it may be useful to evaluate the assumption of a well mixed versus stratified pit water quality prior to mixing Portage and Goose Pits.
- Once Portage and Goose Pits are hydraulically connected, it is recommended to sample the water at different points in the pit area in order to evaluate the mixing efficiency over the entire area. The samples should be taken at different depths over the entire area of the flooded pits before and after the filling season.

As per the recommendations and requirements outlined in the document *Water License: 2AM-MEA1525 Reasons for Decision Including Record of Proceedings* from the Nunavut Water Board and as per the Water License 2AM-MEA1525 (Part E, conditions 7, 8), the Water Management Plan will include an updated water quality model, updated yearly. On an annual basis, during operations and closure period, the predicted water quantity and quality within the pits will be compared to the measured water quantity and quality. The results of this comparaison will be included yearly in the Water Management Plan. The next version of the Meadowbank Water Management Plan Report will be submitted with the Meadowbank Annual Report 2015, in March 2016, and will include the updated water quality model and the comparaison of predicted and measured water quantity and quality.

The 2015 Water Management Plan Report will include an action plan to be implemented if predicted re-flooded pit water quality indicates that treatment is necessary. Reflooding volume will be revised during the process as runoff, underground water inflow and evapotranspiration could differ from what has been planned. Details on the water treatment options will be discussed in the report.

Section 5.0 - 2014 INTEGRATED DEPOSITION PLAN

A Tailings deposition plan prepared by AEM has been used to update last year's model. As stated in the water management strategies, the important milestone for 2014 is the North Cell closure planned in October, 2015. Water transfer will be required from the North Cell to the South Cell during summer 2015 to maintain the proper freeboard elevation. This deposition plan is presented in the Updated Mine Waste Rock and Tailings Management Plan 2015.

Section 6.0 - CONCLUSION

This report presents an updated/revised water management plan for the Meadowbank mine based on the AEM 2013 Water Management Plan submitted to the NWB as part of the AEM 2013 Annual Report. Validation and updates of the site parameters (i.e. runoff and pit inflows) was conducted in 2014. In addition further updates/modifications/revisions to the mine plan (LOM), site wide water management, tailings deposition plans and operating schedule were evaluated in preparing this report.

The water balance presented has been optimized to reduce freshwater consumption as much as possible and to minimize water treatment requirements. The water deficit encountered in the Tailings Storage Facilities, mainly the North near the end of operation (as the tailings volume limits the water volume) during the winter months due to the ice cover, is mitigated by an increase in freshwater consumption during the winter months. Water transfer from pits to tailings ponds aids in reducing the freshwater consumption as this increases reclaim volume.

Phaser lake dewatering (once approved by the NIRB and NWB) is planned in 2016 to allow mining of a small ore body (approximately 30 days mining). Approximately 405,665m^3 of water will need to be dewatered after fish out has been undertaken. The current strategy is to transfer this water from Phaser to Vault ATP and then discharge to Wally with the current dewatering infrastructure already in place.

Since December 2013, the East Dike seepage has been redirected to Second Portage Lake in order to reduce this water from entering the site wide system. This also reduced the in-pit pumping requirements (to the former Portage Attenuation Pond before it became the South Cell TSF in Oct 2014) and subsequently the water treatment required in 2014. This seepage collection system recovered around 40% of the estimated total volume in 2014. The other 60 % was allowed to flow into the Portage pit and was subsequently pumped to the Portage ATP before it became the South Cell TSF in November, 2014. . Once Portage Pit enters its reflooding stage, the East Dike seepage will flow freely into the Portage pit and form part of the reflooding water.

Pit reflooding volumes and sequencing (including Portage, Goose and Vault Pits) is presented in this report. Reflooding will commence in 2015 with Goose Pit once mining has been completed, and later in 2017 for both Portage and Vault Pits. The entire reflooding process will be completed by the beginning of 2024. Once water quality in the reflooded pits meet CCME Guidelines for the Protection of Aquatic Life, dike breaching of the surrounding structures will occur to reconnect the Portage and Goose areas to Second Portage Lake and Vault area to Wally

Lake (2024). It should be understood that the dikes will not be breached unless the water quality meets the CCME criteria.

A Water quality forecasting model was completed by SNC Lavallin (SNC, 2015) for the life of mine and included in this report. The mandate of this report is to analyse the water quality as we proceed through the operating life of the mine and the reflooding operation and to determine the need for potential treatment of contaminants of concern. The impact of transferring the TSF water to the pits during the reflooding process was explored using the all available water quality results from the North Cell TSF (since mine commencement) and actual mill tailings composition. Based on current water quality and the 2014 water balance, the report identifies that copper and selenium may require removal treatment in order for the pit water quality to meet CCME criteria in 2024.

Section 7.0 - RECOMMENDATIONS

This section presents a series of recommendations in order to improve on the current water management strategies and water balance.

- Continue to monitor and include any new flow monitoring locations/devices for any additional or new inflows observed in 2015. Continue to update the deposition plans of the North and South Cell as needed to maximize water use and availability as well as increasing the accuracy of the models including but not limited to bathymetric readings.
- Conduct the water quality modelling analysis on a yearly basis based on updated water quality results and water balance through the life of mine.
- Develop a sediment flux model to evaluate erosion of geotechnical structures on site for the closure, primarily for TSS control: diversion ditches, rock storage facilities, capping of the tailings storage facilities, dikes and dams.

Section 8.0 - REFERENCES

1. SNC (2013) – Water Management Plan 2012. SNC Lavalin. March 2013.
2. Golder (2009) – Meadowbank Gold Project Updated Water Management Plan. Golder Associated Limited. July 2009.
3. Environment Canada (2011a) - National Climate Data and Information Archive, http://climat.meteo.gc.ca/advanceSearch/searchHistoricData_f.html.
   14. Nunavut Water Board, Water Licence NO: 2AM-MEA0815, June 9 2008 to May 3 2015.
4. AEM (2015) – Waste Management Plan 2014
5. SNC (2015) – Meadowbank Water Quality Forecasting Update Base on the 2014 Water Management Plan. February 2015.

APPENDIX A – WATER BALANCE

	Year 2014												ANNUAL TOTAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	364 275	314 877	303 462	355 557	339 395	356 065	361 983	341 168	354 171	308 014	349 780	371 417	**4 120 164**
Cummulative Tailings (tonnes):	10 687 190	11 080 786	11 460 114	11 815 671	12 098 500	12 352 832	12 533 823	12 696 284	12 873 370	13 093 380	13 443 160	13 814 577	-
Cummulative Tailings (tonnes) - North Cell	10 687 190	11 080 786	11 460 114	11 815 671	12 098 500	12 352 832	12 533 823	12 696 284	12 873 370	13 093 380	13 303 248	13 303 248	-
Cummulative Tailings (tonnes) - South Cell	0	0	0	0	0	0	0	0	0	0	90 684	434 588	-
North Cell (TSF)													
Starting Pond Volume (m^3)	993 297	745 449	587 681	466 283	370 045	374 251	390 742	430 319	410 992	418 139	310 973	246 466	-
Water from tailings slurry (m^3)	0	26 172	29 024	29 517	122 608	204 845	208 115	195 420	205 220	68 417	46 117	0	**1 135 457**
Runoff (m^3)	0	0	0	0	0	36 426	79 362	17 684	44 122	0	0	0	**177 594**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	20 175	6 067	0	3 417	6 925	0	0	0	**36 584**
Total Inflow (m^3)	0	26 172	29 024	29 517	142 783	247 338	287 477	216 521	256 267	68 417	46 117	0	**1 349 635**
Transfer to South Cell (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Reclaim water to the mill (m^3)	247 849	183 940	150 422	125 755	138 577	230 846	247 901	235 848	249 120	175 584	110 624	0	**2 096 466**
Total Outflow (m^3)	247 849	183 940	150 422	125 755	138 577	230 846	247 901	235 848	249 120	175 584	110 624	0	**2 096 466**
Net Inflow (m^3)	-247 849	-157 768	-121 398	-96 238	4 206	16 491	39 576	-19 327	7 147	-107 167	-64 506	0	**-746 831**
End-of-Month Volume (m^3)	745 449	587 681	466 283	370 045	374 251	390 742	430 319	410 992	418 139	310 973	246 466	246 466	-
South Cell (TSF)													
Starting Pond Volume (m^3)	380 883	0	0	0	0	0	190 882	0	0	0	0	93 856	-
Pumped From Goose Pit (m^3)	26 304	31 040	17 601	16 210	31 906	31 158	23 072	36 083	34 163	21 596	12 989	25 647	**307 769**
Pumped From Portage Pit (m^3)	0	0	0	0	0	0	0	13 212	47 195	4 396	0	0	**64 803**
Runoff (m^3)	86 000	60 000	16 000	40 000	46 900	30 000	34 972	50 705	9 800	0	0	0	**374 377**
Transfer from North Cell (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Water from tailings slurry (m^3)	0	0	0	0	0	0	0	0	0	0	17 935	168 348	**186 283**
Total Inflow (m^3)	112 304	91 040	33 601	56 210	78 806	61 158	58 044	100 000	91 158	25 992	30 924	193 995	**933 232**
Decant - TSS to Third Portage (m^3)	0	0	0	0	0	190 882	0	0	0	0	0	0	**190 882**
Reclaim water to the mill (m^3)	0	0	0	0	0	0	0	0	0	0	93 856	256 680	**350 536**
Transfer to Goose Pit (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Outflow (m^3)	0	0	0	0	0	190 882	0	0	0	0	93 856	256 680	**541 418**
Net Inflow (m^3)	112 304	91 040	33 601	56 210	78 806	-129 724	58 044	100 000	91 158	25 992	-62 933	-62 685	**391 813**
End-of-Month Volume (m^3)	493 187	584 227	617 828	674 038	752 844	623 120	681 164	781 164	872 322	898 314	835 381	772 696	-
Mill/Camp													
Ore water (m^3)	3 381	2 533	1 763	2 723	2 908	3 151	2 504	3 117	3 702	4 310	4 870	4 841	**39 803**
Reclaim water (m^3)	247 849	183 940	150 422	125 755	138 577	230 846	247 901	235 848	249 120	175 584	204 480	256 680	**2 447 002**
Freshwater from Third Portage Lake (m^3)	55 651	77 905	141 003	169 546	167 980	61 488	49 848	43 152	43 200	96 720	113 760	78 120	**1 098 373**
Total Inflow (m^3)	306 881	264 378	293 188	298 024	309 466	295 485	300 253	282 117	296 022	276 614	323 110	339 641	**3 585 178**
Freshwater for camp purposes (m^3)	2 945	2 660	2 945	2 850	2 945	2 850	2 945	2 945	2 850	2 945	2 850	2 945	**34 675**
Slurry water (m^3)	303 936	261 718	290 243	295 174	306 521	292 635	297 308	279 172	293 172	273 669	320 260	336 696	**3 550 503**
Total Outflow (m^3)	306 881	264 378	293 188	298 024	309 466	295 485	300 253	282 117	296 022	276 614	323 110	339 641	**3 585 178**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Reclaim water pumping rate (m^3/hr)	333	274	202	175	186	321	333	317	346	236	284	345	-
Freshwater pumping rate (m^3/hr)	75	116	190	235	226	85	67	58	60	130	158	105	-
TSF Water Balance													
Slurry water (m^3)	303 936	261 718	290 243	295 174	306 521	292 635	297 308	279 172	293 172	273 669	320 260	336 696	**3 550 503**
Tailings water/ice entrampment (%)	100%	90%	90%	90%	60%	30%	30%	30%	30%	75%	80%	50%	**63%**
Void and ice entrapment losses (m^3)	303 936	235 546	261 219	265 656	183 912	87 791	89 192	83 752	87 952	205 252	256 208	168 348	**2 228 763**
Slurry water returned to the pond (m^3)	0	26 172	29 024	29 517	122 608	204 845	208 115	195 420	205 220	68 417	64 052	168 348	**1 321 740**

	Year 2014												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Goose Pit (ATP)													
Runoff (m^3)	26 304	31 040	17 601	16 210	31 906	31 158	23 072	36 083	34 163	21 596	12 989	25 647	**307 769**
Transfer from South Cell (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Inflow (m^3)	26 304	31 040	17 601	16 210	31 906	31 158	23 072	36 083	34 163	21 596	12 989	25 647	**307 769**
Pumped to Attenuation Pond (m^3)	26 304	31 040	17 601	16 210	31 906	31 158	23 072	36 083	34 163	21 596	12 989	25 647	**307 769**
Total Outflow (m^3)	26 304	31 040	17 601	16 210	31 906	31 158	23 072	36 083	34 163	21 596	12 989	25 647	**307 769**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-
Portage Pit													
Runoff (m^3)	0	0	0	0	22 000	40 393	38 681	13 212	47 195	4 396	0	0	**165 877**
East Dike Seepage (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Inflow (m^3)	0	0	0	0	22 000	40 393	38 681	13 212	47 195	4 396	0	0	**165 877**
Pumped to Attenuation Pond (m^3)	0	0	0	0	0	0	0	13 212	47 195	4 396	0	0	**64 803**
Total Outflow (m^3)	0	0	0	0	0	0	0	13 212	47 195	4 396	0	0	**64 803**
Net Inflow (m^3)	0	0	0	0	22 000	40 393	38 681	0	0	0	0	0	**101 074**
End-of-Month Volume (m^3)	0	0	0	0	22 000	62 393	101 074	101 074	101 074	101 074	101 074	101 074	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	0	0	0	123 925	0	0	0	**123 925**
Pumped From Vault Pit (m^3)	0	0	0	0	0	0	9 146	53 542	26 539	11 250	1 140	0	**101 617**
Total Inflow (m^3)	0	0	0	0	0	0	9 146	53 542	150 464	11 250	1 140	0	**225 542**
Decant - TSS to Wally Lake (m^3)	0	0	0	0	0	132 400	0	23 363	0	0	0	0	**155 763**
Total Outflow (m^3)	0	0	0	0	0	132 400	0	23 363	0	0	0	0	**155 763**
Net Inflow (m^3)	0	0	0	0	0	-132 400	9 146	30 180	150 464	11 250	1 140	0	**69 780**
End-of-Month Volume (m^3)	618 533	618 533	618 533	618 533	618 533	618 533	486 133	495 279	645 743	656 993	658 133	658 133	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	0	9 146	53 542	26 539	11 250	1 140	0	**101 617**
Total Inflow (m^3)	0	0	0	0	0	0	9 146	53 542	26 539	11 250	1 140	0	**101 617**
Pumped to Vault Attenuation Pond (m^3)	0	0	0	0	0	0	9 146	53 542	26 539	11 250	1 140	0	**101 617**
Total Outflow (m^3)	0	0	0	0	0	0	9 146	53 542	26 539	11 250	1 140	0	**101 617**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-
Phase Open Pit													

	Year 2015												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	361 119	319 648	318 618	346 230	320 509	350 160	357 182	320 416	351 840	360 406	318 060	367 598	**4 091 786**
Cummulative Tailings (tonnes):	13 814 577	14 134 225	14 452 843	14 799 073	15 119 582	15 469 742	15 826 924	16 147 340	16 499 180	16 859 586	17 177 646	17 545 244	-
Cummulative Tailings (tonnes) - North Cell	13 549 714	13 549 714	13 549 714	13 549 714	13 549 714	13 899 874	14 257 056	14 577 472	14 929 312	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	768 958	1 064 928	1 359 945	1 680 528	1 923 338	1 923 338	1 923 338	1 923 338	1 923 338	2 196 373	2 490 873	2 831 241	-
North Cell (TSF)													
Starting Pond Volume (m^3)	246 466	246 466	246 466	246 466	246 466	246 466	432 761	372 300	258 919	180 069	180 069	180 069	-
Water from tailings slurry (m^3)	0	0	0	0	0	207 072	214 717	213 665	206 837	0	0	0	**842 290**
Runoff (m^3)	0	0	0	0	0	2 767	1 962	0	0	0	0	0	**4 729**
Total Inflow (m^3)	0	0	0	0	0	209 839	216 679	213 665	206 837	0	0	0	**847 019**
Transfer to South Cell (m^3)	0	0	0	0	0	23 544	277 140	327 045	285 687	0	0	0	**913 416**
Reclaim water to the mill (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Outflow (m^3)	0	0	0	0	0	23 544	277 140	327 045	285 687	0	0	0	**913 416**
Net Inflow (m^3)	0	0	0	0	0	186 295	-60 461	-113 380	-78 850	0	0	0	**-66 397**
End-of-Month Volume (m^3)	246 466	246 466	246 466	246 466	246 466	432 761	372 300	258 919	180 069	180 069	180 069	180 069	-
South Cell (TSF)													
Pumped From Goose Pit (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Pumped From Portage Pit (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Runoff (m^3)	0	0	0	0	0	46 107	10 726	13 954	25 856	0	0	0	**96 643**
Transfer from North Cell (m^3)	0	0	0	0	0	23 544	277 140	327 045	285 687	0	0	0	**913 416**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Water from tailings slurry (m^3)	152 817	138 875	152 513	148 062	183 334	0	0	0	0	158 945	103 124	106 930	**1 144 600**
Total Inflow (m^3)	190 817	176 875	190 513	186 062	254 419	134 651	335 866	388 999	371 133	196 945	141 124	144 930	**2 712 334**
Reclaim water to the mill (m^3)	193 440	174 720	193 440	187 200	238 080	230 400	238 080	238 080	230 400	238 080	216 000	223 200	**2 601 120**
Transfer to Goose Pit (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Outflow (m^3)	193 440	174 720	193 440	187 200	238 080	230 400	238 080	238 080	230 400	238 080	216 000	223 200	**2 601 120**
Net Inflow (m^3)	-2 623	2 155	-2 927	-1 138	16 339	-95 749	97 786	150 919	140 733	-41 135	-74 876	-78 270	**111 214**
End-of-Month Volume (m^3)	770 073	772 229	769 302	768 164	784 503	688 754	786 540	937 459	1 078 192	1 037 056	962 180	883 910	-
Mill/Camp													
Ore water (m^3)	3 539	4 891	2 931	3 774	3 461	3 467	4 643	3 140	3 131	3 568	2 290	3 419	**42 254**
Reclaim water (m^3)	193 440	174 720	193 440	187 200	238 080	230 400	238 080	238 080	230 400	238 080	216 000	223 200	**2 601 120**
Freshwater from Third Portage Lake (m^3)	111 600	100 800	111 600	108 000	66 960	64 800	66 960	66 960	64 800	66 960	79 200	81 840	**990 480**
Total Inflow (m^3)	308 579	280 411	307 971	298 974	308 501	298 667	309 683	308 180	298 331	308 608	297 490	308 459	**3 633 854**
Freshwater for camp purposes (m^3)	2 945	2 660	2 945	2 850	2 945	2 850	2 945	2 945	2 850	2 945	2 850	2 945	**34 675**
Slurry water (m^3)	305 634	277 751	305 026	296 124	305 556	295 817	306 738	305 235	295 481	305 663	294 640	305 514	**3 599 179**
Total Outflow (m^3)	308 579	280 411	307 971	298 974	308 501	298 667	309 683	308 180	298 331	308 608	297 490	308 459	**3 633 854**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Reclaim water pumping rate (m^3/hr)	260	260	260	260	320	320	320	320	320	320	300	300	-
Freshwater pumping rate (m^3/hr)	150	150	150	150	90	90	90	90	90	90	110	110	-
TSF Water Balance													
Slurry water (m^3)	305 634	277 751	305 026	296 124	305 556	295 817	306 738	305 235	295 481	305 663	294 640	305 514	**3 599 179**
Tailings water/ice entrampment (%)	50%	50%	50%	50%	40%	30%	30%	30%	30%	48%	65%	65%	
Void and ice entrapment losses (m^3)	152 817	138 875	152 513	148 062	122 223	88 745	92 022	91 571	88 644	146 718	191 516	198 584	**1 612 290**
Slurry water returned to the pond (m^3)	152 817	138 875	152 513	148 062	183 334	207 072	214 717	213 665	206 837	158 945	103 124	106 930	**1 986 890**

	Year 2015												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Transfer from South Cell (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Pumped to Attenuation Pond (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Total Outflow (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
East Dike Seepage (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Inflow (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Pumped to Attenuation Pond (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Total Outflow (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	244 048	31 457	46 996	123 925	0	0	0	**446 426**
Pumped From Vault Pit (m^3)	0	0	0	0	0	7 934	5 769	6 352	6 068	0	0	0	**26 123**
Total Inflow (m^3)	0	0	0	0	0	251 982	37 226	53 348	129 993	0	0	0	**472 549**
Decant - TSS to Wally Lake (m^3)	0	0	0	0	0	120 000	120 000	106 426	100 000	0	0	0	**446 426**
Total Outflow (m^3)	0	0	0	0	0	120 000	120 000	106 426	100 000	0	0	0	**446 426**
Net Inflow (m^3)	0	0	0	0	0	131 982	-82 774	-53 078	29 993	0	0	0	**26 123**
End-of-Month Volume (m^3)	658 133	658 133	658 133	658 133	658 133	790 115	707 341	654 263	684 256	684 256	684 256	684 256	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	7 934	5 769	6 352	6 068	0	0	0	**26 123**
Total Inflow (m^3)	0	0	0	0	0	7 934	5 769	6 352	6 068	0	0	0	**26 123**
Pumped to Vault Attenuation Pond (m^3)	0	0	0	0	0	7 934	5 769	6 352	6 068	0	0	0	**26 123**
Total Outflow (m^3)	0	0	0	0	0	7 934	5 769	6 352	6 068	0	0	0	**26 123**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-
Phase Open Pit													

	Year 2016												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**366**
Tailings (tonnes):	349 618	327 062	349 618	335 790	346 983	335 790	343 139	343 139	332 070	346 053	334 890	346 053	**4 090 205**
Cummulative Tailings (tonnes):	17 894 862	18 221 924	18 571 542	18 907 332	19 254 315	19 590 105	19 933 244	20 276 383	20 608 453	20 954 506	21 289 396	21 635 449	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	3 180 859	3 507 921	3 857 539	4 193 329	4 540 312	4 876 102	5 219 241	5 562 380	5 894 450	6 240 503	6 575 393	6 921 446	-
North Cell (TSF)													
Starting Pond Volume (m^3)	180 069	180 069	180 069	180 069	180 069	180 069	1 075	1 075	1 075	1 075	1 075	1 075	-
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Transfer to South Cell (m^3)	0	0	0	0	0	178 994	0	0	0	0	0	0	**178 994**
Total Outflow (m^3)	0	0	0	0	0	178 994	0	0	0	0	0	0	**178 994**
Net Inflow (m^3)	0	0	0	0	0	-178 994	0	0	0	0	0	0	**-178 994**
End-of-Month Volume (m^3)	180 069	180 069	180 069	180 069	180 069	1 075	1 075	1 075	1 075	1 075	1 075	1 075	-
South Cell (TSF)													
Pumped From Goose Pit (m^3)	38 000	38 000	38 000	38 000	0	0	0	154 237	300 000	0	0	0	**606 237**
Pumped From Portage Pit (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	30 000	30 000	30 000	**145 000**
Runoff (m^3)	0	0	0	0	0	48 766	9 120	12 021	25 135	0	0	0	**95 042**
Transfer from North Cell (m^3)	0	0	0	0	0	178 994	0	0	0	0	0	0	**178 994**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 180	0	0	0	11 590	0	0	0	**34 770**
Water from tailings slurry (m^3)	106 932	100 663	107 006	103 604	159 038	206 972	214 589	213 820	206 714	122 208	29 476	30 531	**1 601 554**
Total Inflow (m^3)	144 932	138 663	145 006	141 604	192 218	449 732	233 709	390 078	553 439	152 208	59 476	60 531	**2 661 597**
Reclaim water to the mill (m^3)	223 200	208 800	223 200	216 000	223 200	230 400	238 080	238 080	230 400	223 200	216 000	223 200	**2 693 760**
Transfer to Portage Pit (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Outflow (m^3)	223 200	208 800	223 200	216 000	223 200	230 400	238 080	238 080	230 400	223 200	216 000	223 200	**2 693 760**
Net Inflow (m^3)	-78 268	-70 137	-78 194	-74 396	-30 982	219 332	-4 371	151 998	323 039	-70 992	-156 524	-162 669	**-32 163**
End-of-Month Volume (m^3)	805 643	735 506	657 312	582 915	551 933	771 265	766 894	918 893	1 241 931	1 170 940	1 014 416	851 747	-
Mill/Camp													
Ore water (m^3)	3 426	5 004	3 636	3 660	3 747	3 324	4 461	3 363	2 955	3 426	2 411	3 218	**42 633**
Reclaim water (m^3)	223 200	208 800	223 200	216 000	223 200	230 400	238 080	238 080	230 400	223 200	216 000	223 200	**2 693 760**
Freshwater from Third Portage Lake (m^3)	81 840	76 560	81 840	79 200	81 840	64 800	66 960	66 960	64 800	81 840	79 200	81 840	**907 680**
Total Inflow (m^3)	308 466	290 364	308 676	298 860	308 787	298 524	309 501	308 403	298 155	308 466	297 611	308 258	**3 644 073**
Freshwater for camp purposes (m^3)	2 945	2 755	2 945	2 850	2 945	2 850	2 945	2 945	2 850	2 945	2 850	2 945	**34 770**
Slurry water (m^3)	305 521	287 609	305 731	296 010	305 842	295 674	306 556	305 458	295 305	305 521	294 761	305 313	**3 609 303**
Total Outflow (m^3)	308 466	290 364	308 676	298 860	308 787	298 524	309 501	308 403	298 155	308 466	297 611	308 258	**3 644 073**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Reclaim water pumping rate (m^3/hr)	300	300	300	300	300	320	320	320	320	300	300	300	-
Freshwater pumping rate (m^3/hr)	110	110	110	110	110	90	90	90	90	110	110	110	-
TSF Water Balance													
Slurry water (m^3)	305 521	287 609	305 731	296 010	305 842	295 674	306 556	305 458	295 305	305 521	294 761	305 313	**3 609 303**
Tailings water/ice entrampment (%)	65%	65%	65%	65%	48%	30%	30%	30%	30%	60%	90%	90%	
Void and ice entrapment losses (m^3)	198 589	186 946	198 725	192 407	146 804	88 702	91 967	91 637	88 592	183 313	265 285	274 782	**2 007 748**
Slurry water returned to the pond (m^3)	106 932	100 663	107 006	103 604	159 038	206 972	214 589	213 820	206 714	122 208	29 476	30 531	**1 601 554**

	Year 2016												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Pumpped from Third Portage Lake (m^3)	0	0	0	0	0	300 000	300 000	300 000	300 000	0	0	0	**1 200 000**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	338 000	338 000	338 000	38 000	38 000	38 000	**1 668 000**
Pumped to Attenuation Pond (m^3)	38 000	38 000	38 000	38 000	0	0	0	154 237	300 000	0	0	0	**606 237**
Total Outflow (m^3)	38 000	38 000	38 000	38 000	0	0	0	154 237	300 000	0	0	0	**606 237**
Net Inflow (m^3)	0	0	0	0	38 000	350 000	338 000	183 763	38 000	38 000	38 000	38 000	**1 061 763**
End-of-Month Volume (m^3)	0	0	0	0	38 000	388 000	726 000	909 763	947 763	985 763	1 023 763	1 061 763	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
East Dike Seepage (m^3)	0	0	0	0	0	0	0	0	0	30 000	30 000	30 000	**90 000**
Total Inflow (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	30 000	30 000	30 000	**145 000**
Pumped to Attenuation Pond (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	30 000	30 000	30 000	**145 000**
Total Outflow (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	30 000	30 000	30 000	**145 000**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	101 074	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	243 879	31 435	46 964	123 839	0	0	0	**446 117**
Pumped From Vault Pit (m^3)	0	0	0	0	0	8 096	5 887	6 481	6 192	0	0	0	**26 656**
Pumped From Phaser Pit (m^3)	0	0	0	0	0	0	200 000	200 000	5 665	0	0	0	**405 665**
Total Inflow (m^3)	0	0	0	0	0	251 975	237 322	253 445	135 696	0	0	0	**878 438**
Decant - TSS to Wally Lake (m^3)	0	0	0	0	0	200 000	400 000	200 000	78 438	0	0	0	**878 438**
Total Outflow (m^3)	0	0	0	0	0	200 000	400 000	200 000	78 438	0	0	0	**878 438**
Net Inflow (m^3)	0	0	0	0	0	51 975	-162 678	53 445	57 258	0	0	0	**0**
End-of-Month Volume (m^3)	684 256	684 256	684 256	684 256	684 256	736 231	573 553	626 998	684 256	684 256	684 256	684 256	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	8 096	5 887	6 481	6 192	0	0	0	**26 656**
Total Inflow (m^3)	0	0	0	0	0	8 096	5 887	6 481	6 192	0	0	0	**26 656**
Pumped to Vault Attenuation Pond (m^3)	0	0	0	0	0	8 096	5 887	6 481	6 192	0	0	0	**26 656**
Total Outflow (m^3)	0	0	0	0	0	8 096	5 887	6 481	6 192	0	0	0	**26 656**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-
Phase Open Pit													
Phaser Lake dewatering (m^3)	0	0	0	0	0	0	200 000	200 000	5 665	0	0	0	**405 665**
Total Inflow (m^3)	0	0	0	0	0	0	200000	200000	5665	0	0	0	405 665
Pumped to Vault Attenuation Pond (m^3)	0	0	0	0	0	0	200 000	200 000	5 665	0	0	0	**405 665**
Total Outflow (m^3)	0	0	0	0	0	0	200 000	200 000	5 665	0	0	0	405 665
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-

	Year 2017												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	341 992	308 896	341 992	330 960	341 992	330 960	350 300	350 300	100 324	0	0	0	**2 797 716**
Cummulative Tailings (tonnes):	21 977 441	22 286 337	22 628 329	22 959 289	23 301 281	23 632 241	23 982 541	24 332 841	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	7 263 438	7 572 334	7 914 326	8 245 286	8 587 278	8 918 238	9 268 538	9 618 838	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Pumped From Portage Pit (m^3)	30 000	30 000	30 000	30 000	40 000	45 000	40 000	40 000	0	0	0	0	**285 000**
Runoff (m^3)	0	0	0	0	0	48 589	7 474	10 494	24 588	0	0	0	**91 145**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Water from tailings slurry (m^3)	30 545	27 759	30 565	29 596	122 315	206 939	214 654	213 870	91 870	0	0	0	**968 112**
Total Inflow (m^3)	60 545	57 759	60 565	59 596	185 400	300 528	262 128	264 364	128 048	0	0	0	**1 378 932**
Reclaim water to the mill (m^3)	223 200	201 600	215 760	208 800	260 400	252 000	260 400	260 400	108 000	0	0	0	**1 990 560**
Transfer to Portage Pit (m^3)	0	0	0	0	0	0	0	100 000	50 000	0	0	0	**150 000**
Total Outflow (m^3)	223 200	201 600	215 760	208 800	260 400	252 000	260 400	360 400	158 000	0	0	0	**2 140 560**
Net Inflow (m^3)	-162 655	-143 841	-155 195	-149 204	-75 000	48 528	1 728	-96 036	-29 952	0	0	0	**-761 628**
End-of-Month Volume (m^3)	689 092	545 251	390 056	240 851	165 852	214 379	216 108	120 071	90 119	90 119	90 119	90 119	-
Mill/Camp													
Ore water (m^3)	3 352	4 726	3 557	3 607	3 694	3 277	4 554	3 433	893	0	0	0	**31 092**
Reclaim water (m^3)	223 200	201 600	215 760	208 800	260 400	252 000	260 400	260 400	108 000	0	0	0	**1 990 560**
Freshwater from Third Portage Lake (m^3)	81 840	73 920	89 280	86 400	44 640	43 200	44 640	44 640	25 200	2 976	2 880	2 945	**542 561**
Total Inflow (m^3)	308 392	280 246	308 597	298 807	308 734	298 477	309 594	308 473	134 093	2 976	2 880	2 945	**2 564 213**
Freshwater for camp purposes (m^3)	2 945	2 660	2 945	2 850	2 945	2 850	2 945	2 945	2 850	2 976	2 880	2 945	**34 736**
Slurry water (m^3)	305 447	277 586	305 652	295 957	305 789	295 627	306 649	305 528	131 243	0	0	0	**2 529 477**
Total Outflow (m^3)	308 392	280 246	308 597	298 807	308 734	298 477	309 594	308 473	134 093	2 976	2 880	2 945	**2 564 213**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Reclaim water pumping rate (m^3/hr)	300	300	290	290	350	350	350	350	150	0	0	0	-
Freshwater pumping rate (m^3/hr)	110	110	120	120	60	60	60	60	35	4	4	4	-
TSF Water Balance													
Slurry water (m^3)	305 447	277 586	305 652	295 957	305 789	295 627	306 649	305 528	131 243	0	0	0	**2 529 477**
Tailings water/ice entrampment (%)	90%	90%	90%	90%	60%	30%	30%	30%	30%	0%	0%	0%	
Void and ice entrapment losses (m^3)	274 902	249 827	275 087	266 362	183 473	88 688	91 995	91 658	39 373	0	0	0	**1 561 365**
Slurry water returned to the pond (m^3)	30 545	27 759	30 565	29 596	122 315	206 939	214 654	213 870	91 870	0	0	0	**968 112**

	Year 2017												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	1 180 000	1 168 000	1 168 000	1 168 000	38 000	38 000	38 000	**4 988 000**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	1 180 000	1 168 000	1 168 000	1 168 000	38 000	38 000	38 000	**4 988 000**
End-of-Month Volume (m^3)	1 099 763	1 137 763	1 175 763	1 213 763	1 251 763	2 431 763	3 599 763	4 767 763	5 935 763	5 973 763	6 011 763	6 049 763	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Transfer from South Cell (m^3)	0	0	0	0	0	0	0	100 000	50 000	0	0	0	**150 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	30 000	30 000	30 000	30 000	40 000	45 000	40 000	140 000	90 000	30 000	30 000	30 000	**565 000**
Pumped to Attenuation Pond (m^3)	30 000	30 000	30 000	30 000	40 000	45 000	40 000	40 000	0	0	0	0	**285 000**
Total Outflow (m^3)	30 000	30 000	30 000	30 000	40 000	45 000	40 000	40 000	0	0	0	0	**285 000**
Net Inflow (m^3)	0	0	0	0	0	0	0	100 000	90 000	30 000	30 000	30 000	**280 000**
End-of-Month Volume (m^3)	101 074	101 074	101 074	101 074	101 074	101 074	101 074	201 074	291 074	321 074	351 074	381 074	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
Pumped From Vault Pit (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Pumped From Phaser Pit (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Inflow (m^3)	0	0	0	0	0	251 753	40 522	56 684	131 305	0	0	0	**480 264**
Decant - TSS to Wally Lake (m^3)	0	0	0	0	0	120 000	110 000	105 839	144 425	0	0	0	**480 264**
Total Outflow (m^3)	0	0	0	0	0	120 000	110 000	105 839	144 425	0	0	0	**480 264**
Net Inflow (m^3)	0	0	0	0	0	131 753	-69 478	-49 155	-13 120	0	0	0	**0**
End-of-Month Volume (m^3)	684 256	684 256	684 256	684 256	684 256	816 009	746 531	697 376	684 256	684 256	684 256	684 256	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Total Inflow (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Pumped to Vault Attenuation Pond (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Total Outflow (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-
Phase Open Pit													
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-

	Year 2018												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Transfer to Portage Pit (m^3)	0	0	0	0	0	0	89 294	0	0	0	0	0	**89 294**
Total Outflow (m^3)	0	0	0	0	0	0	89 294	0	0	0	0	0	**89 294**
Net Inflow (m^3)	0	0	0	0	0	0	-89 294	0	0	0	0	0	**-89 294**
End-of-Month Volume (m^3)	90 119	90 119	90 119	90 119	90 119	90 119	825	825	825	825	825	825	-
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Inflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Freshwater for camp purposes (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Outflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Transfer from South Cell (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	300 000	60 000	0	0	0	0	0	**0**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	98 000	38 000	38 000	38 000	38 000	38 000	**828 000**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	98 000	38 000	38 000	38 000	38 000	38 000	**828 000**
End-of-Month Volume (m^3)	6 087 763	6 125 763	6 163 763	6 201 763	6 239 763	6 589 763	6 687 763	6 725 763	6 763 763	6 801 763	6 839 763	6 877 763	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Transfer from South Cell (m^3)	0	0	0	0	0	0	89 294	0	0	0	0	0	**89 294**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 259 294	1 170 000	1 181 590	30 000	30 000	30 000	**5 058 969**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 259 294	1 170 000	1 181 590	30 000	30 000	30 000	**5 058 969**
End-of-Month Volume (m^3)	411 074	441 074	471 074	501 074	564 159	1 739 159	2 998 453	4 168 453	5 350 043	5 380 043	5 410 043	5 440 043	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
Total Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
End-of-Month Volume (m^3)	684 256	684 256	684 256	684 256	684 256	922 516	953 227	999 109	1 120 095	1 120 095	1 120 095	1 120 095	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Pumped from Wally Lake (m^3)	0	0	0	0	0	603 783	1 006 306	1 360 338	1 212 177	0	0	0	**4 182 604**
Total Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
End-of-Month Volume (m^3)	0	0	0	0	0	617 276	1 633 393	3 004 533	4 227 029	4 227 029	4 227 029	4 227 029	-
Phase Open Pit													
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-

	Year 2019												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Inflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Freshwater for camp purposes (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Outflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	300 000	60 000	0	0	0	0	0	**0**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	98 000	38 000	38 000	38 000	38 000	38 000	**828 000**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	98 000	38 000	38 000	38 000	38 000	38 000	**828 000**
End-of-Month Volume (m^3)	6 915 763	6 953 763	6 991 763	7 029 763	7 067 763	7 417 763	7 515 763	7 553 763	7 591 763	7 629 763	7 667 763	7 705 763	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 170 000	1 170 000	1 181 590	30 000	30 000	30 000	**4 969 675**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 170 000	1 170 000	1 181 590	30 000	30 000	30 000	**4 969 675**
End-of-Month Volume (m^3)	5 470 043	5 500 043	5 530 043	5 560 043	5 623 128	6 798 128	7 968 128	9 138 128	10 319 718	10 349 718	10 379 718	10 409 718	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
Total Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	120 986	0	0	0	**435 839**
End-of-Month Volume (m^3)	1 120 095	1 120 095	1 120 095	1 120 095	1 120 095	1 358 355	1 389 066	1 434 948	1 555 934	1 555 934	1 555 934	1 555 934	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Pumped from Wally Lake (m^3)	0	0	0	0	0	603 783	1 006 306	1 360 338	1 212 177	0	0	0	**4 182 604**
Total Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
End-of-Month Volume (m^3)	4 227 029	4 227 029	4 227 029	4 227 029	4 227 029	4 844 305	5 860 422	7 231 562	8 454 058	8 454 058	8 454 058	8 454 058	-
Phase Open Pit													
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-

	Year 2020												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**366**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Total Inflow (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Freshwater for camp purposes (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Total Outflow (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	300 000	60 000	0	0	0	0	0	**0**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	98 000	38 000	38 000	38 000	38 000	38 000	**828 000**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	350 000	98 000	38 000	38 000	38 000	38 000	38 000	**828 000**
End-of-Month Volume (m^3)	7 743 763	7 781 763	7 819 763	7 857 763	7 895 763	8 245 763	8 343 763	8 381 763	8 419 763	8 457 763	8 495 763	8 533 763	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 170 000	1 170 000	1 181 590	30 000	30 000	30 000	**4 969 675**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 170 000	1 170 000	1 181 590	30 000	30 000	30 000	**4 969 675**
End-of-Month Volume (m^3)	10 439 718	10 469 718	10 499 718	10 529 718	10 592 803	11 767 803	12 937 803	14 107 803	15 289 393	15 319 393	15 349 393	15 379 393	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	238 260	30 711	45 882	41 184	0	0	0	**356 037**
Total Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	41 184	0	0	0	**356 037**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	41 184	0	0	0	**356 037**
End-of-Month Volume (m^3)	1 555 934	1 555 934	1 555 934	1 555 934	1 555 934	1 794 194	1 824 905	1 870 787	1 911 971	1 911 971	1 911 971	1 911 971	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Pumped from Wally Lake (m^3)	0	0	0	0	0	603 783	1 006 306	1 360 338	1 212 177	0	0	0	**4 182 604**
Total Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
End-of-Month Volume (m^3)	8 454 058	8 454 058	8 454 058	8 454 058	8 454 058	9 071 334	10 087 451	11 458 591	12 681 087	12 681 087	12 681 087	12 681 087	-
Phase Open Pit													
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-

	Year 2021												ANNUAL TOTAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Inflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Freshwater for camp purposes (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Outflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Runoff (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	29 703	0	0	**383 703**
Total Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	29 703	0	0	**383 703**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	29 703	0	0	**383 703**
End-of-Month Volume (m^3)	8 571 763	8 609 763	8 647 763	8 685 763	8 723 763	8 773 763	8 811 763	8 849 763	8 887 763	8 917 466	8 917 466	8 917 466	-
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Transfer from Goose (m^3)	0	0	0	0	0	0	0	0	0	8 297	38 000	38 000	**84 297**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 170 000	1 170 000	1 181 590	38 297	68 000	68 000	**5 053 972**
Pumped to Attenuation Pond (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	30 000	30 000	30 000	30 000	63 085	1 175 000	1 170 000	1 170 000	1 181 590	38 297	68 000	68 000	**5 053 972**
End-of-Month Volume (m^3)	15 409 393	15 439 393	15 469 393	15 499 393	15 562 478	16 737 478	17 907 478	19 077 478	20 259 068	20 297 365	20 365 365	20 433 365	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	238 260	30 711	45 882	41 184	0	0	0	**356 037**
Total Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	41 184	0	0	0	**356 037**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	238 260	30 711	45 882	41 184	0	0	0	**356 037**
End-of-Month Volume (m^3)	1 911 971	1 911 971	1 911 971	1 911 971	1 911 971	2 150 231	2 180 942	2 226 824	2 268 008	2 268 008	2 268 008	2 268 008	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	13 493	9 811	10 802	10 319	0	0	0	**44 425**
Pumped from Wally Lake (m^3)	0	0	0	0	0	603 783	1 006 306	1 360 338	1 212 177	0	0	0	**4 182 604**
Total Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	1 371 140	1 222 496	0	0	0	**4 227 029**
End-of-Month Volume (m^3)	12 681 087	12 681 087	12 681 087	12 681 087	12 681 087	13 298 363	14 314 480	15 685 620	16 908 116	16 908 116	16 908 116	16 908 116	-
Phase Open Pit													
Total Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
End-of-Month Volume (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	-

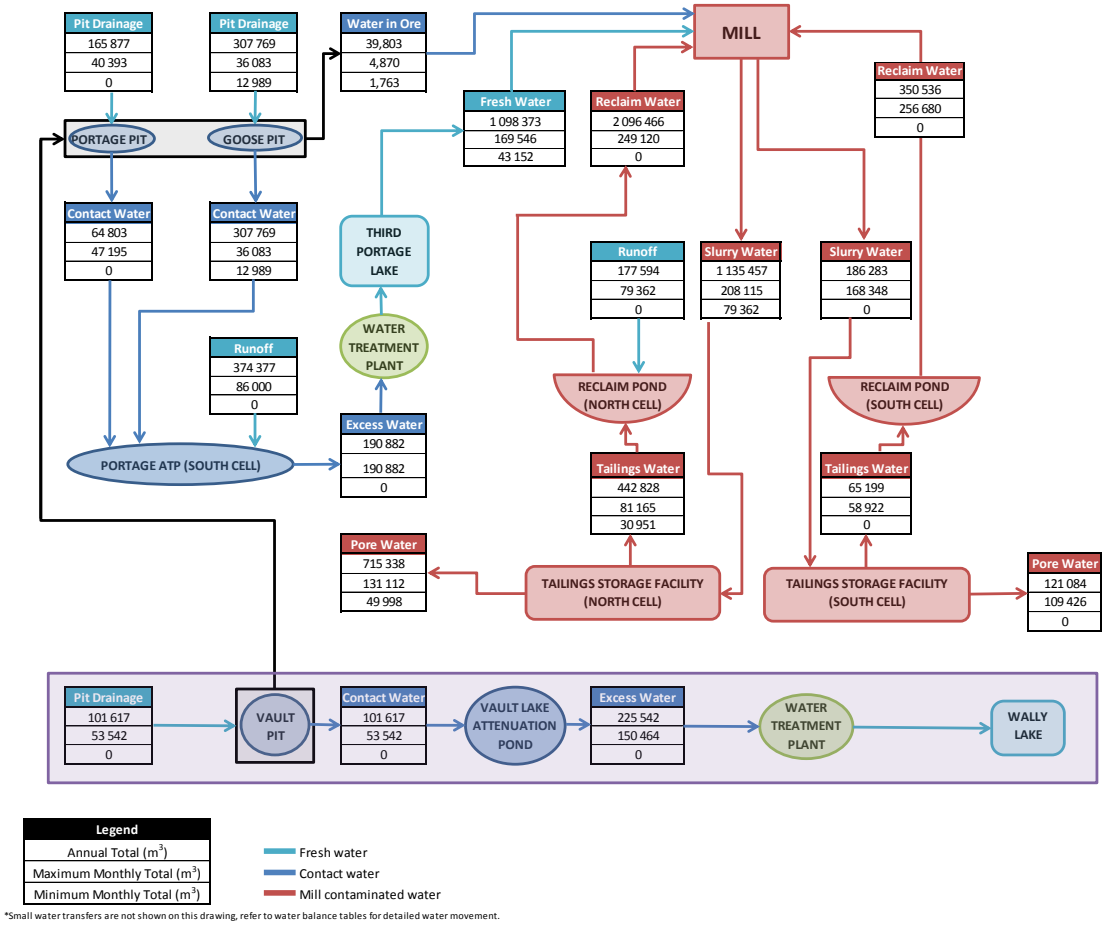
	Year 2022												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Inflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Freshwater for camp purposes (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Outflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Transfer from Goose (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	68 000	68 000	68 000	68 000	101 085	1 225 000	1 208 000	1 208 000	1 219 590	68 000	68 000	68 000	**5 437 675**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	68 000	68 000	68 000	68 000	101 085	1 225 000	1 208 000	1 208 000	1 219 590	68 000	68 000	68 000	**5 437 675**
End-of-Month Volume (m^3)	20 501 365	20 569 365	20 637 365	20 705 365	20 806 450	22 031 450	23 239 450	24 447 450	25 667 040	25 735 040	25 803 040	25 871 040	-
Vault Attenuation Pond													
Runoff (m^3)	0	0	0	0	0	238 260	30 711	45 882	0	0	0	0	**314 853**
Pumped from Wally Lake (m^3)	0	0	0	0	0	0	0	708 102	0	0	0	0	**708 102**
Total Inflow (m^3)	0	0	0	0	0	238 260	30 711	753 984	0	0	0	0	**1 022 955**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	238 260	30 711	753 984	0	0	0	0	**1 022 955**
End-of-Month Volume (m^3)	2 268 008	2 268 008	2 268 008	2 268 008	2 268 008	2 506 268	2 536 979	3 290 963	3 290 963	3 290 963	3 290 963	3 290 963	-
Vault Open Pit													
Runoff (m^3)	0	0	0	0	0	13 493	9 811	10 802	0	0	0	0	**34 106**
Pumped from Wally Lake (m^3)	0	0	0	0	0	603 783	1 006 306	551 137	0	0	0	0	**2 161 226**
Total Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	561 939	0	0	0	0	**2 195 332**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	0	0	0	0	0	617 276	1 016 117	561 939	0	0	0	0	**2 195 332**
End-of-Month Volume (m^3)	16 908 116	16 908 116	16 908 116	16 908 116	16 908 116	17 525 392	18 541 509	19 103 448	19 103 448	19 103 448	19 103 448	19 103 448	-
Phase Open Pit (including Phaser Lake)													
Pumped from Wally Lake (m3)	0	0	0	0	0	571 007	478 420	0	0	0	0	0	**1 049 427**
Total Inflow (m^3)	0	0	0	0	0	571007	478420	0	0	0	0	0	1 049 427
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Inflow (m^3)	0	0	0	0	0	571 007	478 420	0	0	0	0	0	**1 049 427**
End-of-Month Volume (m^3)	0	0	0	0	0	571 007	1 049 427	1 049 427	1 049 427	1 049 427	1 049 427	1 049 427	-

	Year 2023												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Inflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Freshwater for camp purposes (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Total Outflow (m^3)	2 976	2 688	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 040**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Transfer from Goose (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	38 000	38 000	38 000	**468 000**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	1 130 000	0	0	0	**4 520 000**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	**360 000**
Total Inflow (m^3)	68 000	68 000	68 000	68 000	101 085	1 225 000	1 208 000	1 208 000	1 219 590	68 000	68 000	68 000	**5 437 675**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	68 000	68 000	68 000	68 000	101 085	1 225 000	1 208 000	1 208 000	1 219 590	68 000	68 000	68 000	**5 437 675**
End-of-Month Volume (m^3)	25 939 040	26 007 040	26 075 040	26 143 040	26 244 125	27 469 125	28 677 125	29 885 125	31 104 715	31 172 715	31 240 715	31 308 715	-
Vault Attenuation Pond													
Vault Open Pit													
Phase Open Pit (including Phaser Lake)													

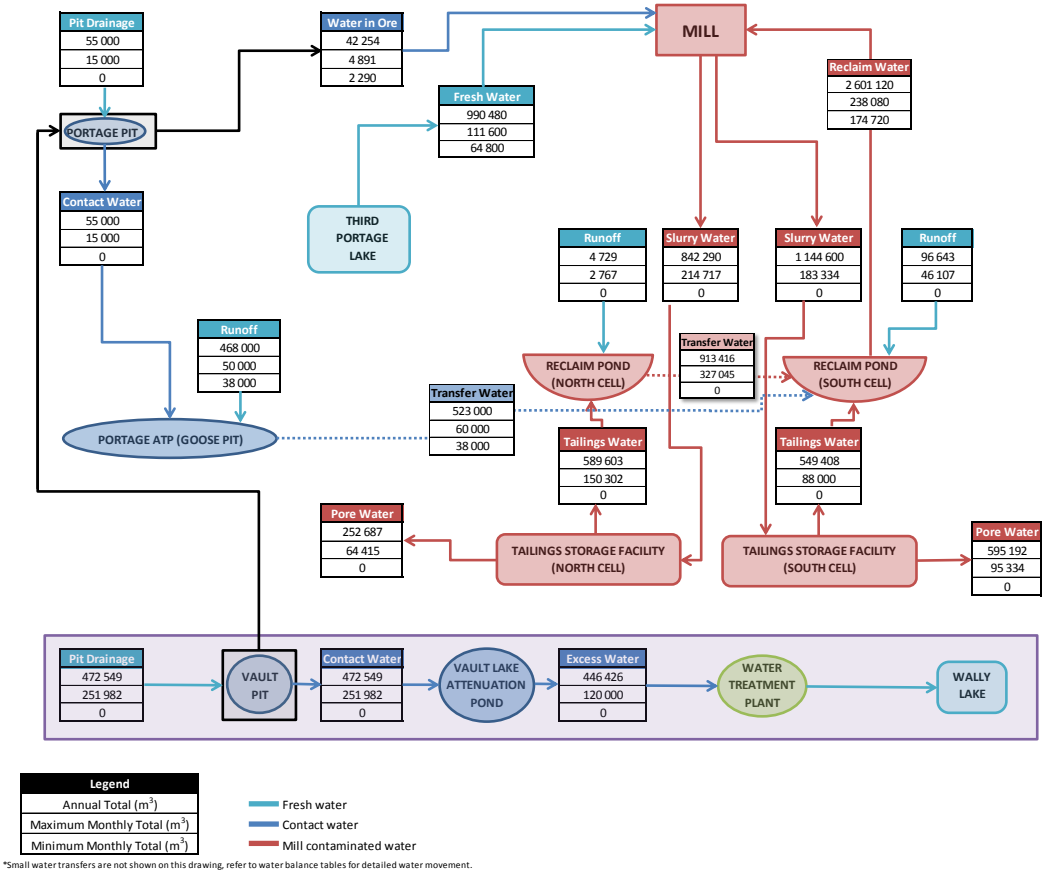
	Year 2024												ANNUAL
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
No. of days	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**366**
Tailings (tonnes):	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cummulative Tailings (tonnes):	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	24 433 165	-
Cummulative Tailings (tonnes) - North Cell	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	15 289 718	-
Cummulative Tailings (tonnes) - South Cell	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	9 719 162	-
North Cell (TSF)													
South Cell (TSF)													
Mill/Camp													
Freshwater from Third Portage Lake (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Total Inflow (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Freshwater for camp purposes (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Total Outflow (m^3)	2 976	2 784	2 976	2 880	2 976	2 880	2 976	2 976	2 880	2 976	2 880	2 976	**35 136**
Net Inflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Freshwater pumping rate (m^3/hr)	4	4	4	4	4	4	4	4	4	4	4	4	-
TSF Water Balance													
Goose Pit (ATP)													
Portage Pit													
Runoff (m^3)	0	0	0	0	10 000	15 000	10 000	10 000	10 000	0	0	0	**55 000**
Transfer from Goose (m^3)	38 000	38 000	38 000	38 000	38 000	50 000	38 000	38 000	38 000	0	0	0	**354 000**
Sewage water from Tear Drop Lake (m^3)	0	0	0	0	23 085	0	0	0	11 590	0	0	0	**34 675**
Pumped from Third Portage Lake (m^3)	0	0	0	0	0	1 130 000	1 130 000	1 130 000	248 634	0	0	0	**3 638 634**
East Dike Seepage (m^3)	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	30 000	0	0	0	**270 000**
Total Inflow (m^3)	68 000	68 000	68 000	68 000	101 085	1 225 000	1 208 000	1 208 000	338 224	0	0	0	**4 352 309**
Total Outflow (m^3)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Net Inflow (m^3)	68 000	68 000	68 000	68 000	101 085	1 225 000	1 208 000	1 208 000	338 224	0	0	0	**4 352 309**
End-of-Month Volume (m^3)	31 376 715	31 444 715	31 512 715	31 580 715	31 681 800	32 906 800	34 114 800	35 322 800	35 661 024	35 661 024	35 661 024	35 661 024	-
Vault Attenuation Pond													
Vault Open Pit													
Phase Open Pit (including Phaser Lake)													

APPENDIX B – GENERAL WATER MOVEMENT

GENERAL WATER MOVEMENT – 2014

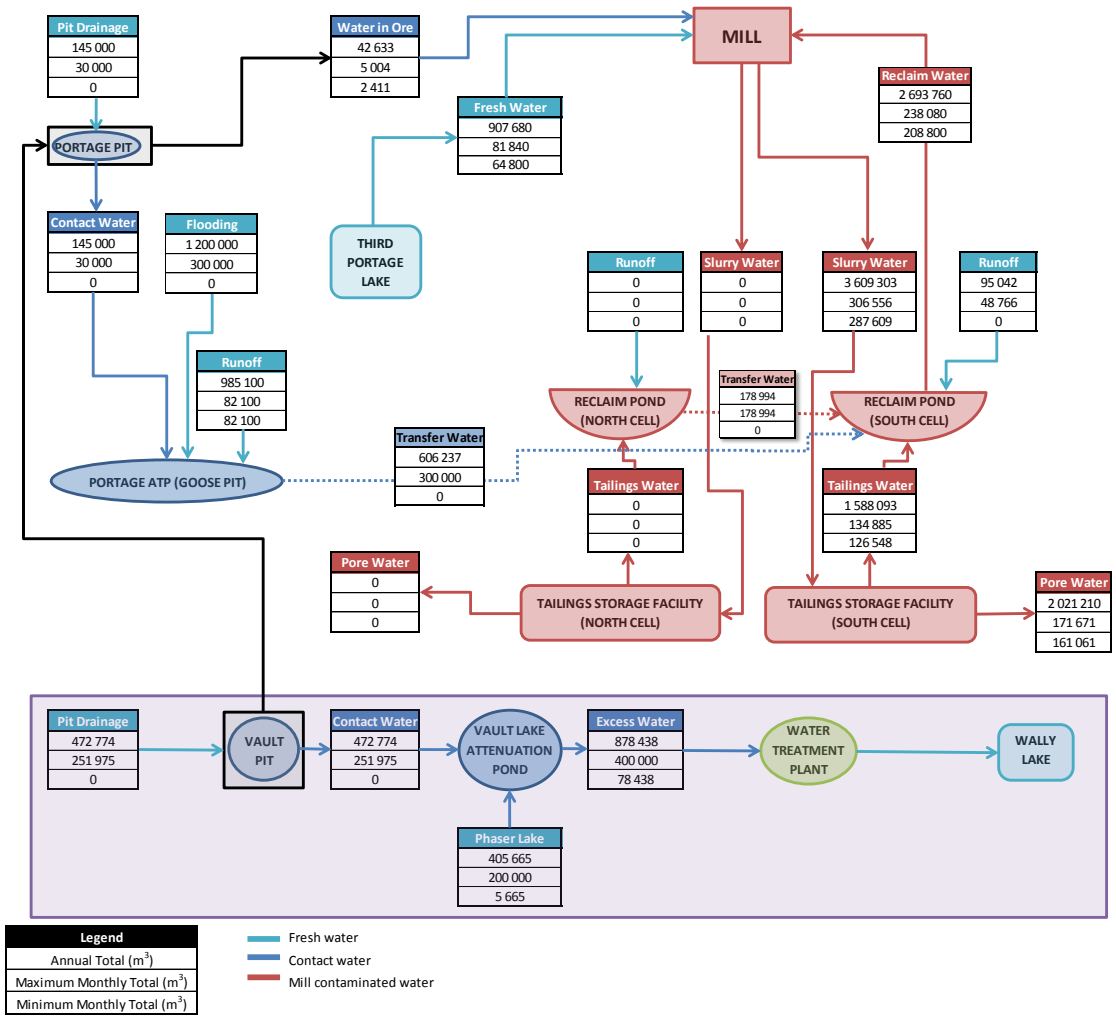


GENERAL WATER MOVEMENT – 2015



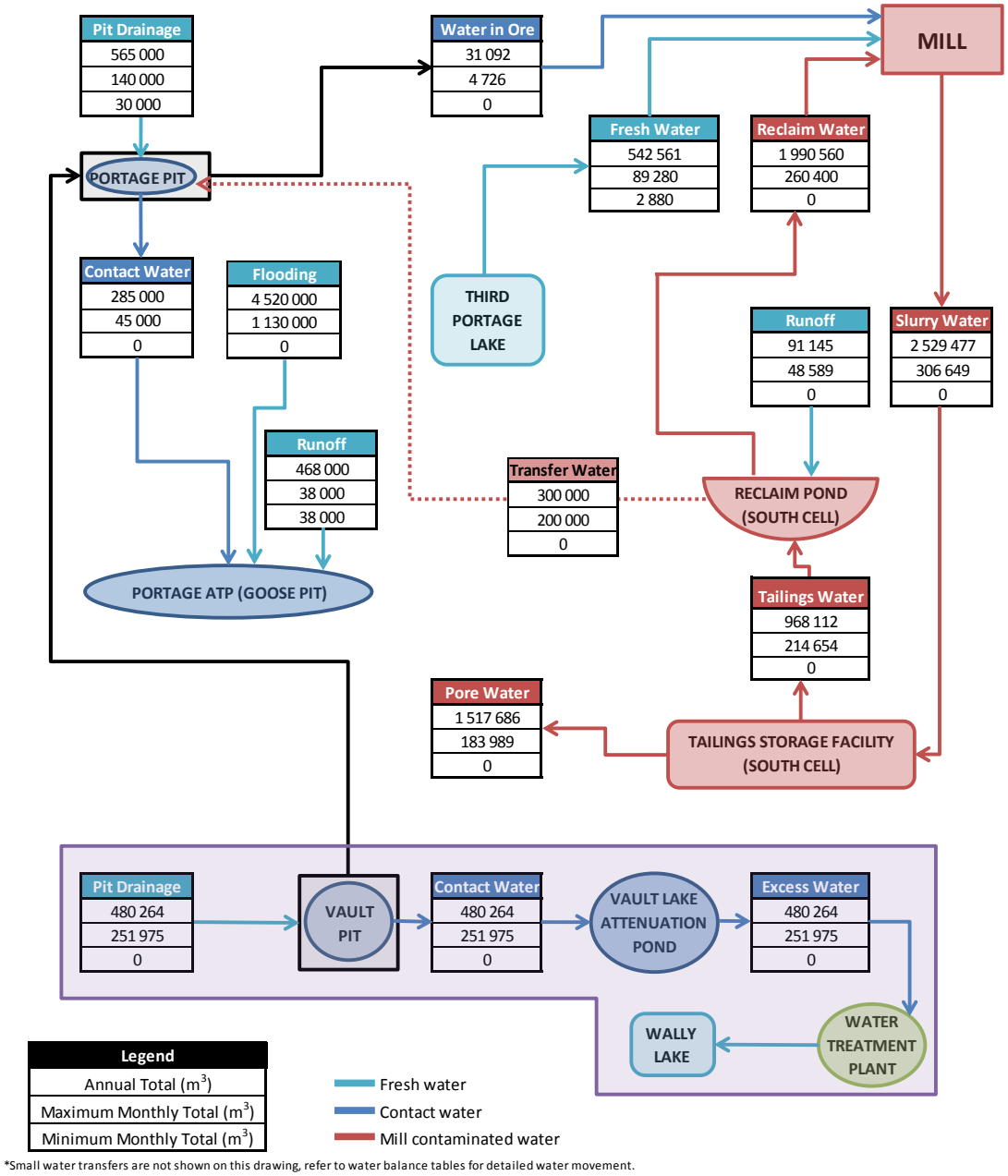
*Small water transfers are not shown on this drawing, refer to water balance tables for detailed water movement.

GENERAL WATER MOVEMENT – 2016



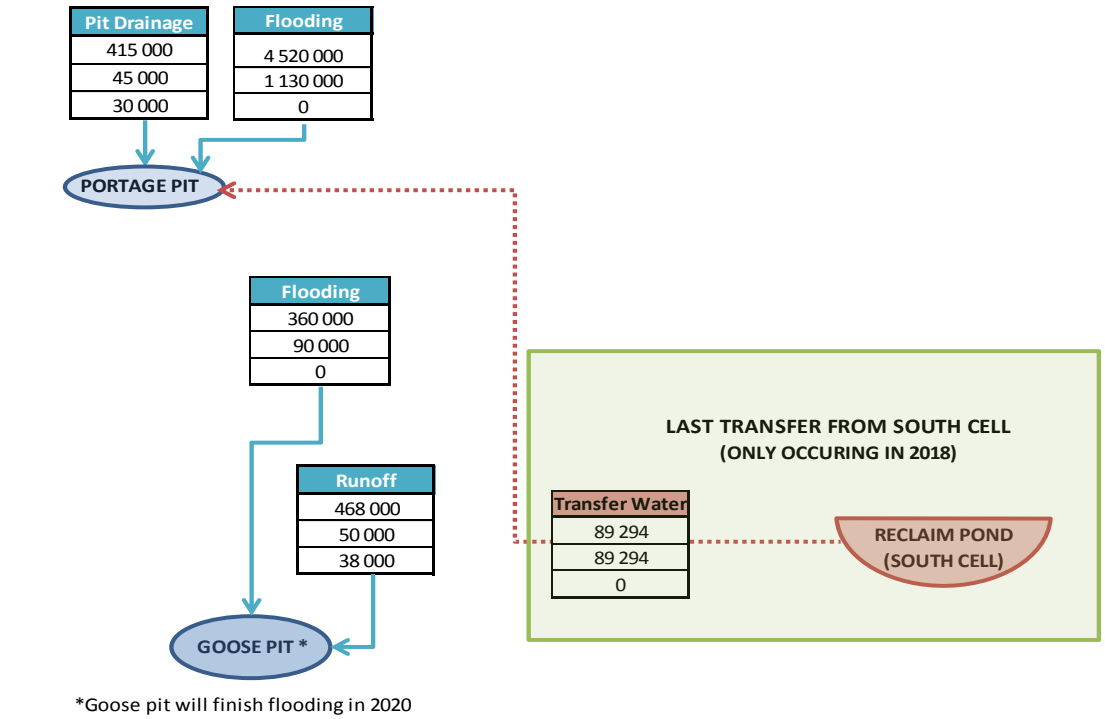
*Small water transfers are not shown on this drawing, refer to water balance tables for detailed water movement.

GENERAL WATER MOVEMENT – 2017

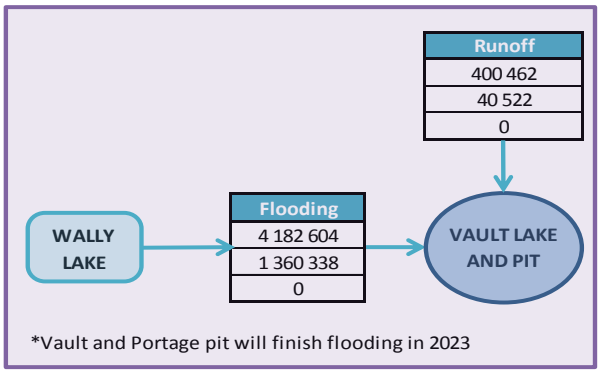


*Small water transfers are not shown on this drawing, refer to water balance tables for detailed water movement.

GENERAL WATER MOVEMENT: PIT FLOODING – 2018-2024



*Goose pit will finish flooding in 2020



Legend
Annual Total (m^3)
Maximum Monthly Total (m^3)
Minimum Monthly Total (m^3)

Fresh water
Contact water
Mill contaminated water

APPENDIX C – 2014 MEADOWBANK WATER QUALITY FORECASTING UPDATE

SNC·LAVALIN

SUSTAINABLE MINE DEVELOPMENT

TECHNICAL NOTE

AGNICO-EAGLE MINES

Meadowbank Water Quality Forecasting Update Based on the 2014 Water Management Plan

Our file: 625618-0000-40ER-0001

February 2015

Certified ISO 9001

WE CARE
NOUS VEILLONS

Title of document: **Meadowbank Water Quality Forecasting Update Based on the 2014 Water Management Plan**

Client : **AGNICO-EAGLE MINES**

Project : **Meadowbank Gold Project**

Prepared by: Geneviève Beaudoin-Lebeuf, ing. Geneviève BL ing. #5026532 2015-02-17

Reviewed by: Anh-Long Nguyen, ing., M.Sc. Anh Long Nguyen ing #122858 2015-02-17

REVISION INDEX

Revision #	Prep.	App.	Date	Pages Revised	Remarks
PA	GBL	ALN	2014-01-19	All	For internal review
PB	GBL	ALN	2014-01-20	All	For client's review
00	GBL	ALN	2014-02-17	All	
	2015-02-17	2015-02-17			

NOTICE TO READER

This document contains the expression of the professional opinion of SNC-Lavalin Inc. ("SLI") as to the matters set out herein, using its professional judgment and reasonable care. It is to be read in the context of the agreement dated * (the "Agreement") between SLI and Agnico Eagle Mine (the "Client") and the methodology, procedures and techniques used, SLI's assumptions, and the circumstances and constraints under which its mandate was performed. This document is written solely for the purpose stated in the Agreement, and for the sole and exclusive benefit of the Client, whose remedies are limited to those set out in the Agreement. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

SLI has, in preparing estimates, as the case may be, followed accepted methodology and procedures, and exercised due care consistent with the intended level of accuracy, using its professional judgment and reasonable care, and is thus of the opinion that there is a high probability that actual values will be consistent with the estimate(s). Unless expressly stated otherwise, assumptions, data and information supplied by, or gathered from other sources (including the Client, other consultants, testing laboratories and equipment suppliers, etc.) upon which SLI's opinion as set out herein are based have not been verified by SLI; SLI makes no representation as to its accuracy and disclaims all liability with respect thereto.

To the extent permitted by law, SLI disclaims any liability to the Client and to third parties in respect of the publication, reference, quoting, or distribution of this report or any of its contents to and reliance thereon by any third party

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Mandate 1
1.2 Study Objectives and Content 1
1.3 Water Management Plan 1
2.0 REVIEW OF MEADOWBANK WATER QUALITY DATA FOR 2014 3
2.1 Documents Reviewed 3
2.1.1 Updates to the Water Management Plan 3
2.2 Review of Meadowbank Water Quality Data 4
2.2.1 North Cell TSF Reclaim Pond (ST-21) 4
2.2.2 Mill Effluent 10
2.2.3 Additional Mill Effluent Water Quality Results 11
2.2.4 Attenuation Pond 12
3.0 UPDATED MASS BALANCE MODEL 13
3.1 Description 13
3.2 Assumptions 13
3.3 Limitations 15
3.4 Input Parameters 16
3.4.1 Mill Effluent Concentration 16
3.4.2 Initial Concentrations in the TSF Reclaim Ponds and Pits 18
3.5 Cyanide Decay 20
4.0 MASS BALANCE RESULTS 22
4.1 Results 22
4.2 Discussion 22
4.2.1 Key Dates 22
4.2.2 Forecasted Concentrations in the North and South Cells TSF Reclaim Pond 23
4.2.3 Forecasted Concentrations in Portage and Goose Pits 25
4.2.4 Treatment Requirements 26
4.2.5 Summary of volume of Reclaim Water sent to the Pits 27
5.0 CONCLUSION 35
5.1 Limitations 35
5.2 Results Summary and Treatment 35
5.3 Recommendations 36

LIST OF TABLES

Table 1-1: Water Management Phases (based on LOM ver. 2014 V2C) 2
Table 2-1: Discharge Criteria for the Parameters Evaluated 5
Table 2-2: Mill Effluent Concentrations Sampled On October 26th, 2014, January 29, 2014 & October 10 and 11, 2012 12
Table 2-3: Average (2014, 2013 and November 2011 to November 2012) Concentrations in the Attenuation Pond 13
Table 3-1: Mill Effluent Concentrations Selected for the Mass Balance Model 16
Table 3-2: Initial Concentration in the North and South Cells TSF Reclaim Pond 19
Table 3-3: Natural Cyanide Degradation: Assumptions and Constants 21
Table 4-1: Summary of Forecasted Concentrations in Reclaim Pond 23
Table 4-2: Summary of Forecasted Concentrations in Portage and Goose Pits 25

LIST OF FIGURES

Figure 2-1: Concentration in the North Cell TSF Reclaim Pond 5
Figure 2-2: Dissolved Metal Concentrations and Cyanide (CN-WAD) in the Mill Effluent from January 2013 to December 2014 11
Figure 3-1: Cyanide Volatilization Process 20
Figure 4-1: Total Cyanide Concentration in the North and South Cells TSF Reclaim Pond 28
Figure 4-2: Total Cyanide Concentration in the Portage and Goose Pits 28
Figure 4-3: Total Copper Concentration in the North and South Cells TSF Reclaim Pond 29
Figure 4-4: Total Copper Concentration in the Portage and Goose Pits 29
Figure 4-5: Total Iron Concentration in the North and South Cells TSF Reclaim Pond 30
Figure 4-6: Total Iron Concentration in the Portage and Goose Pits 30
Figure 4-7: Ammonia Concentration in the North and South Cells TSF Reclaim Pond 31
Figure 4-8: Ammonia Concentration in the Portage and Goose Pits 31
Figure 4-9: Nitrate Concentration in the North and South Cells TSF Reclaim Pond 32
Figure 4-10: Nitrate Concentration in the Portage and Goose Pits 32
Figure 4-11: Chloride Concentration in the North and South Cells TSF Reclaim Pond 33
Figure 4-12: Chloride Concentration in the Portage and Goose Pits 33
Figure 4-13: Selenium Concentration in the North and South Cells TSF Reclaim Pond 34
Figure 4-14: Selenium Concentration in the Portage and Goose Pits 34

LIST OF APPENDICES

APPENDIX A: WATER QUALITY ANALYSES

1.0 INTRODUCTION

1.1 MANDATE

SNC-Lavalin (SLI) was mandated by Agnico-Eagle Mines (AEM) to review and update the water quality forecasting model developed in 2013 using the Water Management Plan 2014 established by AEM.

1.2 STUDY OBJECTIVES AND CONTENT

This Technical Note will present the update of the water quality forecast model for the Meadowbank Gold Project. The update developed in this study is based on the Water Management Plan 2014 of AEM that was developed according to the updated Life of Mine (LOM) (version 2014 V2C - Q3 2017) and the mine development sequence provided by AEM and summarized in Table 1-1. The updated water quality forecast model applies to the North and South Cell TSF Reclaim Ponds, and the Portage and Goose Pits.

The objective of this Technical Note is to forecast the concentration of selected parameters of concern within the North and South Cell TSF Reclaim Ponds, and the Portage and Goose Pits from 2014 until closure, verify last year's assumptions and results, update the model if required, develop recommendations and determine whether water treatment will be required.

For the Vault pit, no treatment would be required when re-flooding the pit. This is largely due to the fact that there is no tailings disposal facility at the Vault site. The Vault Attenuation pond only receives mine pit and freshet water. This will be confirmed through regular monitoring required by the Type A Water License from 2014 – 2018. Active mining of the Vault pit began in January 2014.

1.3 WATER MANAGEMENT PLAN

The Water Management Plan (2014) and water balance was developed by AEM. AEM evaluated the monthly flows and volumes in the Portage and Vault areas, including the maximum storage volumes required for the water management infrastructures during the active life of mine, pit re-flooding activities and post closure, all under average hydrologic conditions.

The Water Management Plan (2014) was based on the revised mining schedule presented in Table 1-1 below.

Table 1-1: Water Management Phases (based on LOM ver. 2014 V2C)

ACTIVITY	UPDATED START DATE[1]	UPDATED END DATE[1]	WMP 2012 START DATE	WMP 2012 END DATE
Pits Mining				
Portage Pit	January 2010	September 2017	January 2010	December 2016
North	January 2010	September 2017	January 2010	December 2015
Central	January 2010	April 2013	January 2010	December 2013
South	January 2010	September 2016	January 2010	December 2016
Goose Island Pit	April 2012	January 2015	April 2012	June 2015
Vault Pit	January 2014	September 2017	January 2014	February 2018
Tailings Storage Facility Operations				
North Cell	January 2010	October 2015	January 2010	March 2015
South Cell	October 2014	September 2017	April 2015	February 2018
Rock Storage Facility (RSF) Operations				
Portage RSF	January 2009	June 2018	January 2009	December 2016
Vault RSF	January 2014	September 2017	January 2014	February 2018
Attenuation / Reclaim Pond Water Management				
Attenuation Pond (South Cell) [2]	January 2009	November 2014	January 2009	March 2015
Attenuation Pond Vault Lake	January 2014	September 2017	January 2014	February 2018
Mill Operations	January 2010	September 2017	January 2010	February 2018
Other Key Activities				
Dewatering of Vault Lake	June 2013	July 2014	September 2013	November 2013
Dewatering of Phaser Lake	July 2016	September 2016	September 2016	October 2016
Flooding of Portage Pit	August 2017	January 2025	March 2017	September 2023
Flooding of Goose Island Pit	May 2015	January 2025	July 2015	September 2023
Flooding of Vault Pit	March 2018	October 2023	March 2018	October 2023
Mine Closure completed	n/a	January 2025	n/a	January 2024

Note :
[1] Periods are given from the beginning of the starting month to the end of the ending month.
[2] After October 2014, the Reclaim Pond is relocated to the South Cell TSF. After this date, there is no Attenuation Pond.

2.0 REVIEW OF MEADOWBANK WATER QUALITY DATA FOR 2014

2.1 DOCUMENTS REVIEWED

A review of the available water quality data measured in 2014 was undertaken by SLI. This included a review of the following documents:

- Chemical analysis results for the Portage Area for 2014. The chemical analysis results of interest for this Technical Note are presented in Appendix A and were integrated in the data previously obtained, specifically:
  - North Cell TSF Reclaim Pond (ST-21) from 2010 to 2014.
  - Attenuation Pond (future South Cell TSF Reclaim Pond) (ST-18) from November 2011 to October 2014.
  - Mill effluent metal and cyanide concentrations from April 2012 to December 2014.
  - Grab sample of Mill Effluent taken in October 2014.

It should be noted that the Mill Effluent is currently being discharged to the South Cell TSF (November 2014). It was discharged previously in the North Cell TSF. The South Cell TSF Reclaim Pond thus collects water from the Mill Effluent and additional runoff water from surrounding areas. This mode of operation is planned to continue until May 2015. Afterwards, the Mill Effluent will be sent to the North Cell TSF from June to September 2015, then back into the South Cell TSF until September 2017.

It is important to remember that the review of the Meadowbank water quality data was undertaken to gain a better understanding of the water quality in the Portage Area, particularly as it affects the TSF Reclaim Ponds, and to provide a basis for the development and update of the mass balance.

2.1.1 Updates to the Water Management Plan

In the 2012 Water Management Plan, South Cell TSF Reclaim Water was to be transferred to the pits in 2018 when there was approximately 6 Mm^3 of non-contact water already accumulated in the pits.

In the 2013 Water Management Plan, the South Cell TSF Reclaim water was to be transferred to the pits beginning in 2015 when there would be very little water in the pits. Runoff water will then be allowed to flow into the pit and mix with the South Cell Reclaim Water.

In the 2014 Water Management Plan (WMP), based on the volume of Reclaim Water anticipated in the North Cell TSF and South Cell TSF, South Cell Reclaim Water will be

transferred to Portage pit starting August 2017. Based on the updated water balance model, no Reclaim Water will be transferred to Goose Pit.

Furthermore, the percentage of tailings water/ice entrapment was also updated in the 2014 WMP to better reflect what is currently observed on site.

2.2 REVIEW OF MEADOWBANK WATER QUALITY DATA

Based on the flows in the Portage Area, it was determined that the most important contributor to the water quality in the TSF Reclaim Pond was the Mill Effluent, since the other inflows consist of snow and ice melt, precipitation, and runoff from nearby areas.

2.2.1 North Cell TSF Reclaim Pond (ST-21)

A review of the chemical analysis for water samples collected in the North Cell TSF Reclaim Pond (station ST-21) was undertaken by SLI in order to identify contaminants that were either above discharge criteria (as stipulated in the MMER, CCME and/or the Water License, Part F). It is understood that the MMER, CCME and Water License criteria apply to mining effluents discharged to the environment and are as such not applicable to the TSF Reclaim Pond since no effluent is discharged from this area to the environment. However, the MMER, CCME and Water License criteria were used as a guide, to identify potential parameters that may become a problem should they be discharged to the environment without treatment.

It should also be noted that the parameters of concern were only determined based on the chemical analyses provided by Meadowbank and summarized in Appendix A.

The parameters of concern identified in the previous water quality forecasting report that may represent a potential long term contamination risk are the following:

- Cyanide (total)
- Copper
- Iron
- Nitrate
- Chloride
- Ammonia

Table 2-1 presents the MMER, Water License and CCME discharge criteria for the 2014 parameters that may represent a potential contamination risk in the Portage Area when filling Portage and Goose Pits after the mining sequence is complete. These criteria are also presented in Figure 2-1, where applicable. Figure 2-1 presents the concentration of the 2014 parameters measured in the North Cell TSF Pond from 2010 until 2014. Also shown in this figure are the forecasted concentrations from the 2013 Water Management Plan.

Table 2-1: Discharge Criteria for the Parameters Evaluated

PARAMETER	DISCHARGE CRITERIA		
	MMER [1]	*Water License* [2] *(Part F)*	*CCME* [3] *(criteria date)*
Cyanide (CN)	1.00 mg/L (as total CN)	0.5 mg/L (as total CN)	5 µg/L (as free CN) (1987)
Copper (Cu)	0.30 mg/L	0.1 mg/L	4 µg/L [4] (1987)
Iron (Fe)	*no criteria*	*no criteria*	0.3 mg/L (1987)
Ammonia (NH_3)	*no criteria*	16 mg N/L	0.86 mg N/L [5] (2001)
Nitrate (NO_3)	*no criteria*	20 mg N/L	2.94 mg N/L (2012)
Chloride (Cl)	*no criteria*	1,000 mg/L	120 mg/L [6] (2011)

Notes:

(1) MMER criteria corresponding to the maximum average monthly concentration
(2) Water License (Part F) criteria corresponding to the maximum average concentration
(3) CCME criteria as per the Water Quality Guidelines for the Protection of Aquatic Life for freshwater and long-term exposure. Criteria referenced from www.ccme.ca in Feb. 2014.
(4) The copper discharge criterion depends on hardness. For water hardness between 200 to 1000 mg/L of $CaCO_3$ (average hardness levels in the North Cell TSF Reclaim Pond and in Third Portage Lake) the copper limit is 4 µg/L.
(5) The ammonia concentration limit depends on temperature and pH (an increase in temperatures and pH leads to a more stringent ammonia concentration limit). In this case, 1.04 mg/L of NH_3, or 0.855 mg N/L was determined assuming a temperature of 10°C and a pH of 8.0.
(6) This is the long-term chloride concentration limit. The short term concentration limit is 640 mg/L.

Figure 2-1: Concentration in the North Cell TSF Reclaim Pond

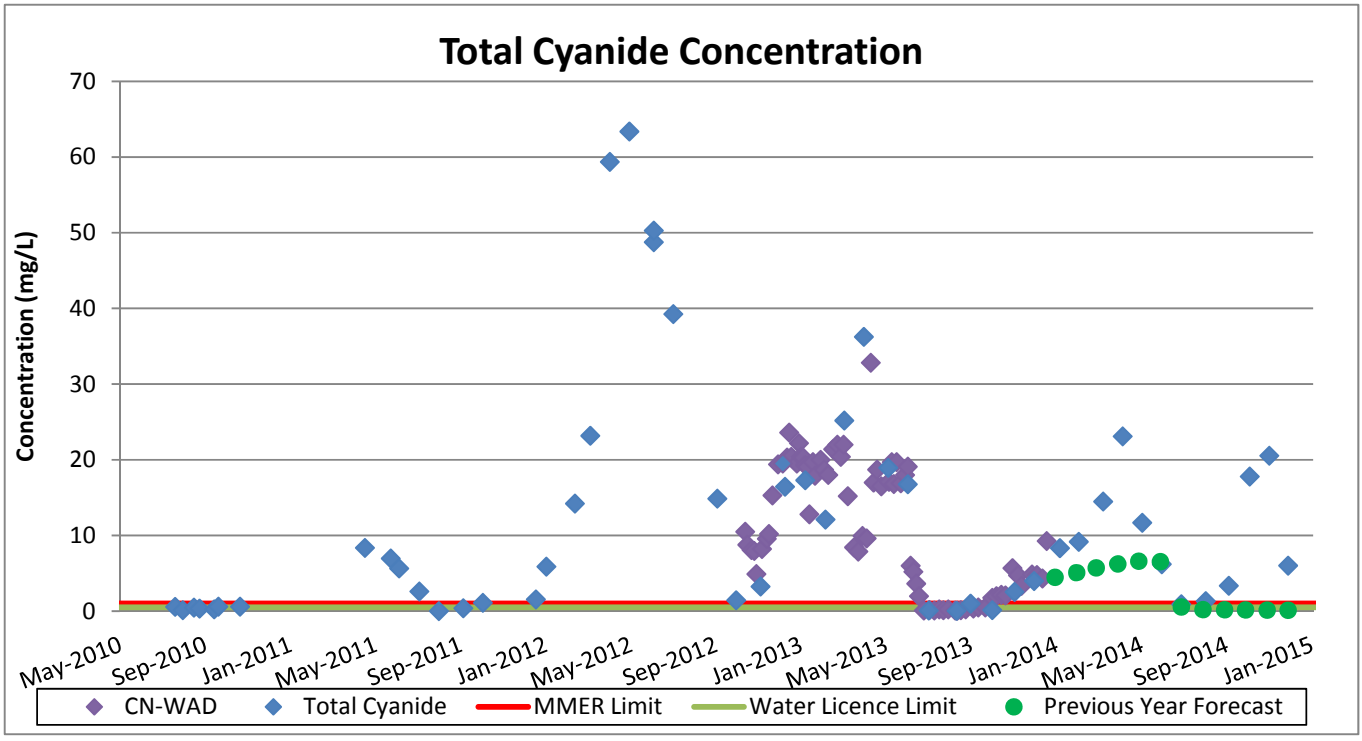
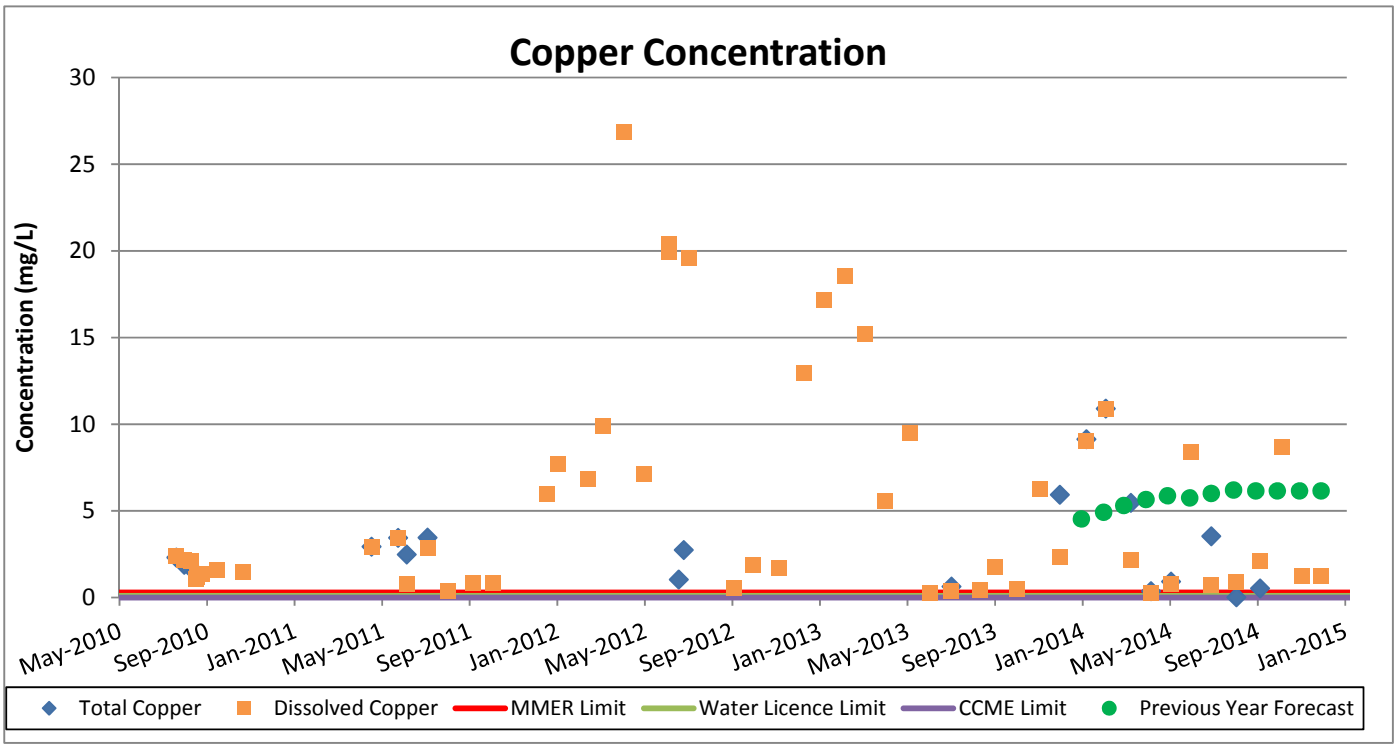


Figure 2-1: (continued) Concentration in the North Cell TSF Reclaim Pond



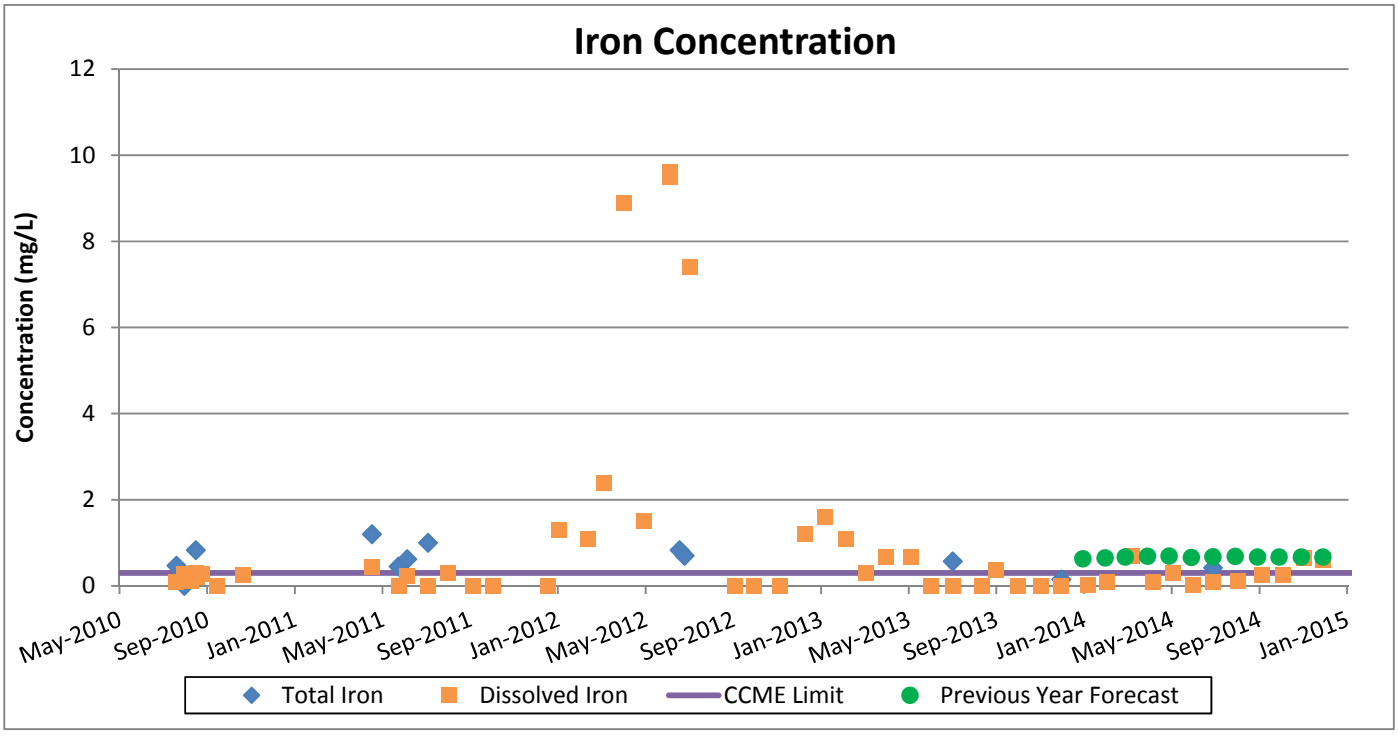
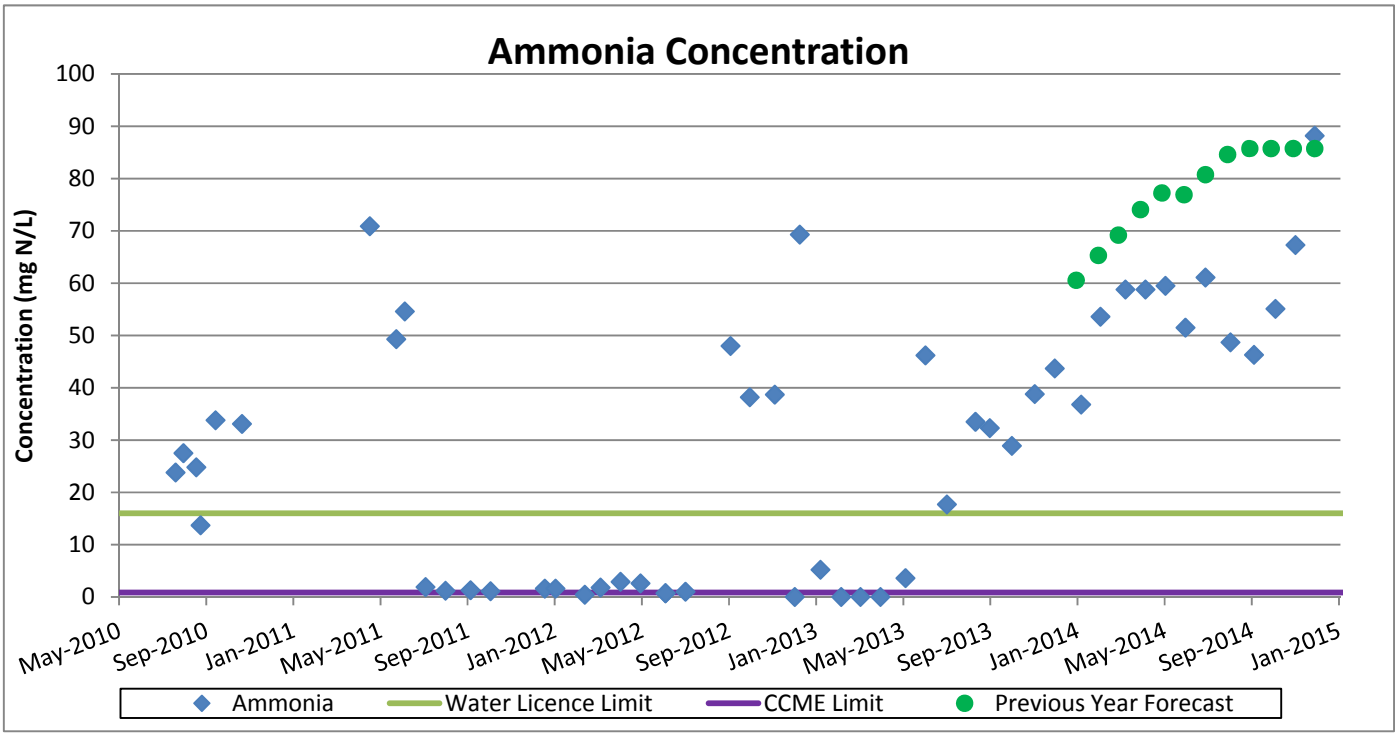


Figure 2-1: (continued) Concentration in the North Cell TSF Reclaim Pond



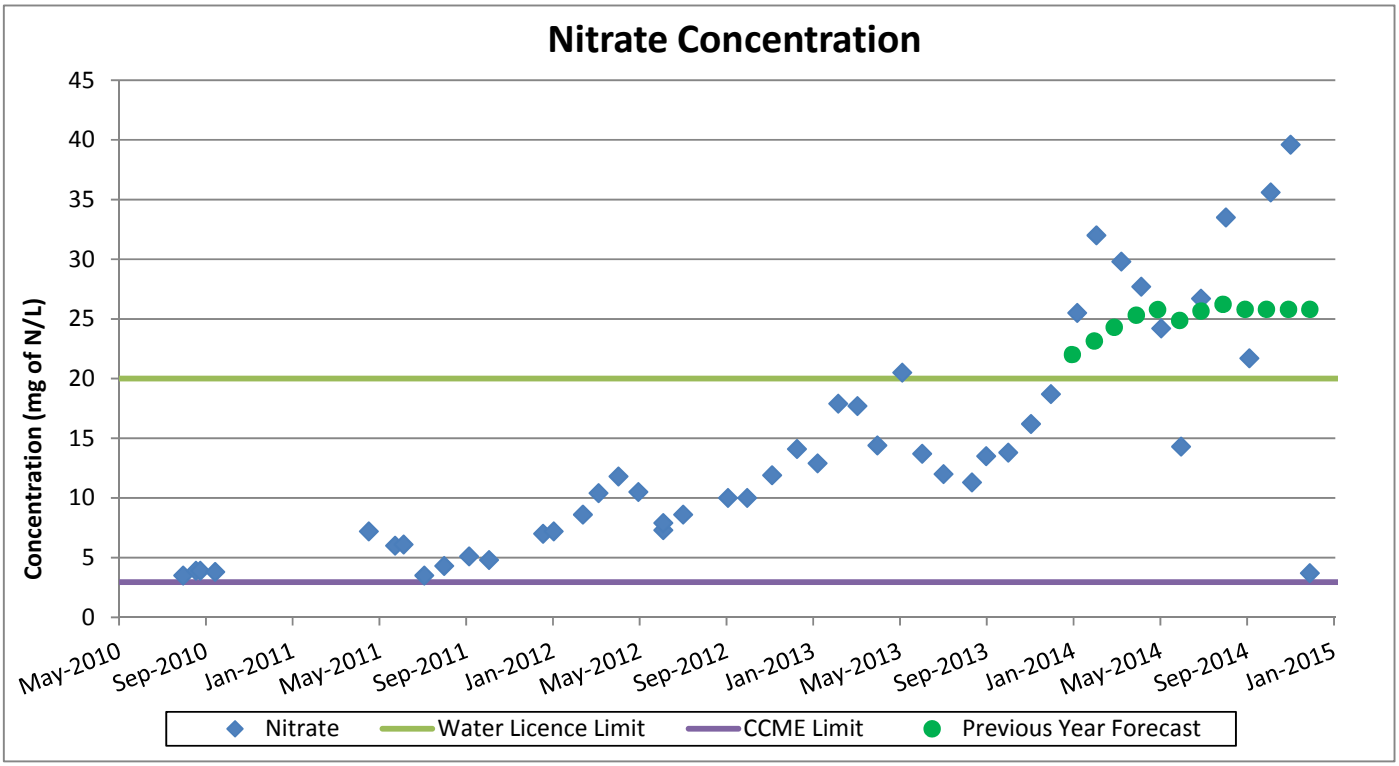
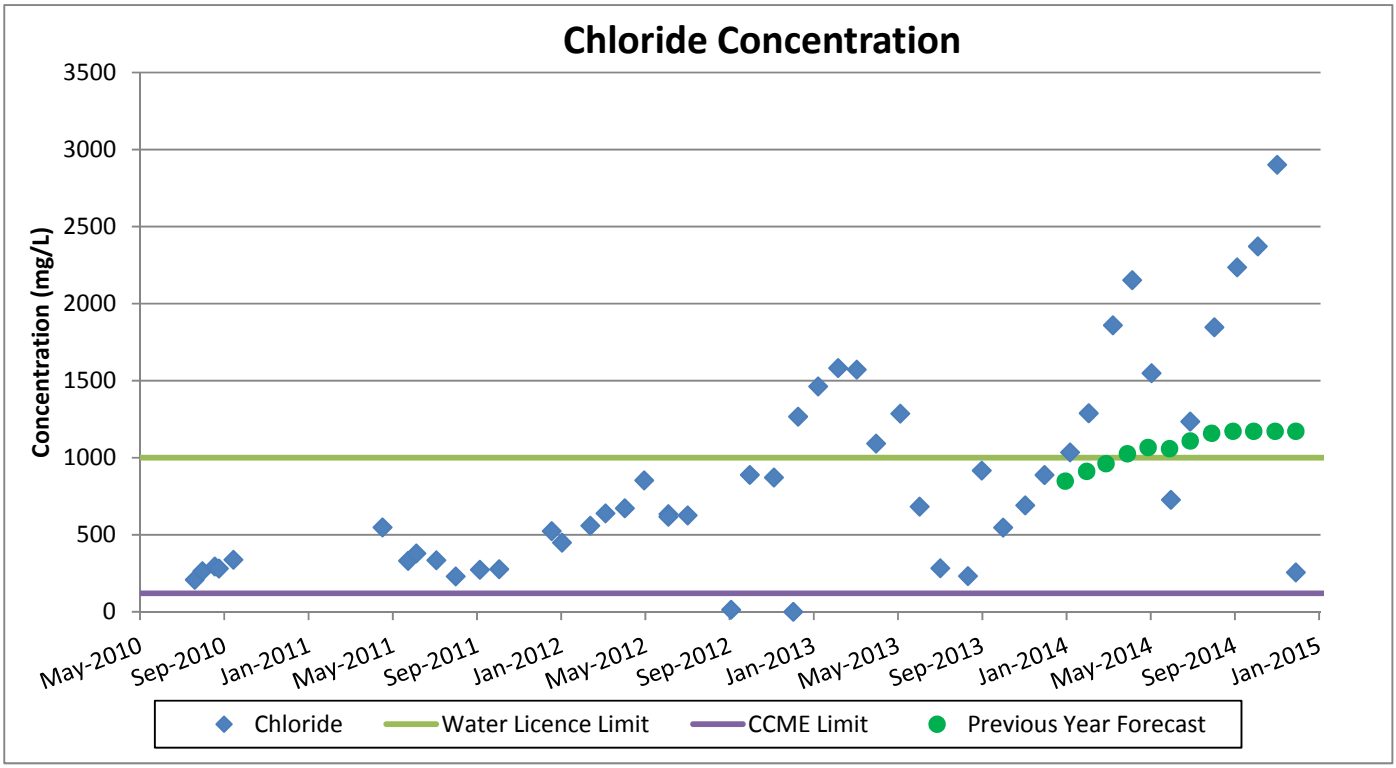


Figure 2-1: (continued) Concentration in the North Cell TSF Reclaim Pond



From the graphs shown in Figure 2-1, the following observations can be made:

i. Total cyanide concentration in the North Cell TSF Reclaim Pond was variable during 2014. There were no major issues reported with the cyanide destruction at the mill during that period. As usual, the concentrations were lower in the summer and were higher in the winter and fall. The values peaked in April and November at 23 mg/L and 21 mg/L respectively.

ii. Copper concentrations followed approximately the same trend as cyanide in 2014. The similar trend indicates that the treatment performance of the cyanide destruction system has an influence on the residual copper and cyanide concentration in the TSF Reclaim pond. Most measurements are lower than the concentrations measured in 2013.

iii. Most of the dissolved iron concentrations measured in 2014 were under the CCME limits. There is no criterion for iron in the Water License (Part F) or in the MMER. Note that total iron concentration was only measured once in 2014 (July) and the value is slightly above the CCME limit.

iv. Ammonia concentrations decreased slightly during the summer, but increased during the fall to reach a peak of 88 mg N/L in December. Ammonia is produced by the hydrolysis of cyanate, which is a by-product of the cyanide destruction system. Therefore, when the cyanide destruction system is operating efficiently, it is expected that the concentration of ammonia will increase.

v. Nitrate concentrations also steadily increased in 2014. The highest concentration is 39 mg N/L and was measured in November. The concentration dropped significantly in December to reach 3.7 mg N/L, just above the CCME limit. This parameter will be monitored during 2015 to confirm if the concentration of nitrate will decrease over time.

vi. Chloride concentrations also increased in 2014. The primary source of chloride found in the TSF Reclaim Pond is due to the use of calcium chloride as an anti-freeze solution. There is a reduction in its use during the summer months, which could explain the drop seen in the summer months.

The graphs in Figure 2-1 also present the forecasted values for 2014 versus the actual measured values. A couple of points to note:

i. The forecasted concentrations for cyanide were very similar as the actual measured values during June, July and August. However, during the winter months, the forecasted values were too low. The data suggest that very little natural cyanide degradation occurs during the winter months.

ii. Forecasted concentrations for copper and iron are generally higher when compared to the actual measurements. The current forecasting model is based on a mass balance using the water balance around the site. It does not take into account possible geochemical reactions that could help precipitate out the metals of the water column phase at equilibrium. For this reasons, the forecasted concentrations for these metals will be more conservative.

iii. Forecasted concentrations for ammonia followed the trend of actual 2014 values, while not being as low as the real concentrations. The model took into consideration the hydrolysis of cyanate (CNO-) to ammonia (NH_3). The forecasted concentrations are conservative.

iv. Forecasted nitrate concentrations were very similar to the measured values for the first half of the year. However, during the fall, three measured values were higher than the forecasted concentrations. The model will be adjusted depending on the evolution of nitrate in 2015.

v. Forecasted chloride concentrations were lower compared to the measured value, even if the model was updated previously to take into account an additional load of chloride into the system. Another review will be undertaken and the model will be updated with the proper concentrations.

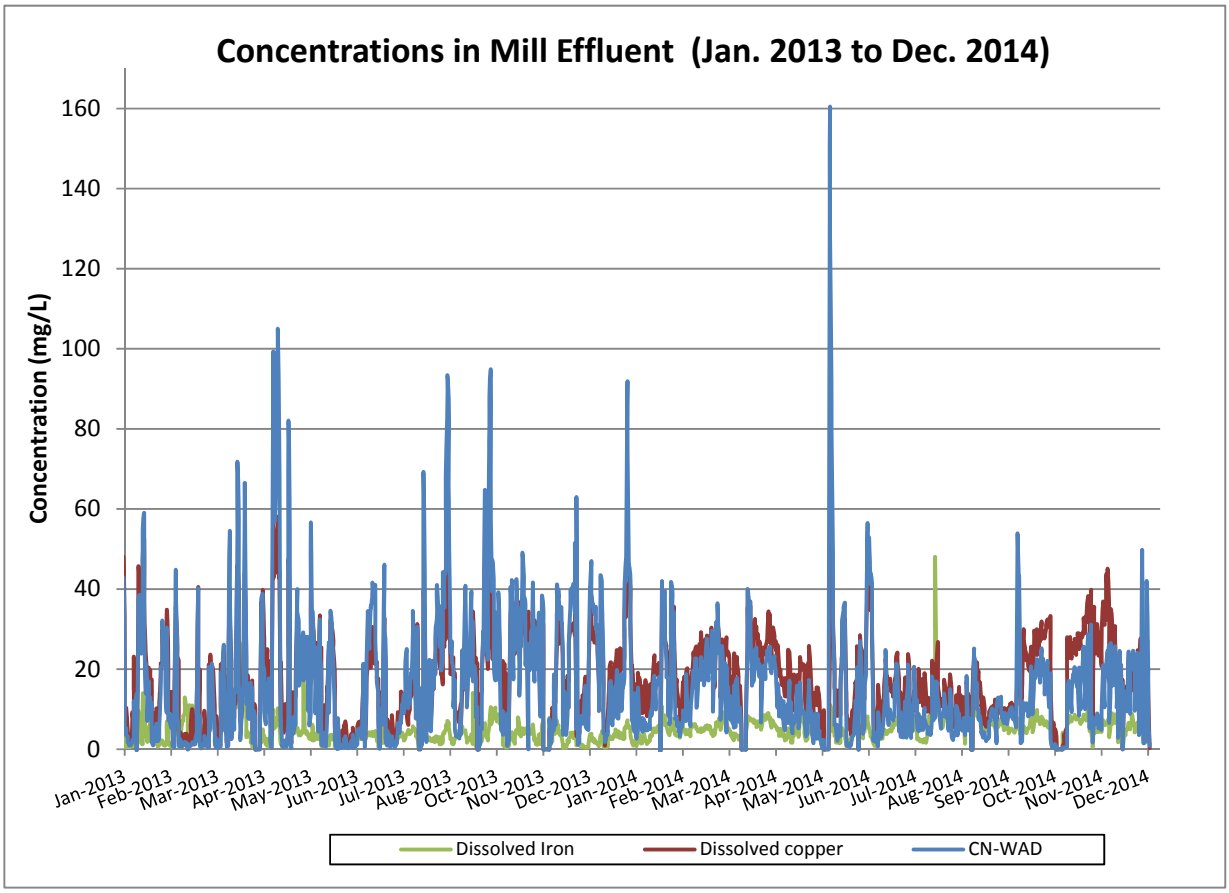
2.2.2 Mill Effluent

A review of the chemical analysis for the Mill Effluent was undertaken by SLI in order to identify the impact of the Mill Effluent water quality on the water quality observed in the North Cell TSF Reclaim Pond. The Mill Effluent is tested twice daily for gold (solid and dissolved) and iron (dissolved), copper (dissolved) and cyanide (CN-WAD) using the on-site lab, which is not accredited for environmental water quality chemical analysis. These chemical analyses were provided to SLI for January 2013 to December 2014 and the results are presented in Appendix A.

Figure 2-2 shows the daily average dissolved metal concentrations and cyanide (CN-WAD) in the Mill Effluent. This figure illustrates the following:

- Dissolved iron and copper concentrations are present in the Mill Effluent. Thus the main source of iron and copper in the TSF Reclaim Pond comes from the Mill Effluent.
- There is a relationship between iron, copper and cyanide concentrations at the Mill Effluent. This is clearly represented in Figure 2-2, where all three (3) trends behaved similarly in 2013 and 2014. A low concentration of CN-WAD is generally accompanied with lower iron and copper concentration. There is only one sample where the concentration of dissolved iron peaked at 48 mg/L without a higher concentration for copper and cyanide.
- Besides an important peak of 157 mg/L in May 2014, the concentration of cyanide (CN-WAD) was lower and varied less in general in 2014 than in 2013. In 2014, the cyanide (CN-WAD) concentrations in the Mill Effluent often met the 15 mg/l discharge criterion, but a few times, the concentrations were higher than 40 mg/L.

Figure 2-2: Dissolved Metal Concentrations and Cyanide (CN-WAD) in the Mill Effluent from January 2013 to December 2014



2.2.3 Additional Mill Effluent Water Quality Results

AEM analyzed a sample of the water fraction of Mill Effluent after cyanide destruction in order to have representative data of the tailings water being discharged to the North Cell. The sample was collected on October 26th, 2014. It is understood that this data point represent a very limited sampling campaign that may not be representative of the Mill Effluent water quality of the entire year.

The chemical analysis results of the additional Mill Effluent sample are presented in Appendix A and are summarized in Table 2-2. The analytical results from sample taken in 2012 and earlier in 2014 are also shown for comparison.

Table 2-2: Mill Effluent Concentrations Sampled On October 26th, 2014, January 29, 2014 & October 10 and 11, 2012

PARAMETER	MILL EFFLUENT CONCENTRATION (mg/L)			
	October 26, 2014	January 29, 2014	October 10, 2012	October 11, 2012
Total Cyanide (CN)	111	18.80	4.7	10.13
Copper (Cu)	7.9	25	10.08	9.02
Dissolved Copper	6.7	7.8	9.53	7.07
Iron (Fe)	55.8	6.7	1.8	2.2
Dissolved Iron	0.14	0.8	0.83	0.83
Ammonia (NH_3)	16.7 (mg N/L)	71.5 (mg N/L)	N/A	N/A
Nitrate (NO_3)	27.9 (mg N/L)	31.6 (mg N/L)	13.2 (mg N/L)	10.8 (mg N/L)
Chloride (Cl)	2199	2129	1288	1375

Table 2-2 shows that concentrations of cyanide, total iron and chloride in the Mill Effluent are higher than those observed in the North Cell TSF Reclaim Pond and concentration of copper, dissolved copper, dissolved iron and nitrate are in the average of the North Cell TSF Reclaim Pond values. These results indicate that the main parameters of concern identified in the North Cell TSF Reclaim Pond can be traced to the Mill Effluent.

However, the concentration of ammonia is lower in the Mill Effluent than in the Reclaim Pond, demonstrating that cyanate is further hydrolyzed to ammonia in the Reclaim Pond. Since the concentration of ammonia in the Reclaim Pond is higher than in the Mill Effluent, the cyanate destruction system seems to operate efficiently.

2.2.4 Attenuation Pond

Table 2-3 presents the average concentrations (November 2011 to November 2012, for 2013, and for 2014) observed in the Attenuation Pond.

Table 2-3: Average (2014, 2013 and November 2011 to November 2012) Concentrations in the Attenuation Pond

PARAMETER	AVERAGE CONCENTRATIONS IN THE ATTENUATION POND (mg/L)		
	2014 (Jan. to Oct.)	2013	Nov 2011 to Nov 2012
Total Cyanide (CN)	0.35	0.15	0.114 [1]
Copper (Cu)	0.006	0.02	0.005
Iron (Fe)[2]	1.26	1.26	1.26
Ammonia (NH_3)	0.17 (mg N/L)	0.20 (mg N/L)	0,15 (mg N/L)
Nitrate (NO_3)	1.25 (mg N/L)	4.20	8,6
Chloride (Cl)	98.20	75.70	39.5

3.0 UPDATED MASS BALANCE MODEL

3.1 DESCRIPTION

The water quality updated mass balance model presented in this Technical Note was developed to help forecast trends in water quality in the Portage Area of Meadowbank for different parameters of interest. The starting date for the model was arbitrarily set for June 2013 in order to keep in-line with the previous model. The end date of the model is set at the mine closure in 2025 .This mass balance model was based on the following:

- Flows and volumes provided in the water balance developed in the Water Management Plan 2014 (AEM, 2014);
- Assumptions presented below in section 3.2;
- Chemical analyses for ST-21 (North Cell TSF Reclaim Pond) (2010-2014);
- Chemical analyses for Third Portage Lake (2014);
- Chemical analyses for ST-18 (Attenuation Pond) (2011-2014);
- Chemical analyses for the Mill Effluent (2014 and sample taken in October 2014).

3.2 ASSUMPTIONS

The assumptions used in the development of the mass balance model for the Portage Area of Meadowbank were the following:

[1] This is a one-time CN-WAD measurement that took place in April 2012.
[2] No values for 2013 and 2014. Average of Nov. 2011 to Nov.2012 was used.

i. For simplification of the model, the North and South Cell TSF Reclaim Ponds and the Portage and Goose Pits are assumed to be completely mixed systems.

ii. The main source of cyanide, copper, ammonia (i.e via the hydrolysis of cyanate), iron, nitrate, and chloride in the TSF Reclaim Pond is the Mill Effluent. All other inflow contaminant concentrations (Third Portage Lake[1], precipitation, runoff, etc.) are assumed to be negligible.

iii. The water quality of the Mill Effluent is assumed to be constant over time for all parameters, except for ammonia and chloride. For ammonia, the water quality for this parameter will continue to vary due to the hydrolysis of cyanate to ammonia. For chloride, the water quality for this parameter will continue to increase due to the continued use of calcium chloride on the site.

iv. The pH in the TSF Reclaim Pond is on average at 7.6 during the summer months, and on average 7.8 for the year (2014).

v. For simplification of the model, the parameters are assumed to be inert: they do not degrade or react with other elements in the system, with the exception of cyanide.

vi. For cyanide, it is assumed that the Mill Effluent meets AEM's CN-WAD operational target of 15 mg/L at all times.

vii. The total cyanide in the TSF Reclaim Pond is comprised of free cyanide and metal-cyanide complexes (weak and strong metal cyanide complexes). As per discussions with AEM, most of the iron- and metal-cyanide complexes are precipitated in the mill. However, since the reaction is not complete or perfect, some dissolved iron- and metal-cyanide complexes are expected to remain in the Mill Effluent. Therefore it was assumed that 10% of the total cyanide concentration was bound as strong iron-cyanide complexes, and that another 10% of the total cyanide concentration was present as weak metal-cyanide complexes (cyanide bound with copper, zinc, and nickel). The balance is present as free cyanide (i.e. HCN and CN^-). This agrees with values observed at other gold mine tailings sites (Simovic, 1984). These same proportions are assumed to apply to the cyanide at the Mill Effluent.

viii. For this model, natural cyanide degradation is only considered for the summer months.

ix. The initial concentration of all parameters in the Portage and Goose are assumed to be the average of 2013, and average of 2013-2014 respectively.

[1] 2013 water quality data continue to show that the concentrations observed in Third Portage Lake were on average 95% lower than those in the North Cell TSF Reclaim Pond. It was therefore assumed that any input of contaminants from Third Portage Lake would be negligible.

x. The initial concentration of all parameters in the North Cell TSF Reclaim Pond is the concentration obtained in June 2013 for station ST-21.

xi. The initial concentration of all parameters in the South Cell TSF Reclaim Pond is assumed to be the average concentration obtained in 2014 (or average of 2010-2014 when there is not enough data) for station ST-18 (known as Attenuation Pond from January to October 2014).

xii. The initial concentration of all parameters in the Third Portage Lake is assumed to be the average concentration obtained in 2014.

xiii. For this analysis, it is assumed that no treatment will take place at the North or South Cell TSF Reclaim Pond, or at the Portage or Goose Pits.

3.3 LIMITATIONS

The limitations of the Meadowbank water quality mass balance model and ensuing results and conclusions presented in this Technical Note are listed below:

i. In order to simplify the model, the mass balance model assumes that the pond and pits are completely mixed systems. Consequently, the results from this model provide only an indication of the concentrations in the ponds and pits and should not to be considered as an absolute value at this time. Future monitoring results both for flows and water quality will provide for a better indication of concentrations of contaminants.

ii. The mass balance model is based on the water quality analysis results provided by AEM:

- Water quality data provided for ST-21 is taken from samples collected at the surface of the North Cell TSF Reclaim Pond. Therefore the concentrations provided by AEM for ST-21 may not be representative of the entire TSF Reclaim Pond water quality.
- There is limited water quality data available for the Mill Effluent, in terms of contaminants analyzed: the Mill Effluent is only analyzed on a regular basis for a total of four (4) parameters: gold, iron, copper, cyanide (CN-WAD).

iii. The model does not make allowances for the impact that changes in the TSF (surface area, volume, tailings characteristics, etc.) will have on the TSF Reclaim Pond water quality over time.

iv. The model is based on a monthly time-step and the resulting concentrations provided represent monthly values.

v. It should be noted that at this point, given the limitations, assumptions and limited data currently available, the model should be used as a preliminary means to evaluate

the impact of Mill Effluent on the future water quality in the North and South Cell TSF Reclaim Pond and Portage and Goose Pits.

vi. Furthermore, this model is intended as an initial model for the mass balance in the Portage Area and should be updated and calibrated as concentrations of different flows in the Portage Area become available. Refer to section 5.3 for recommendations on improving the mass balance.

3.4 INPUT PARAMETERS

The mass balance model for the Portage area of Meadowbank was developed to forecast the long-term concentration of cyanide, copper, ammonia, nitrate and chloride in the North and South Cell TSF Reclaim Pond and in the pits. As of this year, the report will also evaluate a broader selection of parameters: alkalinity, hardness, aluminum, silver, arsenic, barium, cadmium, chromium, manganese, mercury, molybdenum, nickel, lead, selenium, zinc, fluoride, sulphate and total dissolved solids.

The mass balance model is based on the assumptions presented in section 3.2 and on the following input parameters:

- Mill effluent concentration;
- Initial concentration in the North and South Cells TSF Reclaim Pond;
- Initial concentration in the Portage and Goose Pits, and Third Portage Lake.

3.4.1 Mill Effluent Concentration

Table 3-1 presents the Mill Effluent concentrations considered for the input parameters of the mass balance. The additional sample taken in October 2014 was used in the model. The values are also compared to the 2013 and 2012 WMP values used in the previous model.

Table 3-1: Mill Effluent Concentrations Selected for the Mass Balance Model

PARAMETER	MILL EFFLUENT CONCENTRATION (mg/L)		
	For 2014 WMP Forecast	For 2013 WMP Forecast	For 2012 WMP Forecast
Alkalinity	257 (mg CaCO3/L)		
Hardness	4079 (mg CaCO3/L)		
Aluminium (Al)	0.049		
Silver (Ag)	< 0.0001		

PARAMETER	MILL EFFLUENT CONCENTRATION (mg/L)		
	For 2014 WMP Forecast	For 2013 WMP Forecast	For 2012 WMP Forecast
Arsenic (As)	0.0084		
Barium (Ba)	0.3805		
Cadmium (Cd)	0.00105		
Chromium (VI)	0.0094		
Copper (Cu)	6.795[1]	7.8[1]	28.3[1]
Iron (Fe)	0.14[1]	0.8[1]	11.8[1]
Manganese (Mn)	12.21		
Mercury (Hg)	0.00206		
Molybdenum (Mo)	0.0114		
Nickel (Ni)	3.562		
Lead (Pb)	0.0157		
Selenium (Se)	0.154		
Zinc	0.028		
Ammonia (NH3) (ionized)	+ 41 (mg N/L/month)	+ 45 (mg N/L/month)	17.1 (mg N/L)[2]
Chloride	+ 1500 (mg/L/month)	+ 600 (mg/L/month)	674[3]
Fluoride (F)	0.65		
Nitrate (NO3)	27.9 (mg N/L)	31.6 (mg N/L)	9.9 (mg N/L)[3]
Total Cyanide (CNt)	111	15	16.7[4]
Sulphate (SO4)	2400 (mg SO4/L)		
Total dissolved solids	-		

[1] The dissolved copper and iron concentration were used instead of the total concentrations, since the solids will tend to decant in the TMF.
[2] Average January to December 2012 ST-21 concentrations.
[3] Average April to December 2012 Mill Effluent concentrations.
[4] The internal CN-WAD criterion for the Mill Effluent is a CN-WAD concentration of 15 mg/L. Assuming that CN-WAD represents 90% of total CN (refer to section 3.2), then this CN-WAD internal criterion translates to a CN total criterion of 16.7 mg/L.

A couple of items to note on the parameters used for the 2014 updated water quality forecast model:

- For copper and iron, the dissolved concentration values were used instead of the total concentrations since the copper and iron precipitates will settle in the TSF.
- To evaluate the concentration of ammonia that may be added to the TSF Reclaim Pond on a monthly basis, the difference in concentration of CN-WAD before and after the cyanide destruction system was evaluated. In 2014, on average, 76 mg/L of CN-WAD was removed and converted to cyanate (CNO^-). Assuming that 100% of the cyanate is hydrolyzed to ammonia (NH_3), it was evaluated that on average approximately 41 mg N/L of ammonia was added to the Mill Effluent. For the purpose of the model, it is assumed that 41 mg N/L of ammonia is added to the Mill Effluent every month. This additional ammonia load is added to the load already present in the Reclaim Water.
- Based on the measured data, the chloride concentration continues to increase in the Mill Effluent. To account for this trend, it is assumed that 1500 mg/L of chloride is added to the Mill Effluent every month of 2014, compared to 600 mg/L assumed in 2013. This additional chloride load is added to the load already present in the Reclaim Water. This value was evaluated by adjusting the model to fit with the measured chloride values in the Reclaim Pond in 2014.

3.4.2 Initial Concentrations in the TSF Reclaim Ponds and Pits

As noted previously, the mass balance model arbitrarily begins in June 2013 to fit the previous model. Therefore, the initial concentrations selected for the North Cell TSF Reclaim Pond correspond to the June 2013 chemical analysis results from station ST-21. These initial concentrations are presented in Table 3-2.

Concentrations selected for the South Cell TSF Reclaim Pond (former Attenuation Pond) correspond to the 12-month (2014) average concentration results from station ST-18 (current Attenuation Pond). When there was not any or little data available, the average values from 2010 to 2014 was used. Note that in general, the concentrations observed in the Attenuation Pond had little variation from one month to the other. These initial concentrations are also presented in Table 3-2.

Input parameters for Goose and Portage Pit, and Third Portage Lake, are also shown in table 3-2. For Goose Pit, the average value of 2013 and 2014 was used. The average of 2013 was used for Portage Pit and the average value of 2014 was used for Third Portage Lake.

Table 3-2: Initial Concentration in the North and South Cells TSF Reclaim Pond

PARAMETER	UNITS	INITIAL CONCENTRATION				
		RECLAIM POND ST-21 (June 2013)	ATTENUATION POND ST-18 (Avg 2014)	PORTAGE PIT ST-19 (Avg 2013)	GOOSE PIT ST-20 (Avg 2013-2014)	THIRD PORTAGE LAKE (Avg. 2014)
Alkalinity	mg CaCO3/L	77	106.4	72.2	115.4	17.370
Hardness	mg CaCO3/L	891	362	0.000	0.000	10.478
Aluminium (Al)	mg/L	0.14[1]	0.76[2]	0.000	0.031	0.007
Silver (Ag)	mg/L	0.004[1]	0.0004[2]	0.000	0.000	0.000
Arsenic (As)	mg/L	0.008[1]	0.007	0.020	0.009	0.000
Barium (Ba)	mg/L	0.06[1]	0.10[2]	0.000	0.028	0.003
Cadmium (Cd)	mg/L	0.001[1]	0.0001[2]	0.000	0.000	0.000
Chromium (VI)	mg/L	0.000	0.007[2]	0.000	0.000	0.000
Copper (Cu)	mg/L	0.6[3]	0.007	0.004	0.004	0.000
Iron (Fe)	mg/L	0.6[2]	1.26[2]	0.000	0.010	0.010
Manganese (Mn)	mg/L	0.07[1]	1.71[2]	0.000	0.059	0.002
Mercury (Hg)	mg/L	0.000[1]	0.0005[2]	0.000	0.000	0.000
Molybdenum (Mo)	mg/L	0.25[1]	0.02[2]	0.000	0.018	0.000
Nickel (Ni)	mg/L	0.09[1]	0.06	0.004	0.058	0.000
Lead (Pb)	mg/L	0.000[1]	0.001	0.001	0.002	0.000
Selenium (Se)	mg/L	0.008[1]	0.002[2]	0.000	0.001	0.000
Zinc	mg/L	0.001[1]	0.02	0.016	0.010	0.002
Ammonia (NH3)(ionized)	mg N/L	46.2	0.17	0.200	0.213	0.007
Chloride	mg/L	683	98.2	0.000	52.450	0.703
Fluoride (F)	mg/L	0.07	0.57	0.000	0.935	0.068
Nitrate (NO3)	mg N/L	13.7	1.25	0.000	10.850	0.034
Total Cyanide (CNt)	mg/L	16.77	0.35	0.000	0.000	0.003
Sulphate (SO4)	mg SO4/L	1276	541.5	0.000	60.8	4.441
Total dissolved solids	mg/L	2954	1437	126.6	397.3	17.370

[1] Dissolved concentration was used since no data was available
[2] Average concentration of 2010-2014 data was used since no data was available
[3] Initial copper concentration was not available, so the values taken in July were used instead.

3.5 CYANIDE DECAY

The water quality model developed during this study takes natural cyanide degradation into account: the most important mechanism in the natural degradation of cyanide is the volatilization of hydrogen cyanide (HCN). In fact, tests carried out in Canada found that volatilization of HCN accounted for 90% of cyanide removed from solution in a tailings impoundment (Botz and Mudder, 2000).

Oxidation of cyanide ions (CN-) to orthocyanate (OCN) with atmospheric oxygen is possible but extremely slow when compared to HCN volatilization. Similarly, the probability of microbial degradation of cyanide to carbon dioxide, ammonia, nitrite and nitrate is low due to the limited presence of microorganisms and low nutrient levels in tailings water.

Cyanide volatilization can be summarized as a two (2)-step process presented in Figure 3-1 below. First, metal-cyanide complexes dissociate to free cyanide (HCN and CN^-)[1] based on a first-order decay constant[2] (k_1); followed by HCN volatilization based on a first-order decay constant[2] (k_v). Both decay constants k_1 and k_v depend on the presence of UV light (sun) and air (wind), and water temperature and pH. The volatilization decay constant, k_v, also depends on the surface area to volume ratio of the pond.

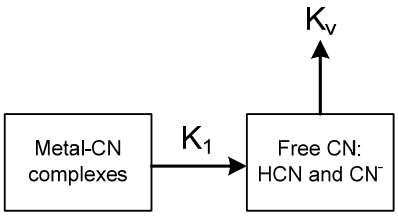


Figure 3-1: Cyanide Volatilization Process

Since both constants depend to a great extent on temperature, UV light and air, separate constants were determined for summer (May to October) and winter (November to April) conditions. The decay constants were based on laboratory values recorded by Simovic (1984). The assumptions made for the development of the cyanide decay constants were the following:

- Summer conditions: an average water temperature of 10°C, presence of air and UV light. Furthermore, since metal-CN dissociation and HCN volatilization by air and UV is particularly important in the summer months, the decay constant factors in the physical property of the tailings impoundment, represented by the open surface area

[1] Equilibrium between HCN and CN^- is based on pH.
[2] A first order decay constant signifies that the final concentration (C_f) can be estimated as, $C_f=C_i e^{-kt}$, where k is the first order decay constant.

to volume ratio. Multiplying the decay constant by this ratio takes into account the accelerated reaction due to a large exposed surface area of the Reclaim Pond.

- Winter conditions: no natural cyanide degradation occurs.
- The pH in the Reclaim Pond is maintained constant at 8.0, which means that most (94%)[1] of the free cyanide will be present as HCN. Note that as the pH decreases, the proportion of free cyanide as HCN increases, which increases cyanide degradation through volatilization.
- As stated in section 3.2, it was assumed that 10% of the total cyanide concentration was bound as iron-cyanide complexes, another 10% as metal (copper, nickel and zinc) cyanide complexes, and 80% as free cyanide. This agrees with values observed at other gold mine tailings impoundments.

It should be noted that these decay constants (referred to as k_0) were established based on an hourly time step, and were not deemed reliable for longer time-periods (i.e. months). Therefore, the summer and winter decay constants obtained based on volatilization conditions and assumptions, were calibrated so as to represent more accurately and conservatively the expected cyanide concentrations on a monthly time-step.

Table 3-3 presents the assumptions and cyanide decay constants used in the water quality model.

Table 3-3: Natural Cyanide Degradation: Assumptions and Constants

DECAY CONSTANT	DESCRIPTION	WINTER CONDITIONS[2]			SUMMER CONDITIONS		
		Conditions	k_0	Calibrated value (k)	Conditions	k_0	Calibrated value (k)
K_1	Metal-CN dissociation	4° No air No UV	n/a	n/a	10° Air (wind) UV (sunlight)	0.01443/hr	2.11/month
K_V (3)	HCN volatilization		n/a	n/a		2.382 cm/hr	58.0 m/month

[1] The dissociation constant for HCN is pKa = $10^{-9.2}$.
[2] During the winter, most of the Reclaim Pond is covered in ice and/or snow. Assume no natural degradation of cyanide is occurring.
[3] In the summer k_v strongly depends on the presence of air and UV, and thus it also depends on the surface area to volume ratio (A/V). Therefore, the k_v value for the summer season has units of cm/h or m/month and should be multiplied by A/V.

4.0 MASS BALANCE RESULTS

4.1 RESULTS

The results of the mass balance model are presented in the Figures 4-1 to 4-14, for total cyanide, copper, iron, ammonia, nitrate, and chloride. Selenium, which will be discussed in section 4.2.3, was also identified as a parameter of concern. The graphs show the forecasted monthly concentration of the parameter from 2013 to 2025. A total of two (2) graphs are presented per parameter: the first shows the forecasted concentration in the North and South Cells TSF Reclaim Pond and the second shows the forecasted concentration in the Portage and Goose Pits, assuming that the water is pumped without treatment. The Water License and CCME limits (refer to Table 2-1) were also included in the figures, where applicable.

Again, it is important to remember that the results presented in Figures 4-1 to 4-14 are based on the concentrations presented in Tables 3-1 and 3-2. It is also important to note that the results from this model assume that no treatment of the Reclaim Pond effluent is undertaken; and provide only a forecast of the concentrations of the selected parameters. These results must be reviewed while keeping in mind the assumptions and limitations described in sections 3.2 and 3.3.

4.2 DISCUSSION

4.2.1 Key Dates

The mass balance model presented in this Technical Note is based on the updated water management plan. The following key dates are important to keep in mind while reviewing the forecasted concentration data presented in Figures 4-1 to 4-14:

1. November 2014: The former Attenuation Pond becomes the South Cell and TSF Reclaim Pond.
2. August 2017: start of water transfer from South Cell TSF Reclaim Pond to Portage Pit
3. July 2018: South Cell TSF Reclaim Pond is completely empty.
4. June 2016 to July 2020: Pumping water from Third Portage Lake to Goose Pit and allow runoff water and ground water to accumulate in the pit.
5. June 2018 to August 2024: Pumping water from Third Portage Lake to Portage Pit and allow runoff water, ground water and East Dike Seepage to accumulate in the pit.

4.2.2 Forecasted Concentrations in the North and South Cells TSF Reclaim Pond

Table 4-1 summarizes the observations noted in Figures 4-1 to 4-14, specifically for the forecasted concentrations of parameters of concern in the Reclaim Pond (North and South cells).

Table 4-1: Summary of Forecasted Concentrations in Reclaim Pond

PARAMETER	FORECASTED CONCENTRATION (mg/L)				WATER LICENSE PART F (CCME) (mg/L)
	NORTH CELL TSF RECLAIM POND		SOUTH CELL TSF RECLAIM POND		
	June 2013 (initial)	2013 to 2016	Nov 2014[1] (initial)	2014 to 2018	
Total Cyanide (CN)	16.8	Fluctuate from 0.14 to 6.9	0.35	Fluctuate from 0.12 to 7.6	0.5 (free CN 0.005)
Copper (Cu)	0.6	Fluctuate from 1.4 to 6.6	0.007	Fluctuate from 1.1 to 5.6	0.1 (0.004)
Iron (Fe)	0.6	Fluctuate from 0.1 to 0.5	1.26	Fluctuate from 0.1 to 1	n/a (0.3)
Ammonia (NH_3)	46.2 (mg N/L)	Fluctuate from 42 to 76	0.17 (mg N/L)	Fluctuate from 7 to 97	16 (0.86) (mg N/L)
Nitrate (NO_3)	13.7 (mg N/L)	Fluctuate from 14.1 to 27.3	1.25 (mg N/L)	Fluctuate from 5.6 to 23	20 (2.9) (mg N/L)
Chloride (Cl)	683	Fluctuate from 683 to 2553	98.2	Fluctuate from 329 to 3562	1000 (120)
Selenium (Se)	0.008	Fluctuate from 0.056 to 0.150	0.0017	Fluctuate from 0.017 to 0.127	n/a (0.001)

Based on the model for forecasting concentrations in the North and South Cell TSF Reclaim Pond, the following notes and observations can be made:

i. The fluctuations observed from 2013 to 2018 are primarily due on seasonal variability (runoff from nearby areas, snow and ice melt, temperature, etc.).

ii. Natural degradation of cyanide during summer plays a significant role in reducing the concentration of cyanide in the TSF Reclaim Ponds.

[1] Values of November were not available, so the average from January to October 2014 was used.

iii. For ammonia, it is important to note that (1) the mass balance model developed here does not include seasonal variability (sunlight, microbial or algae degradation of ammonia, etc.), and (2) ammonia concentrations can vary significantly depending on temperature, pH, sunlight, algae activity, etc. Ammonia concentrations may be lower in the summer and higher in the winter.

iv. Similarly, for nitrate, it is important to remember that (1) the mass balance model developed here does not include seasonal variability, and (2) ammonia decomposes to nitrate, therefore nitrate concentrations can vary significantly depending on temperature, pH, sunlight, algae activity, etc. Nitrate concentrations may be lower in the winter and higher in the summer.

v. Guidelines:

   a. For comparison purposes, the forecasted concentrations in the North and South Cells TSF Reclaim pond for all the parameters are above the Water License discharge criteria.

   b. For comparison purposes, almost all forecasted concentrations for the parameters of concern are also above the CCME guidelines for the protection of aquatic life

   c. However, it is important to note that no water in the TSF Reclaim Pond from 2013 to July 2018 is discharged to the environment. Thus, the Water License discharge criteria are not applicable but rather are used as a comparison herein.

4.2.3 Forecasted Concentrations in Portage and Goose Pits

Table 4-2 presents the forecasted concentration of all parameters for Portage and Goose Pits in 2025 at mine closure.

Table 4-2: Summary of Forecasted Concentrations in Portage and Goose Pits

			FORECASTED CONCENTRATIONS		
PARAMETERS	**UNITS**	**CCME GUIDELINES**	**PORTAGE PIT**	**GOOSE PIT**	**ASSUME COMPLETE MIXING OF BOTH PITS**
Alkalinity	mg $CaCO_3$/L	n/a	19	17	
Hardness	mg $CaCO_3$/L	n/a	31	10	
Total dissolved solids	mg/L	n/a	0.4	0.0	
Aluminium (Al)	mg/L	0.1	0.007	0.007	
Silver (Ag)	mg/L	0.0001	0.000	0.000	
Arsenic (As)	mg/L	0.005	0.001	0.000	
Barium (Ba)	mg/L	n/a	0.005	0.003	
Cadmium (Cd)	mg/L	0.00004	0.00001	0.00001	
Chromium (VI)	mg/L	0.001	0.00015	0.00010	
Copper (Cu)	mg/L	0.002	0.035	0.0004	0.028
Iron (Fe)	mg/L	0.3	0.011	0.010	
Manganese (Mn)	mg/L	n/a	0.065	0.002	
Mercury (Hg)	mg/L	0.000026	0.000016	0.000005	
Molybdenum (Mo)	mg/L	0.073	0.0003	0.0002	
Nickel (Ni)	mg/L	0.025	0.0187	0.0004	
Lead (Pb)	mg/L	0.001	0.0002	0.0001	
Selenium (Se)	mg/L	0.001	0.0008	0.00005	
Zinc	mg/L	0.03	0.002	0.002	
Ammonia (NH_3) (ionized)	mg N/L	0.86	0.582	0.000	
Chloride	mg/L	120	21.26	0.120	
Fluoride (F)	mg/L	0.12	0.07	0.07	
Nitrate (NO_3)	mg N/L	2.94	0.18	0.03	
Sulphate (SO4)	mg SO4/L	n/a	16.74	4.44	
Total Cyanide (CNt)	mg/L	0.005	0.000	0.000	

Legend: XXX: Concentration higher than the CCME guidelines.

Based on the model for forecasting of the concentrations in Portage and Goose Pits, the following notes and observations can be made:

i. All forecasted concentrations meets the CCME guidelines in 2025 except for copper in Portage Pit.

ii. There are no longer any issues in Goose Pit since no Reclaim Water is transferred to this pit.

iii. It is important to note that the water quality in the pits will be subject to CCME guidelines once the water level in the Goose and Portage Pits are equal to the water level in Second Portage Lake, and the dikes are breached.

iv. It is also important to note that once the water elevation in the pits reaches a level above 131 m, both Portage and Goose Pits will be hydraulically connected. This should help in attenuating some of the concentrations in Portage Pit. As shown in the 4th column of Table 4-2, when assuming complete mixing of both pits, the concentration of copper reduces, but not sufficiently to meet the CCME guidelines.

v. When using the USGS geochemical modelling tool PHREEQC (USGS 2014) to evaluate the equilibrium concentration of dissolved copper in the water column, the forecasted concentration is evaluated approximately at 0.0001 mg/L, much lower than the CCME guidelines. Thus, at equilibrium, most of the copper could precipitate out as an oxide, hydroxide or co-precipitate and adsorb to amorphous ferrihydrite.

vi. Selenium was identified as a possible parameter of concern since its forecasted concentration in Portage Pit for 2025 is close to the CCME guidelines.

Consequently, copper remains a parameter of concern and should be closely monitored. However, overall the forecasted water quality in the pits in 2025 does not raise any major concerns at the moment.

4.2.4 Treatment Requirements

Based on the results of the water quality mass balance presented in section 4.2.3, treatment may be required for copper. Treatment could be undertaken at the South Cell TSF Reclaim Pond, or in the Portage Pit.

If high copper concentrations persist, this metal may be removed through pH adjustment: caustic or lime can be added to the effluent to increase the pH to 9, causing the formation of metal hydroxide precipitates, which settle out. The different treatment options that may be considered to implement the precipitation of copper are listed below:

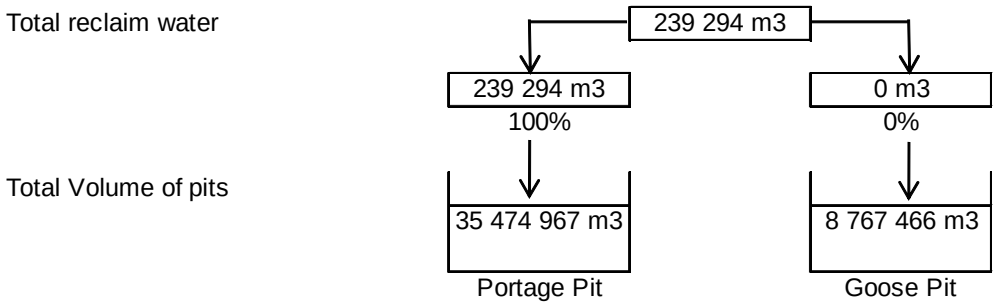
a) The existing Attenuation Pond water treatment plant (WTP) can be modified for copper precipitation with the addition of lime or caustic dosing system. The water from the South Cell TSF pond can be pumped to the WTP for treatment, with the treated water recycled back to the pond. Note that the average pH in 2014 in the Attenuation Pond was 7.5.

b) Treatment in situ at South Cell TSF Reclaim Pond or at Portage pit. Note that the average pHs in the Reclaim Pond in 2014 and in Portage pit in 2013 were respectively of 7.8, and 7.5.

These technologies should be studied and evaluated in detail to determine if they are applicable to site and effluent conditions at Meadowbank. Laboratory and/or in-situ pilot tests should also be considered to validate the treatment method selected.

4.2.5 Summary of volume of Reclaim Water sent to the Pits

In the 2014 Water Management Plan, the Reclaim Water is sent to Portage Pit beginning in August 2017. As shown in the figure below, 100% of the South Cell TSF Reclaim Water is sent to Portage Pit.



This illustrates that all Reclaim Water is sent to Portage Pit.

Figure 4-1: Total Cyanide Concentration in the North and South Cells TSF Reclaim Pond

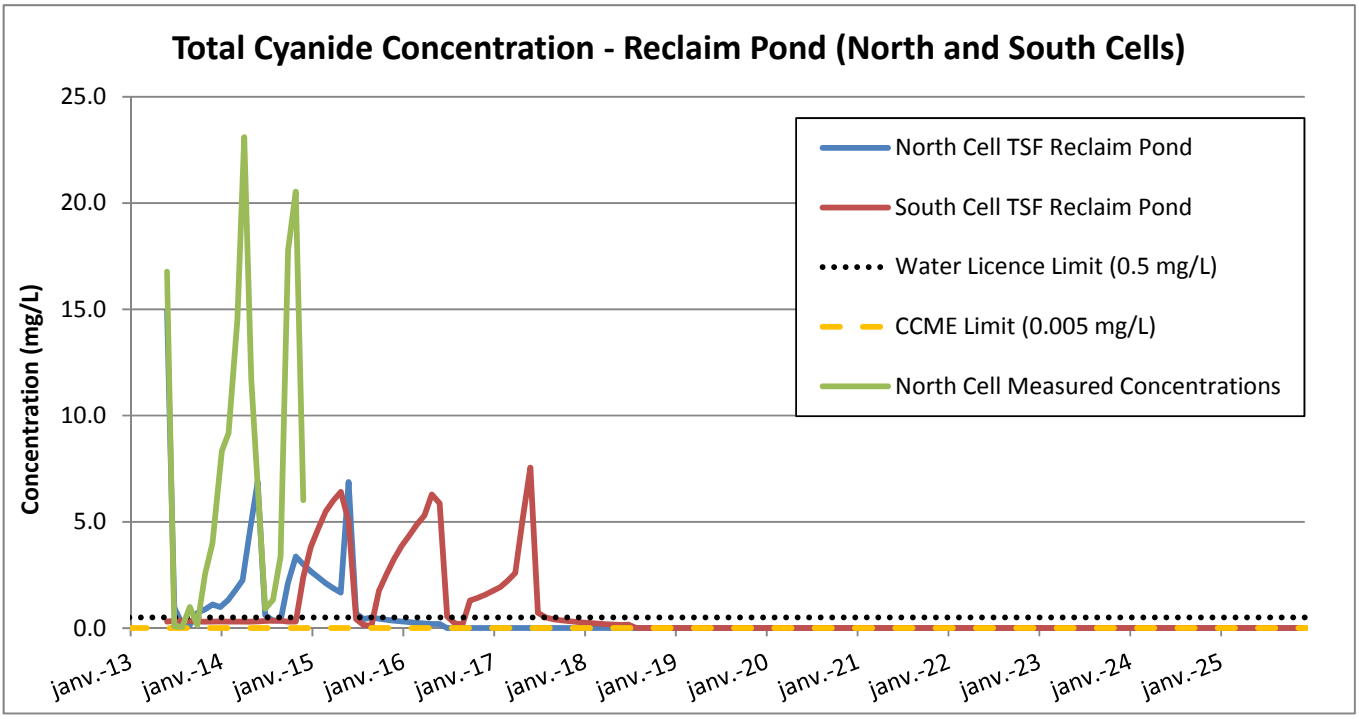


Figure 4-2: Total Cyanide Concentration in the Portage and Goose Pits

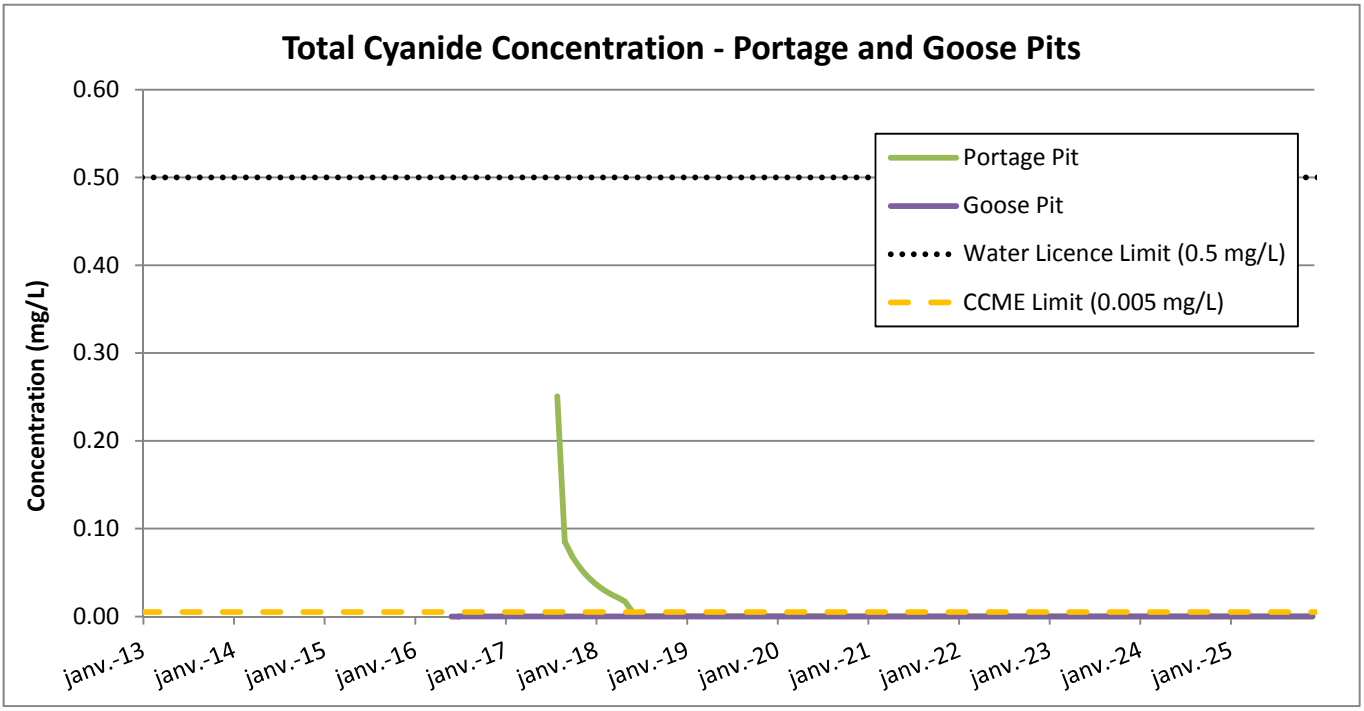


Figure 4-3: Total Copper Concentration in the North and South Cells TSF Reclaim Pond

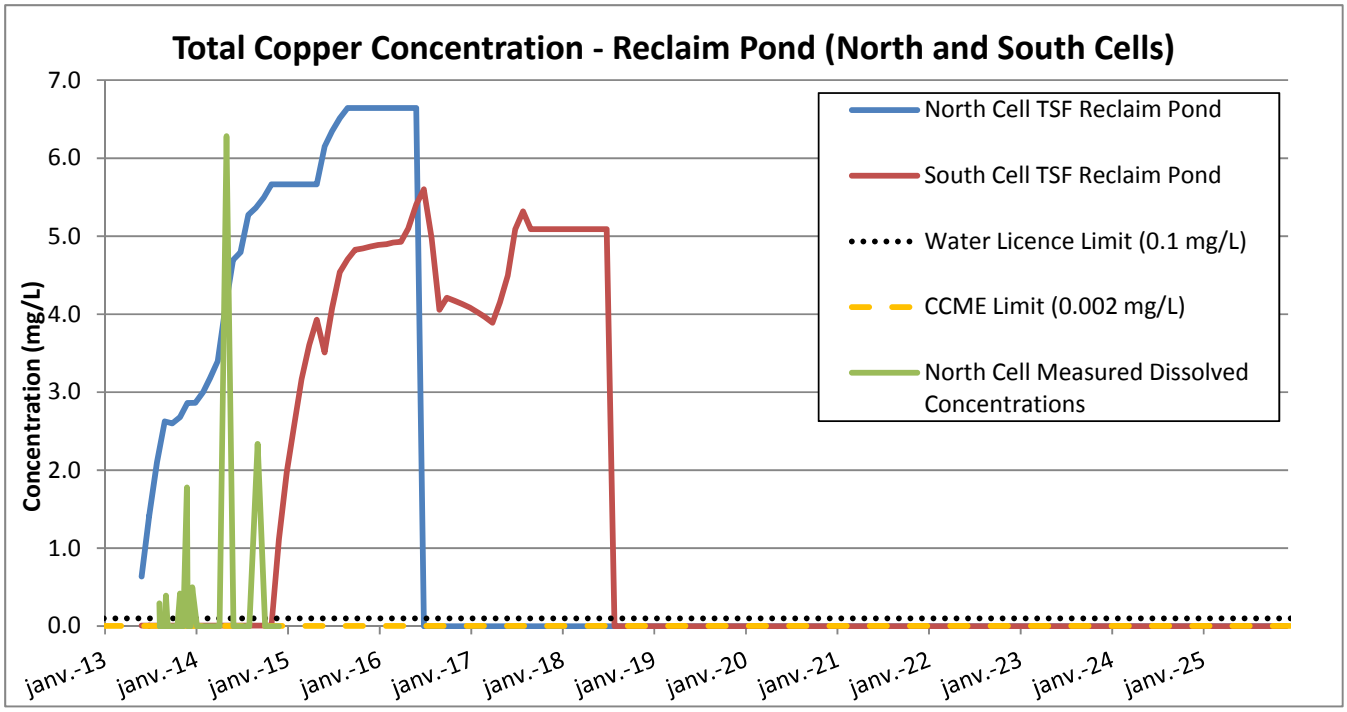


Figure 4-4: Total Copper Concentration in the Portage and Goose Pits

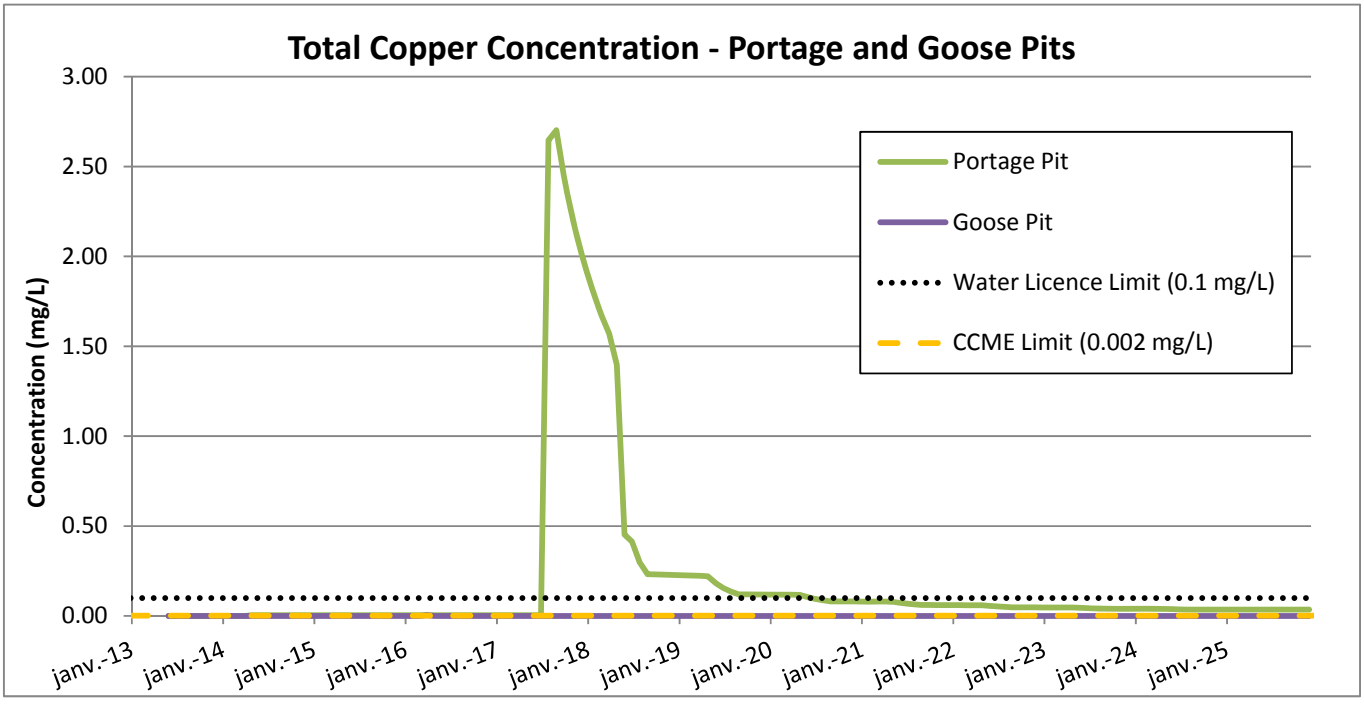


Figure 4-5: Total Iron Concentration in the North and South Cells TSF Reclaim Pond

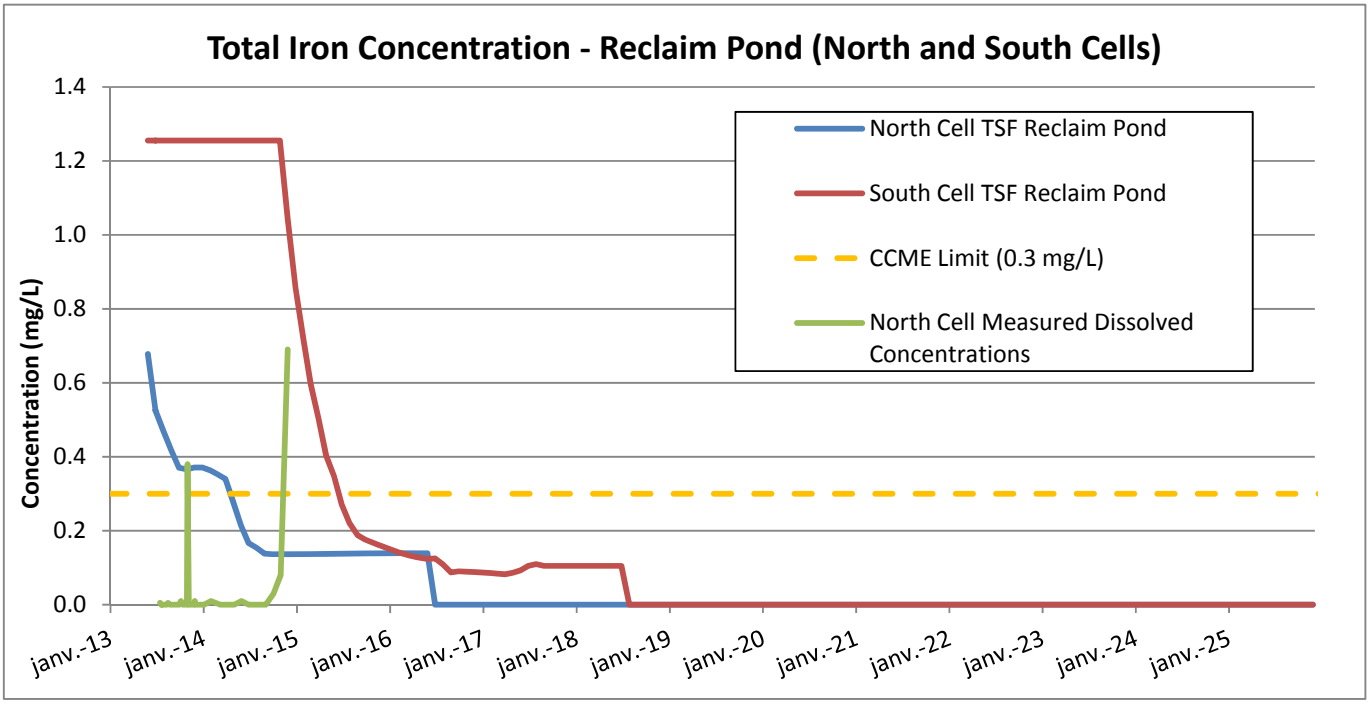


Figure 4-6: Total Iron Concentration in the Portage and Goose Pits

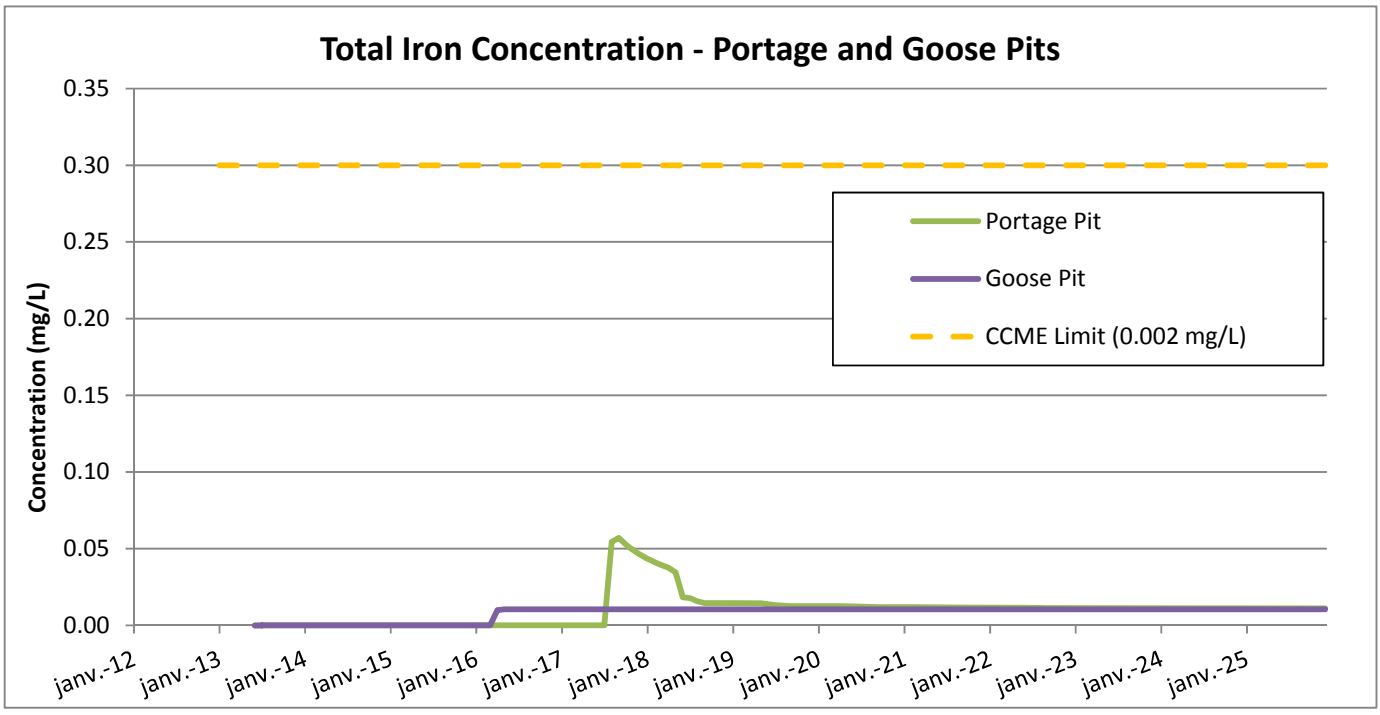


Figure 4-7: Ammonia Concentration in the North and South Cells TSF Reclaim Pond

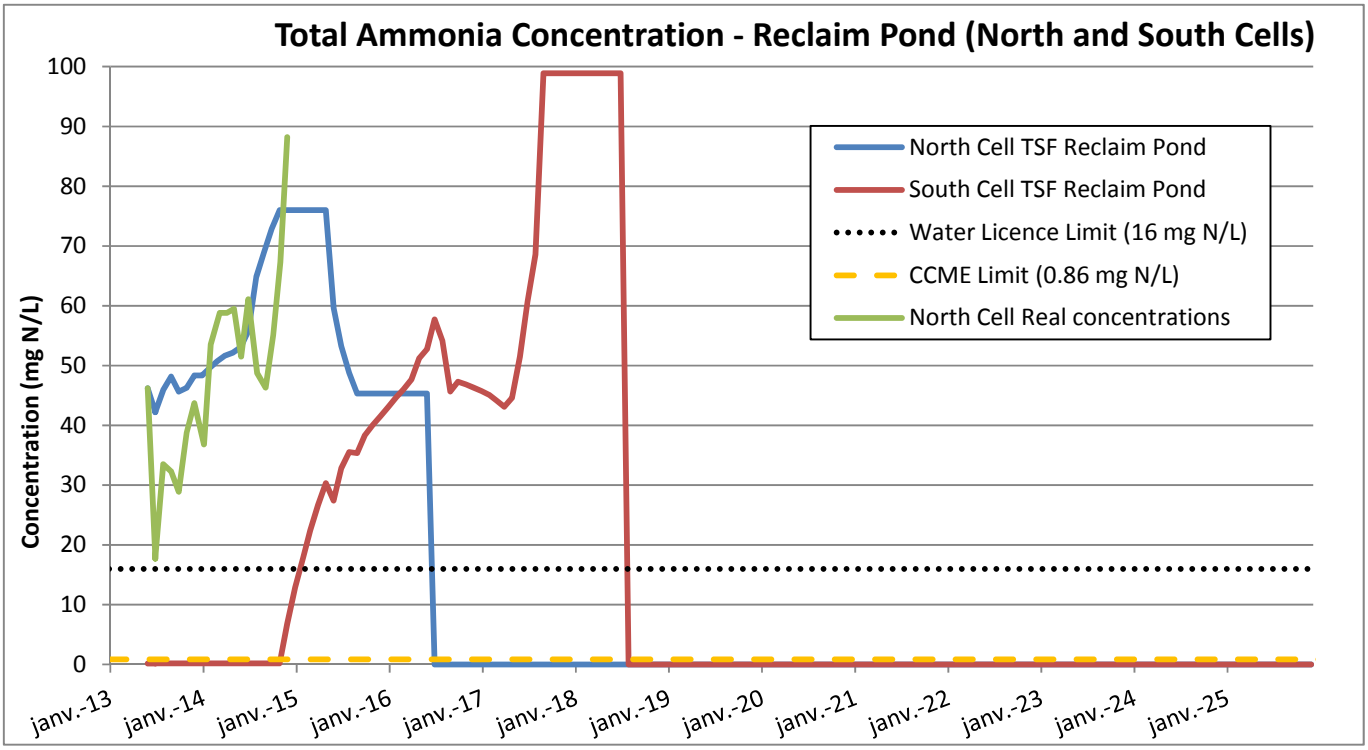


Figure 4-8: Ammonia Concentration in the Portage and Goose Pits

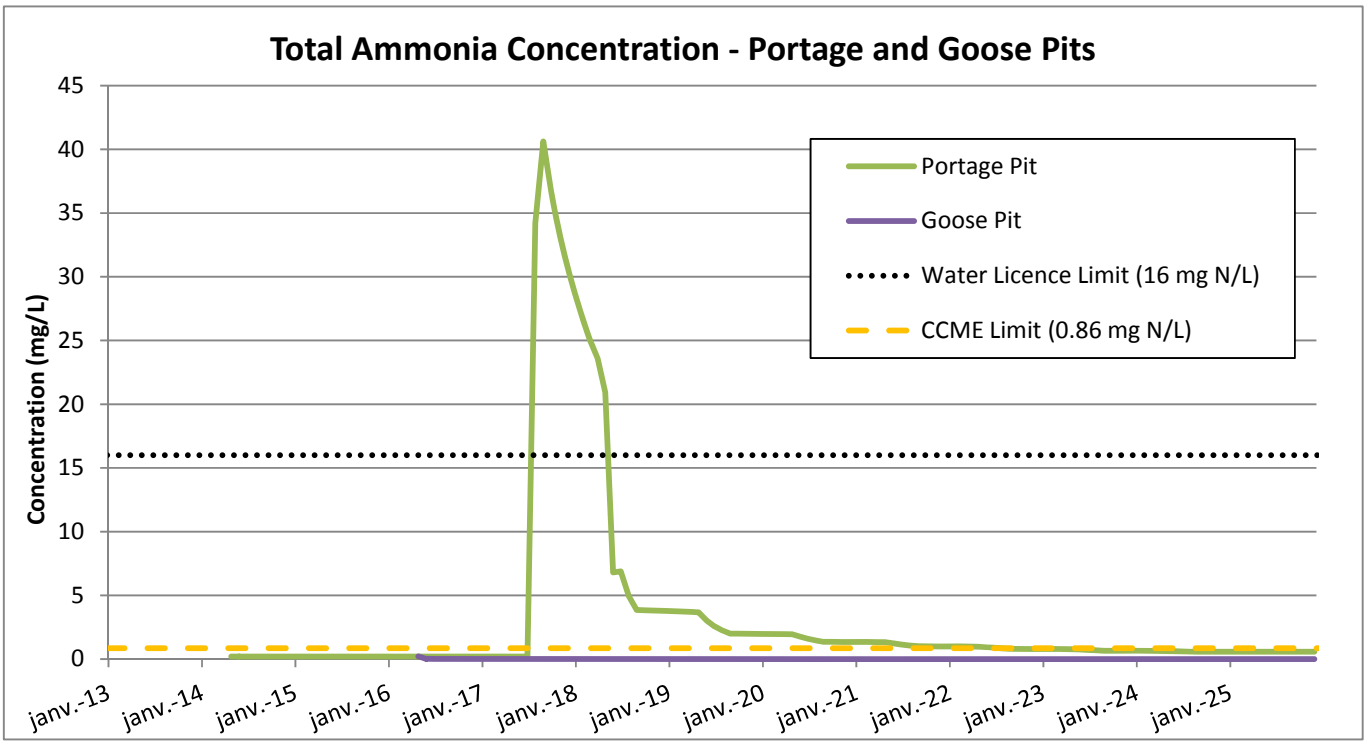


Figure 4-9: Nitrate Concentration in the North and South Cells TSF Reclaim Pond

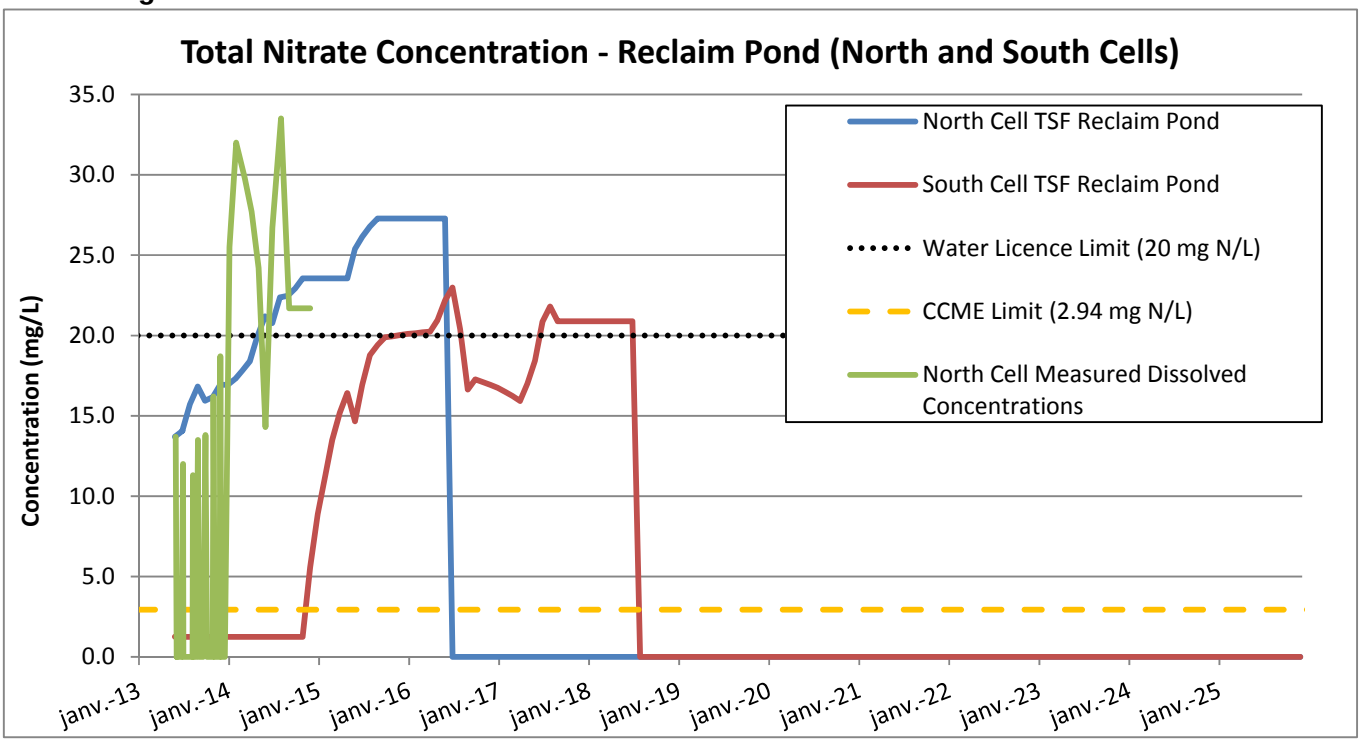


Figure 4-10: Nitrate Concentration in the Portage and Goose Pits

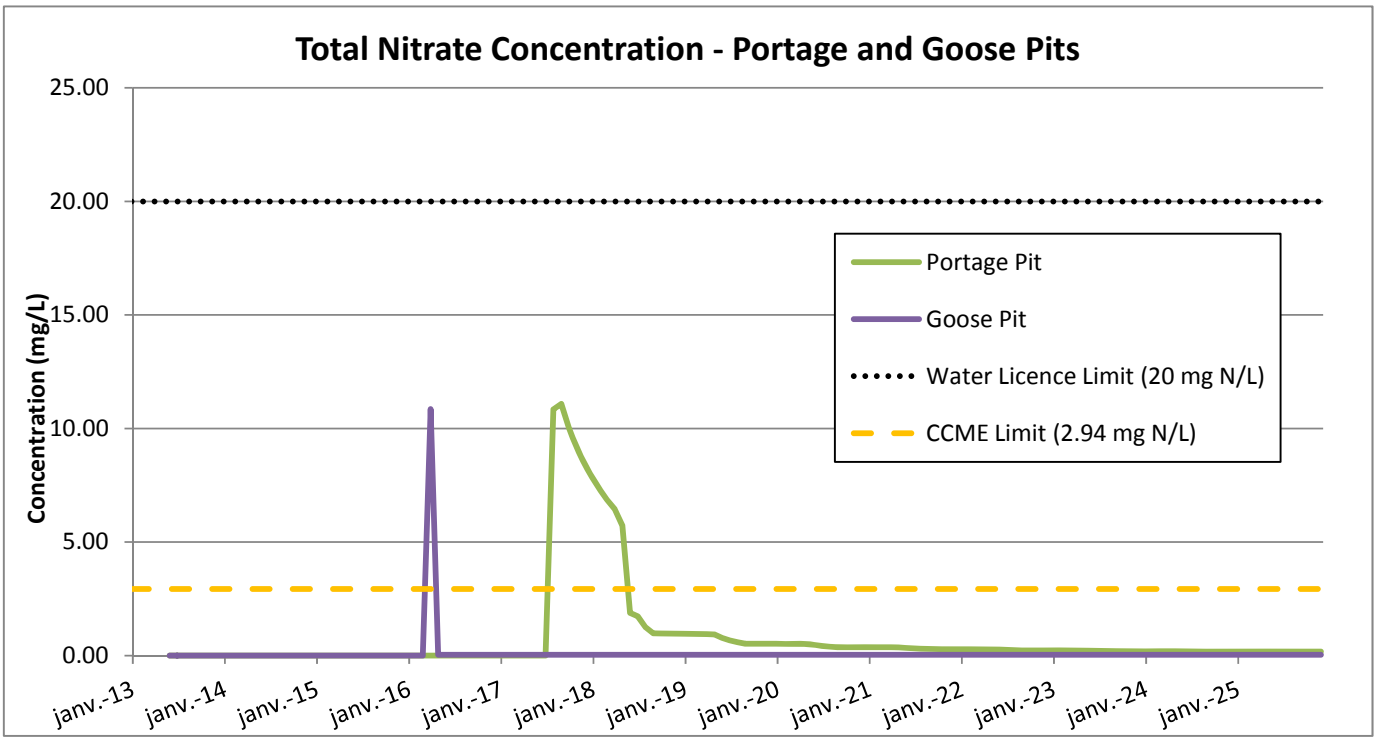


Figure 4-11: Chloride Concentration in the North and South Cells TSF Reclaim Pond

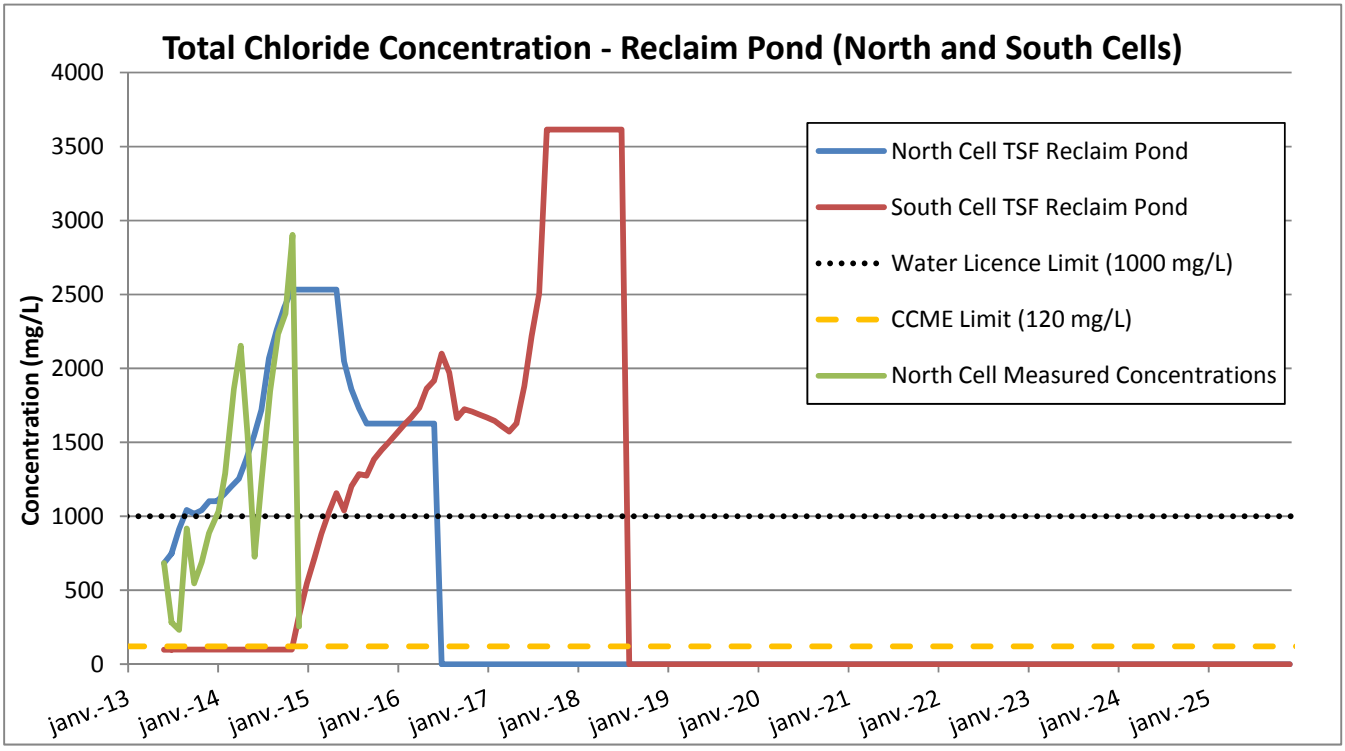


Figure 4-12: Chloride Concentration in the Portage and Goose Pits

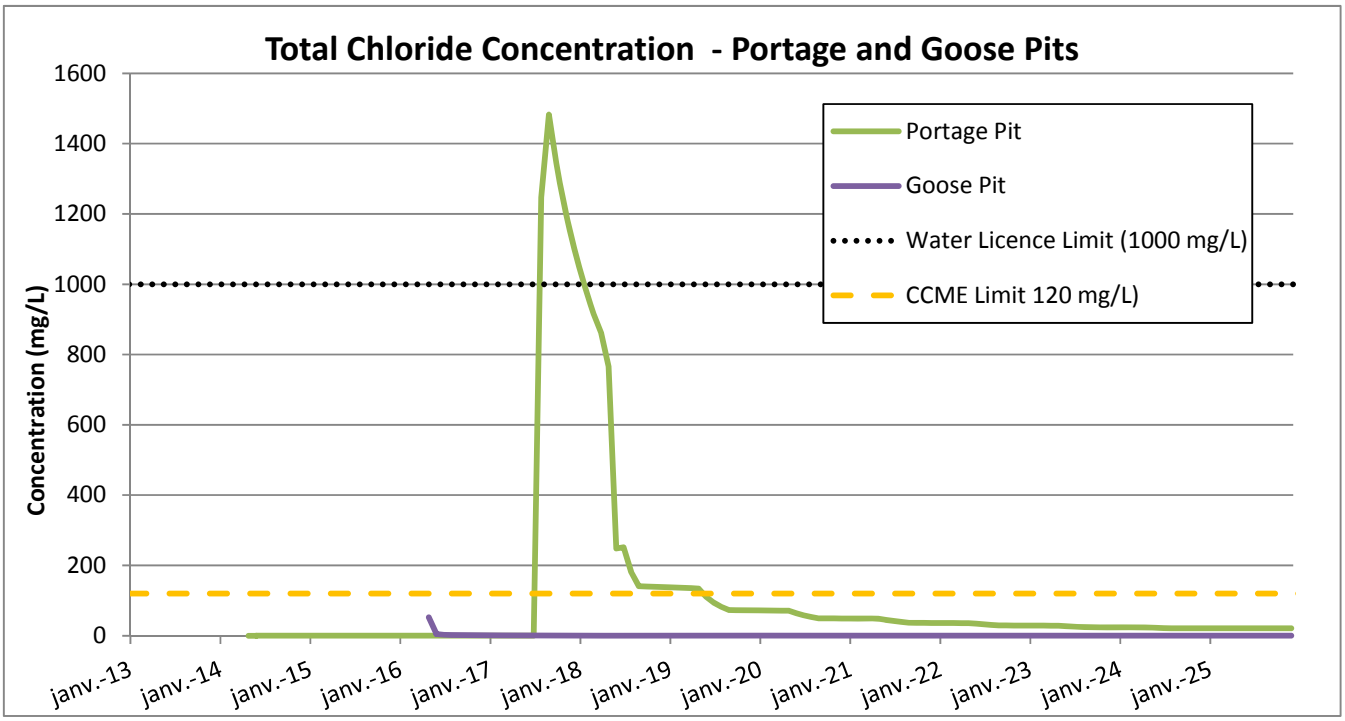


Figure 4-13: Selenium Concentration in the North and South Cells TSF Reclaim Pond

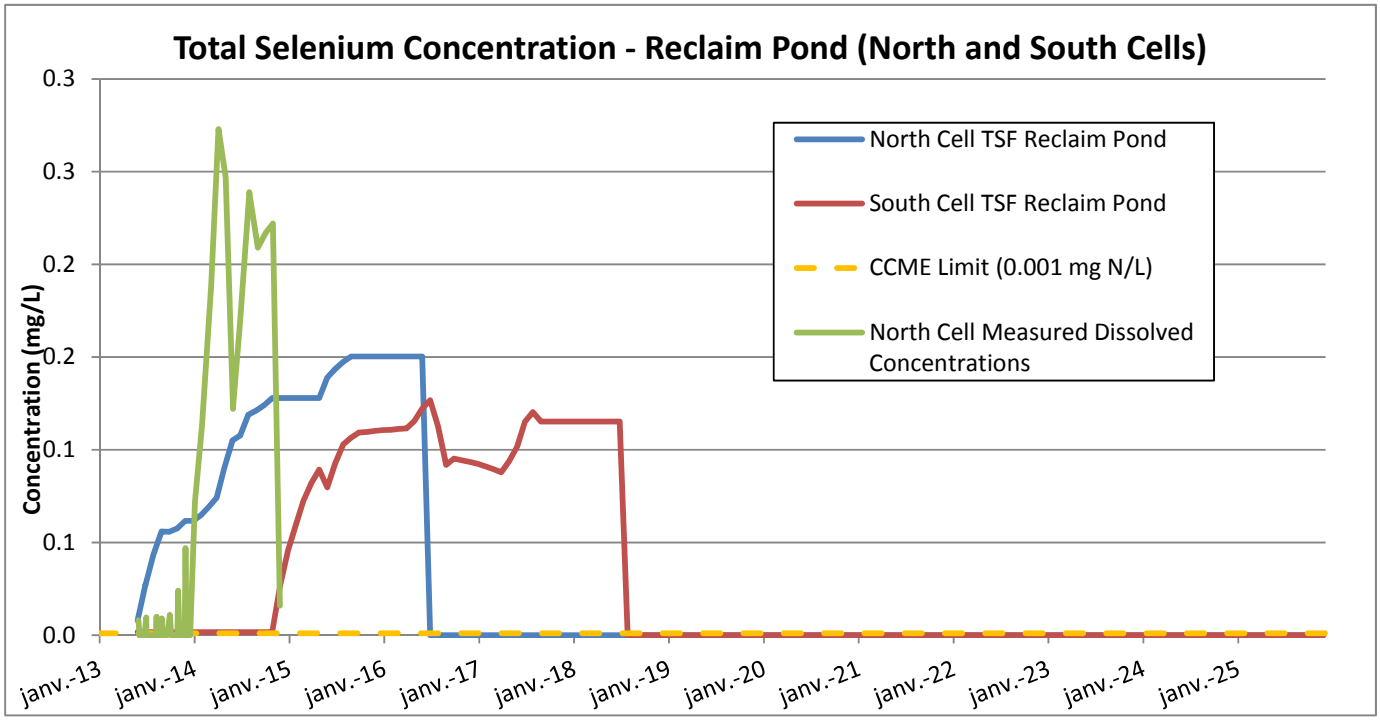
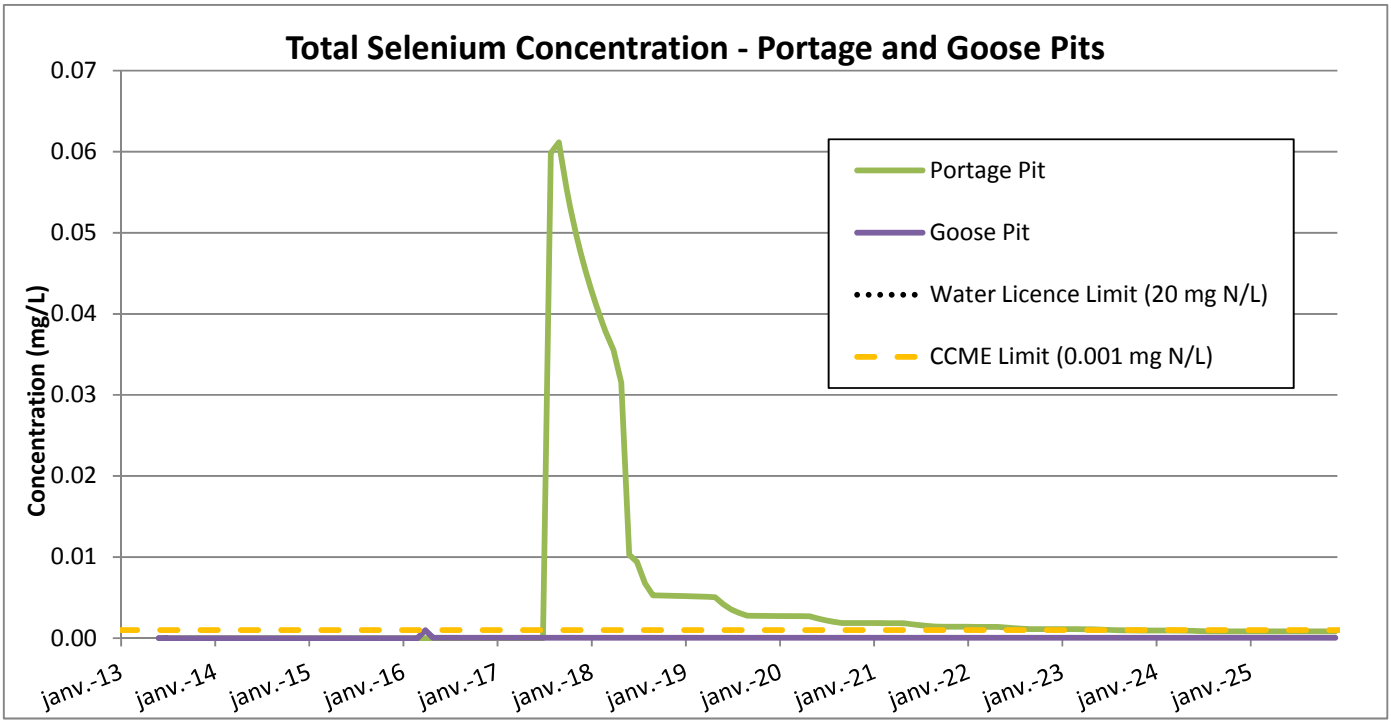


Figure 4-14: Selenium Concentration in the Portage and Goose Pits



5.0 CONCLUSION

Based on the water management plan 2014 developed by AEM, the objective of this Technical Note was to forecast the long term concentration of different contaminants in the North and South Cells TSF Reclaim Pond and in the Portage and Goose Pits from 2014 until closure in 2025. The water quality mass balance model was updated to forecast these long-term concentrations.

5.1 LIMITATIONS

It is important to understand the limitations of the mass balance model and of this Technical Note. The limitations are presented in section 3.3 and are briefly summarized here:

- In order to simplify the model, the mass balance model assumes the following:
  - Pond and pits are completely mixed systems;
  - No change in the water quality of the Mill Effluent;
  - A monthly time-step.
- The mass balance model is based on a limited set of water quality analysis results provided by AEM:
  - Water quality data provided for ST-21 is taken from samples collected at the surface of the North Cell TSF Reclaim Pond;
  - Limited water quality data available for the Mill Effluent;
  - Limited water quality data for some of the inflows and outflows of the Reclaim Pond.

5.2 RESULTS SUMMARY AND TREATMENT

Based on the results of the water quality mass balance presented in section 4.2, treatment may be required for copper as the pit water quality may exceed CCME limits if the water is not treated. Treatment could be undertaken at the Reclaim Pond, or in the Portage Pit if the trends shown in the model reveal to be true in the field. A potential treatment option for the removal of copper prior to discharge in Portage Pit is caustic or lime precipitation.

However, the forecasted equilibrium concentration for copper in Portage Pit meets the CCME guidelines. Consequently, treatment may not be required if it can be demonstrated in the field that these forecasted equilibrium concentration can be attained.

It is important to note that the water quality in the pits will be subject to CCME guidelines once the water level in the Goose and Portage Pits are equal to the water level in Second

Portage Lake. The dikes will only be breached once the water quality in the pits meets CCME guidelines.

5.3 RECOMMENDATIONS

The water quality mass balance developed for this study is intended as an updated model (from SNC 2012 model) for the mass balance in the Portage Area. Therefore, in order to improve the accuracy of the model so that it can better forecast the concentration of certain parameters in the Reclaim Pond or Portage and Goose Pits, the following studies, tests and monitoring are recommended.

1. In addition to the current set of chemical analyses, regular (at least monthly) monitoring of all inflows and outflows of the North and South Cells TSF Reclaim Pond for cyanide, total and dissolved copper, total and dissolved iron, ammonia, nitrate, chloride and selenium should be undertaken.
2. Implement a water sampling and analysis program once reclamation of the North Cell TSF commences to confirm copper equilibrium concentrations, as well as other parameters, once no Mill Effluent is added into the TSF Reclaim Pond. This could be carried out between the months of December 2014 to May 2015 while no tailings are being deposited in the North Cell TSF.
3. Regular analysis are also required of the Mill Effluent water discharged to the TSF in order to better monitor the changes in cyanide, copper, iron, ammonia, nitrate, chloride and selenium concentrations. Samples should be taken at least once a quarter.
4. Once transfer of South Cell Reclaim Water begins to the Portage Pit (August 2017), regular (at least monthly) monitoring of all outflows of the TSF Reclaim Pond for all parameters should be undertaken.
5. Sample and analyze the North and South Cell TSF Reclaim Pond at different depths and locations to determine if there is a concentration gradient in the Reclaim Pond.
6. Continued monitoring of the water in the South Cell TSF Reclaim Pond in 2015 on a regular basis to monitor the evolution of the parameters of concern listed in section 2.2.1. It is understood that this recommendation is required as per the water license.
7. In order to validate the assumption of a well mixed system in Portage and Goose Pits, it is recommended to sample and analyze the water at different depths before, during and after the pit is filled with water from South Cell TSF and/or Third Portage Lake. Furthermore, it may be useful to evaluate the assumption of a well mixed versus stratified pit water quality prior to mixing Portage and Goose Pits.
8. Once Portage and Goose Pits are hydraulically connected, it is recommended to sample the water at different points in the pit area in order to evaluate the mixing

efficiency over the entire area. The samples should be taken at different depths over the entire area of the flooded pits before and after the filling season.

REFERENCES

Botz, M. and Mudder, T. (2000). Modeling of Natural Cyanide Attenuation in Tailings Impoundments. *Mineral and Metallurgical Processing*, Vol. 17, No. 4, pp. 228-233. November 2000.

CCME . *Water Quality Guidelines for the Protection of Aquatic Life*. Canadian Environmental Quality Guidelines Summary Table. <http://st-ts.ccme.ca/?chems=all&chapters=1>. Accessed on February 28, 2013.

Nunavut Water Board License (2008). Water License No: 2AM-MEA0815. Agnico-Eagle Mines Ltd. June 2008.

SLI (2012). Water Management Plan 2012. Agnico-Eagle Mines. Document No. 610756-0000-40ER-0001, Rev. 02. March, 2013.

SLI (2012), Water Treatment and Mass Balance. Agnico-Eagle Mine. Document No. 610756-0000-40ER-0002, Rev. 01. March 2013.

AEM (2014). Water Management Plan 2014.

APPENDIX A
WATER QUALITY ANALYSES

1. North Cell TSF Reclaim Pond (ST-21)
2. Attenuation Pond (future South Cell TSF Reclaim Pond) (ST-18)
3. Portage pit (ST-19)
4. Goose Pit (ST-20)
5. Additional tests requested for the Mill Effluent

RECLAIM WATER ST-21 WATER ANALYSIS

DATE	pH	Alkalinity	Turbidity	Hardness	Ammonia nitrogen (NH_3)	Nitrate (NO_3)	Nitrite (NO_2)	Chloride	Fluoride	Sulphate	TDS	Total Cyanide	CN-WAD	Dissolved Aluminum	Dissolved Arsenic	Dissolved Barium	Dissolved Cadmium	Dissolved Copper	Dissolved Iron	Dissolved Lead
Units		mg $CaCO_3$/L	NTU	mg CaCO3/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-01-02													6.52							
2014-01-08	7.39	135	4.6	1329	36.8	25.5	0.97	1035	0.18	2115	1329	8.33		0.072	0.021	0.0838	0.00134	9.053	0.03	0.0016
2014-02-04	7.45	120	4.86	1428	53.6	32	0.97	1289	0.02	2496	2660	9.17		0.15	0.031	0.0914	0.00173	10.9	0.08	0.0003
2014-03-11	8.12	95	0.98	1286	58.8	29.8	0.8	1860	6.8	2542	2740	14.49		0.006	0.024	0.1096	0.00417	2.189	0.69	0.0003
2014-04-08	9.25	110	3.3	1721	58.8	27.7	0.58	2153	0.32	2275	4633	23.1		0.079	0.0229	0.1219	0.0004	0.2578	0.09	0.0003
2014-05-06	8.19	73	10.57	949	59.5	24.2	0.24	1549	2.2	2015	3878	11.69	15.6	0.139	0.0162	0.0826	0.00267	0.7796	0.29	0.0003
2014-06-03	7.05	67	13.88	674	51.5	14.3	0.16	727	0.41	1251	2142	6.21	9.23	0.046	0.0085	0.0512	0.00065	8.398	0.02	0.0003
2014-07-01	8.18	90	3.94	1265	61.1	26.7	0.19	1235	2	2289	8573	0.913		0.099	0.007	0.0691	0.00084	0.7023	0.09	0.0003
2014-08-05	7.8	89	3.78	1246	48.7	33.5	0.24	1847	0.48	2683	3909	1.33		0.134	0.0143	0.0791	0.0013	0.8784	0.12	0.0003
2014-09-07	7.32	84	8.09	1390	46.3	21.7	0.19	2236	3.7	2400	3636	3.36		0.072	0.0075	0.0893	0.00114	2.139	0.25	0.0003
2014-10-07		93	0.95	1387	55.10	35.6	0.19	2372	4.8	2359	4746	17.79		0.034	0.018	0.1068	0.00266	8.68	0.26	0.0003
2014-11-04	7.91	120	2.41	1693	67.30	39.6	0.20	2902	1.5	3033	1694	20.54		0.109	0.0254	0.1048	0.00303	1.261	0.65	0.0003
2014-12-01	7.58	127	1.21	659	88.20	3.7	0.30	256	0.02	951	1461	6.02		0.040	0.0122	0.0439	0.00026	1.267	0.60	0.0003

DATE	Dissolved Manganese	Dissolved Mercury	Dissolved Molybdenum	Dissolved Nickel	Dissolved Selenium	Dissolved Silver	Dissolved Titanium	Dissolved Zinc	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Lead	Lithium	Manganese	Chromium	Copper	Iron
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-01-02																				
2014-01-08	0.0595	0.0002	0.5826	0.2525	0.072	0.0001	0.005	0.001							0.0003				9.135	
2014-02-04	0.0141	0.0004	0.7348	0.0754	0.113	0.0107	0.005	0.001							0.0011				10.9	
2014-03-11	0.0035	0.0004	0.6747	0.0871	0.188	0.0036	0.005	0.002							0.0009				5.466	
2014-04-08	0.0005	0.0003	0.1866	0.0578	0.273	0.0041	0.005	0.001							0.0003				0.37	
2014-05-06	0.003	0.0005	0.3037	0.0756	0.247	0.0016	0.005	0.007											0.9237	
2014-06-03	0.0447	0.0002	0.2232	0.2941	0.122	0.0042	0.005	0.001												
2014-07-01	0.0615	0.0003	0.359	0.6107	0.17	0.0001	0.005	0.001	0.163	0.0036	0.0107	0.0774	0.0005	0.00101	0.0003	0.005	0.0674	0.0006	3.538	0.42
2014-08-05	0.0212	0.0006	0.5202	0.2237	0.239	0.0001	0.005	0.001							0.0003				0.015	
2014-09-07	0.0269	0.0004	0.5631	0.5444	0.209	0.0222	0.005	0.001											0.5292	
2014-10-07	0.0285	0.0006	0.65	1.399	0.217	0.0333	0.005	0.001												
2014-11-04	0.0261	0.0009	0.721	1.518	0.222	0.1837	0.005	0.011												
2014-12-01	1.355	<0.0001	0.0641	0.2428	0.016	0.0032	0.005	0.001												

DATE	Mercury	Molybdenum	Nickel	Selenium	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-01-02											
2014-01-08											
2014-02-04											
2014-03-11											
2014-04-08											
2014-05-06											
2014-06-03											
2014-07-01	0.00035	0.3672	0.6694	0.177	0.743	0.005	0.002	0.71	0.01	0.0005	0.01
2014-08-05											
2014-09-07											
2014-10-07											
2014-11-04											
2014-12-01											

ATTENUATION POND, SOUTH CELL (ST-18)

DATE	pH	Alkalinity	Turbidity	Ammonia	Ammonia-Nitrogen (NH3-NH4)	Arsenic	Chloride	Copper	Dissolved Aluminum	Dissolved Arsenic	Dissolved Barium	Dissolved Cadmium	Dissolved Copper	Dissolved Iron	Dissolved Lead	Dissolved Manganese	Dissolved Mercury	Dissolved Molybdenum	Dissolved Nickel	Dissolved Selenium
Units		mg $CaCO_3$/L	NTU	mg N/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-06-03	6.86	113	38.9	0.12	8.5	0.0041		0.0076												
2014-07-01	7.78	96	26.3	0.2	8.4	0.0061	84.4	0.0064	0.006	0.0041	0.0447	0.00007	0.0041	0.01	0.0003	2.43	0.0001	0.0237	0.0346	0.001
2014-08-05	7.83	103	8.11		9.7		112		0.006	0.0068	0.0462	0.0001	0.0052	0.01	0.0003	2.858	0.0001	0.0269	0.041	0.004
2014-09-07		114		0.18		0.0111		0.0054												
2014-10-13		106		0.19	11.8	0.0084		0.0065												

DATE	Dissolved Silver	Dissolved Thallium	Dissolved Zinc	Fluoride	Hardness	Lead	Nickel	Nitrate	Nitrite	Sulphate	TDS	Zinc	Conductivity	Total Cyanide
Units	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mgN/L	mgN/L	mg/L	mg/L	mg/L		mg/L
2014-06-03						0.0003	0.0427				754	0.002	1830	0.247
2014-07-01	0.0001	0.005	0.001	0.57	318	0.0003	0.0398	1.2	0.27	471	2628	0.04	1021	0.34
2014-08-05	0.0001	0.005	0.001	0.56	406			1.3	0.21	612	1155		1497	0.462
2014-09-07						0.0003	0.0659				1283	0.006		0.346
2014-10-13						0.0017	0.0727				1363	0.012		0.336

Portage Pit (ST-19)

Date	pH	Alkalinity	Turbidity	Ammonia	Ammonia-Nitrogen (NH_3-NH_4)	Arsenic	Copper	Lead	Nickel	TDS	Zinc
Units	**Units**	**mg $CaCO_3$/L**	**NTU**	**mg N/L**	**mg N/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
2013-01-16	7.61	112	61.6	0.41	7.1	0.0179	0.0059	0.00015	0.0043	252	0.0005
2013-02-06	7.68	95	21.5	0.29	12.6	0.0367	0.0143	0.00015	0.0032	238	0.116
2013-03-06	7.22	111	25.3	0.99	10.7	0.0107	0.0044	0.0097	0.0045	253	0.008
2013-04-03	7.02	55	2.1	0.025	0.19	0.0011	0.0073	0.00015	0.004	57	0.001
2013-05-07	7.17	73	5.48	0.025	0.35	0.0191	0.0026	0.00015	0.0024	116	0.011
2013-07-08	8.16	53	5.74	0.025	0.71	0.0245	0.0012	0.0006	0.0063	103	0.0005
2013-08-14	7.54	50	5.76	0.025	0.25	0.0493	0.0015	0.0006	0.0094	2	0.0005
2013-09-09	7	52	1.42	0.005	0.13	0.0083	0.00025	0.00015	0.0011	54	0.004
2013-10-07	8	49	1.75	0.005	0.11	0.0139	0.00025	0.00015	0.00025	64	0.001

Goose Pit (ST-20)

Date	pH	Alkalinity	Turbidity	Ammonia	Ammonia-Nitrogen (NH3-NH4)	Arsenic	Chloride	Copper	Dissolved Aluminum	Dissolved Arsenic	Dissolved Barium	Dissolved Cadmium	Dissolved Copper	Dissolved Iron	Dissolved Lead	Dissolved Manganese	Dissolved Mercury	Dissolved Molybdenum	Dissolved Nickel
Units		mg $CaCO_3$/L	NTU	mg N/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-03-11	8.38	93	2.82	0.01	0.017	0.017		0.0005											
2014-06-03	6.82	90	30.86	0.05	2.4	0.0061		0.0022											
2014-07-01	8.21	94	79.2	0.22	5.6	0.0045	73.6	0.0005	0.016	0.0013	0.0163	0.00002	0.0005	0.01	0.0003	0.0115	0.0001	0.0191	0.0043
2014-08-10	8.22	83	7.4	0.03	0.4	0.0075		0.0022											
2014-09-08	8.24	88	16.42	0.01	0.61	0.0059	31.3	0.002	0.046	0.0059	0.0387	0.00002	0.0013	0.01	0.0003	0.1072	0.0001	0.0166	0.0253

Date	Dissolved Selenium	Dissolved Silver	Dissolved Zinc	Fluoride	Hardness	Lead	Nickel	Nitrate	Nitrite	Sulphate	TDS	Zinc	Conductivity	Dissolved Titanium
Units	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mgN/L	mgN/L	mg/L	mg/L	mg/L		mg/L
2014-03-11						0.0006	0.0018				175	0.001	310	
2014-06-03						<0.0003	0.0137				288	0.001	463	
2014-07-01	0.001	0.0001	0.001	0.91	111	<0.0003	0.0109	16.4	0.39	50.9	1544	<0.001	517	0.005
2014-08-10						0.0009	0.036				319	0.003	473	
2014-09-08	0.001	0.0001	0.001	0.96	151	0.0003	0.0277	5.3	0.13	70.6	322	0.009	477	0.005

MILL EFFLUENT (ADDITIONAL TESTS)

DATE	Alkalinity	Aluminium (Al)	Dissolved Aluminium (Al)	Antimony (Sb)	Dissolved Antimony (Sb)	Silver (Ag)	Dissolved Silver (Ag)	Arsenic (As)	Dissolved Arsenic (As)	Barium (Ba)	Dissolved Barium (Ba)	Beryllium (Be)	Dissolved Beryllium (Be)	Boron (B)	Dissolved Boron (B)	Cadmium (Cd)	Dissolved Cadmium (Cd)
	mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-01-29	91	0.22	0.16	0.01	0.003	0.005	0.002	0.025	0.022	0.17	0.14	0.001	0.001	0.39	0.37	0.005	0.0005
2014-10-26	257	0.049	0.386	0.001	0.0086	< 0.0001	< 0.0001	0.0084	0.073	0.3805	0.1018	< 0.0005	< 0.0005	0.65	0.29	0.00105	0.02071

	Chloride	Chrome (Cr)	Dissolved Chromium (Cr)	Copper (Cu)	Dissolved Copper (Cu)	Cynanide WAD	Total Cyanide (CNt)	Hardness	Tin (Sn)	Dissolved Tin (Sn)	Iron (Fe)	Dissolved Iron (Fe)	Fluoride (F)	Lithium (Li)	Dissolved Lithium (Li)	Manganese (Mn)	Dissolved Manganese (Mn)
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg $CaCO_3$/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2014-01-29	2129	0.005	0.0025	25	7.8	0.898	18.80	1500	0.025	0.025	6.7	0.8	0.41	0.05	0.05	0.005	0.0015
2014-10-26	2199	0.0094	0.0046	7.942	6.795	72.96	111	4079	< 0.001	< 0.001	55.8	0.14	0.65	0.013	< 0.005	12.21	0.0013

	Mercury (Hg)	Dissolved Mercury (Hg)	Molybdenum (Mo)	Dissolved Molybdenum (Mo)	Ammonia (NH_3) (ionized)	Ammonia (NH3-NH4)	Nickel (Ni)	Dissolved Nickel (Ni)	Nitrate (NO_3)	Nitrite (NO2)	Lead (Pb)	Dissolved Lead (Pb)	Selenium (Se)	Dissolved Selenium (Se)	Strontium (Sr)	Dissolved Strontium (Sr)	Sulfate (SO_4)
	mg/L	mg/L	mg/L	mg/L	mg N/L		mg/L	mg/L	mg N/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg SO_4/L
2014-01-29	0.00005	0.00005	0.81	0.75	11.8	71.5	0.06	0.005	31.6	0.69	0.005	0.0005	0.19	0.17	2.5	2.3	2565
2014-10-26	0.00206	0.0023	0.0114	0.6517	11.3	16.7	3.56	0.8618	27.9	0.23	0.0157	< 0.0003	0.154	0.158	6.06	2.1	2400

	Thallium (Tl)	Dissolved thallium (Tl)	Titanium (Ti)	Dissolved titanium (Ti)	Uranium (U)	Dissolved Uranium (U)	Vanadium (V)	Dissolved Vanadium	Zinc (Zn)	Dissolved Zinc		
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
2014-01-29	0.005	0.005	0.025	0.025	0.01	0.003	0.005	0.005	0.01	0.0025	Certificat V-32370	Final Tailings
2014-10-26	< 0.005	< 0.005	1	0.5	0.014	< 0.001	0.0006	< 0.0005	0.028	0.03	Certificat V-39451	Final Tailings

www.snclavalin.com

Sustainable Mine Development
Global Mining & Metallurgy
SNC-LAVALIN Inc.
455 René-Lévesque Blvd. West
Montreal, Quebec
H2Z 1Z3 Canada
Tel.: (514) 393-1000
Fax: (514) 390-2765

APPENDIX D – 2015 FRESHET ACTION PLAN

`

AGNICO EAGLE

MEADOWBANK GOLD MINE

FRESHET ACTION AND INCIDENT RESPONSE PLAN

OCTOBER 2015

EXECUTIVE SUMMARY

The purpose of this Action and Response Plan is to identify areas of concern around the Meadowbank mine site and the AWAR that need to be managed in an organized and timely manner during the annual freshet period to prevent adverse environmental and operational impacts. The Incident Response section of the Plan outlines specified actions that have and will be taken by AEM to manage and mitigate areas where environmental incidents have occurred, specifically seepage on the north-east side of the Portage Waste Rock Storage area, known as sample location ST-16 (2013) and seepage from the mill (inside) containment structures through the Assay Road southwest of the mill (Mill Seepage - 2013). Any future incidents that have the potential to affect off site water or land will be added and would include any specific mitigation and monitoring actions.

The freshet period typically occurs during the annual snow and ice melt sometime around mid-May and extending until the end of July. During this period excess water is created and must be managed through additional pumping and management practices at vulnerable areas around the site. Mitigation techniques, timeframes and specified roles and responsibilities are outlined in this document for each area of concern.

The main areas of concern are the mining pits and pit walls, the East and West diversion ditches, Vault Road culverts, the areas around the Portage Waste Rock Storage Facility (RSF) including the northern portions of the NPAG waste rock extension, Vault Waste Rock Storage Facility, Northwest corner of the North Cell TSF, Saddle Dam 1 corner, Saddle Dam 2 sump, AWAR culverts near the site and along the road to Baker Lake, RSF – ST-16 Seepage, Assay Road (Mill) Seepage and the Vault Pit area.

It is important that all dewatering and associated infrastructure be in good working order and adequate to receive the expected water flows associated with the freshet period; this includes but is not limited to pumps, ditch and sump maintenance, critical piping system installation and inspection, adequate resource allocation for preparative work and establishing a viable monitoring program for the areas of concern and incident response locations. A concise summary of the 2015 preparation works and roles and responsibilities is presented in the attached Appendix 1 (2015 Freshet Action Plan Procedures). Appendix 1 will be updated yearly to reflect changes in conditions at the Meadowbank site. Appendix 2 contains diagrams depicting the areas of concern and incident respose locations. Schedules 1 and 2 describe the monitoring programs for incident responses.

DOCUMENT CONTROL

Revision				Pages Revised	Remarks
#	Prep.	Rev.	Date		
01	AEM	Internal	April 2014	All	
02	AEM	Internal	May 2015	All	Comprehensive update from 2014 Plan
03	AEM	Internal	October 2015	All	Comprehensive update from May 2015 Plan

Prepared By: _____

Engineering and Environmental Department

Approved by:

_____

Engineering and Environmental Department

TABLE OF CONTENTS

1 INTRODUCTION 8

2 AREAS OF CONCERN 9

2.1 Mining Pits and Pit walls 9
2.1.1 Goose pit 9
2.1.2 Portage pit 9
2.1.3 Vault Pit 10
2.2 Waste Rock Storage Areas 11
2.2.1 PORTAGE RSF 11
2.2.2 VAULT RSF 12
2.3 North Cell Tailings Storage Facility 12
2.3.1 Diversion Ditches 12
2.3.1.1 AWAR culvert – discharge to Third Portage Lake 13
2.3.1.2 West Diversion Ditch Elbow 14
2.3.1.3 Northwest Corner of North Cell TSF 15
2.3.1.4 East Diversion Ditch Low Point 16
2.3.1.5 East Diversion ditch outlet to NP-2 Lake 17
2.3.1.6 NP-2 Outlet and Vault Road Culvert 18
2.3.1.7 North Portion of NPAG Waste Rock Expansion 21
2.3.2 Saddle Dams 21
2.3.2.1 Saddle Dam 1 21
2.3.2.2 Saddle Dam 2 22
2.4 Vault Road Culvert 22
2.5 Stormwater Management POND 22

2.6 Fuel tank Farms 23
2.6.1 Meadowbank Tank Farm 23
2.6.2 Baker Lake Tank Farms 23
2.7 AWAR Culverts on the Baker Lake Portion 23
2.8 Meadowbank Assay Lab 23

3 INCIDENT RESPONSE 24

3.1 ST-16 SEEPAGE 24
3.2 Mill Seepage 26

LIST OF FIGURES

Figure 2-1: View of Portage Pit E area with the associated sumps and trenches 10

Figure 2-2: View of Vault Attenuation pond its associated ponds 11

Figure 2-3: Location of the areas of interest for the 2015 diversion ditches freshet Action plan 13

Figure 2-4: West diversion ditches area of interest 14

Figure 2-5: North Cell West Diversion ditch interception sump 15

Figure 2-6: View of the northwest corner of the ditches 16

Figure 2-7: View of the north low area where a snow build up retained water in spring 2013 17

Figure 2-8: View of the East Diversion ditch outlet into NP-2 Lake 18

Figure 2-9: View of the diversion ditches at the Vault road area 19

Figure 2-10:Turbidity barriers at inlet of NP1 20

Figure 2-11: Turbidity barriers at the inlet of Dogleg Lake 20

Figure 2-12: Vault Road repair 21

Figure 2-13: Portage Pit area with the Stormwater Management Pond 22

Figure 3-3-1: View of the RSF seepage observed at the ST-16 station with a red arrow representing the flow of the seepage. Red Lines represent installed filters and areas where tailings beaches were built up to minimize flow through. 26

Figure 3-3-2: View of the mill seepage area and initial retention berm construction 27

Figure 3-3: View of the mill seepage area and interception trench design 28

List of Appendix

Appendix 1 - 2015 Freshet Action Plan Procedure
Appendix 2 - 2015 Monitoring Location for the Freshet Action Plan

List of Schedule

Schedule 1 – ST-16 Seepage monitoring program

Schedule 2 – Mill Seepage monitoring program

1 INTRODUCTION

The purpose of this Freshet Action and Incident Response Plan is to ensure that AEM can address and manage excess water associated with the freshet season at the Meadowbank site and to ensure AEM has implemented specific management and mitigation measures in response to environmental incidents with potential for off site impacts to water or land.

The freshet season is loosely defined as being a period of time from approximately May 15 – July 30; in some cases this period of time can extend up to early fall when freezing re-occurs (October 15). There are many areas around the site that are vulnerable to this excess water; the goal is to identify these areas and develop a clear plan with defined roles and responsibilities (among AEM Departments), and to manage the freshet flows.

In addition, several guiding principles are applicable to the formation of this plan. The highest priority principles are:

1) to ensure that mine contact water from runoff or seepage is managed to prevent adverse environmental impacts;
2) to ensure that the health and safety of AEM employees is protected, especially with respect to mining operations when excess water is present; and
3) to make sure the site is in compliance with the Nunavut Water Board (NWB) License, Part D, Item 19 and Part E, Item 10.

The plan will identify the areas of concern and discuss the potential risks as well as mitigation measures necessary to address the identified issues. Appendix 1 contains the actual defined 2015 procedures, the roles and responsibilities and associated timelines. AEM's intent is to update the Procedural Appendix on a yearly basis. For example, there may be additional mitigation measures for a defined problem area or in some cases a previously defined issue may be permanently rectified.

The main areas of concern are the mining pits and pit walls, the East and West diversion ditches, Vault Road culverts, the area around the Portage Waste Rock Storage Facility (RSF) including the northern portions of the NPAG waste rock extension, Vault Waste Rock Storage Facility, Northwest corner of the North Cell TSF, Saddle Dam 1 corner, Saddle Dam 2 sump, AWAR culverts near the site and along the road to Baker Lake, RSF – ST-16 Seepage, Assay Road (Mill) Seepage and the Vault Pit area.

Each area identified above will be discussed in detail below. All areas of concern are considered priorities based on the guiding principles.

2 AREAS OF CONCERN

2.1 MINING PITS AND PIT WALLS

All permanent ramps, jump ramps, ditches and sumps must be cleaned of all ice and snow before the month of May in order to contain any water resulting from the snow melt. All pumps must be checked and serviced before the month of May. In addition, a check must be completed confirming that all piping systems starting from the different pits leading to the attenuation pond or the South Cell TSF are free of ice by validating pumping values (if pumping systems are active) and/or performing an air test in the pipe with a compressor.

2.1.1 Goose pit

Mining in Goose pit was completed in April 2015. All pumping equipment has been removed from the pit. Runoff water that accumulates in the Goose pit will now form part of the Goose pit reflooding process.

2.1.2 Portage pit

Water management in the Portage pit has been simplified since the mining of pits B, C and D has been completed. However, infrastructure is in place to prevent runoff water from reaching Pit A and E.

- A pond and ditch system south of Pit E pushback is presented in Figure 2-1. Runoff water accumulated in ponds GP-3, GP-4, GP-8 and Pond 8 will be pumped into Goose pit;
- A pumping station located in pit B (not shown) will be used to manage runoff water affecting the active mining production area in pit A. The water will be pumped to the South Cell Tailings Storage Facility (TSF); and
- A pumping station located in pit E (not shown) will be used to manage runoff water affecting the active mining production area in pit E. The water will be pumped to the South Cell TSF.

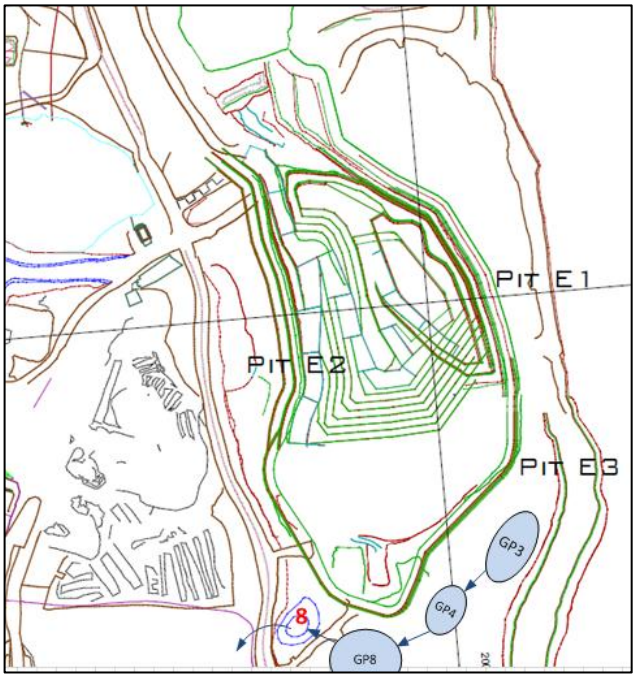


Figure 2-1: View of Portage Pit E area with the associated sumps and trenches

2.1.3 Vault Pit

Since the summer of 2014 (dewatering completed) Vault Lake is now used as an Attenuation pond. The light blue surfaces in Figure 2-2 represent four isolated ponds that form the Attenuation pond (A, B, C & D) used to collect contact water from Vault Pit. Runoff from the pit area and the waste rock storage area that flows into the active mining areas will be pumped to the Attenuation pond.

Discharge from the Vault attenuation pond to Wally Lake may require treatment at the Vault WTP if the water quality does not meet discharge criteria. The Actiflo treatment plant is designed to remove TSS. A diffuser was installed in Wally Lake to meet the Type A Water License requirement. The Environmental department must be notified ten days before discharging any water to Wally Lake to comply with notification and sampling requirements. All piping and the discharge diffuser must be inspected in April in order to have all installations in place to proceed with pumping and/or treatment activities during freshet. The WTP will also be inspected and commissioned to be ready for the pumping season.

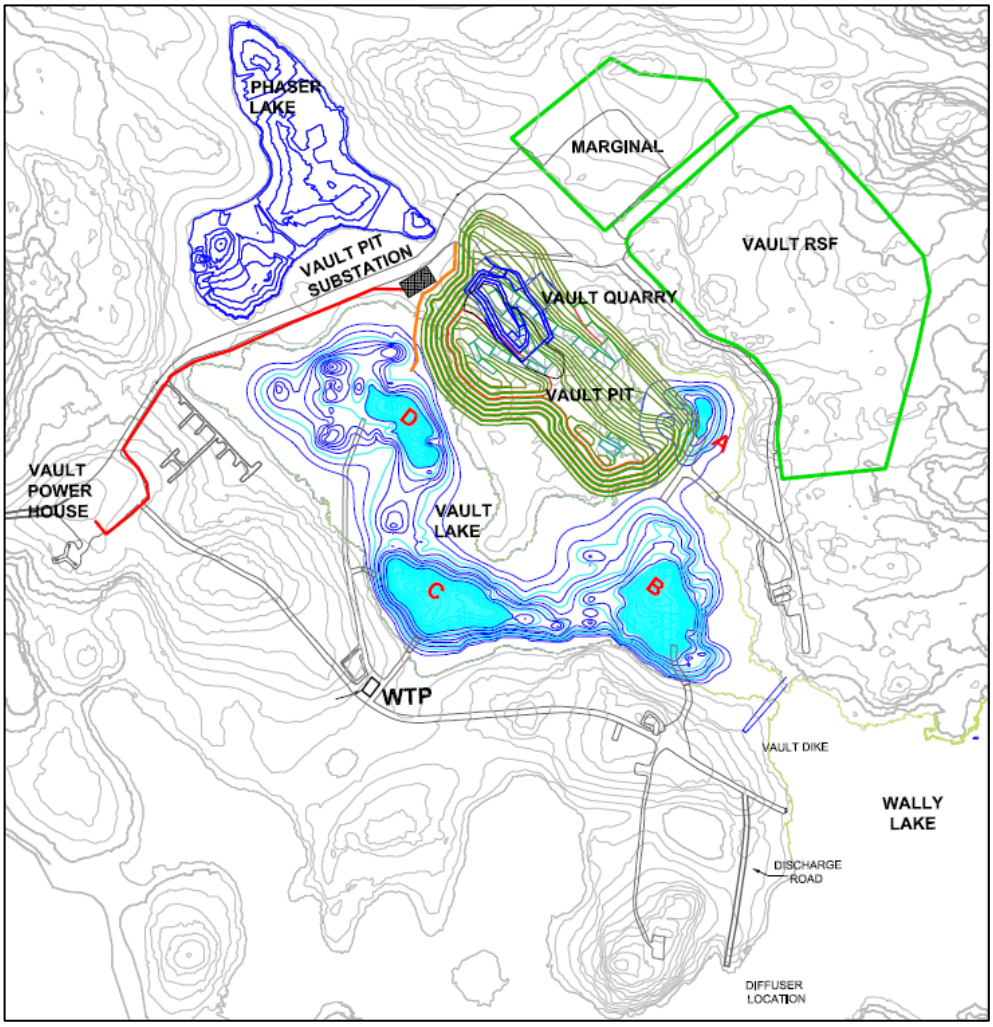


Figure 2-2: View of Vault Attenuation pond its associated ponds

2.2 WASTE ROCK STORAGE AREAS

2.2.1 PORTAGE RSF

The Portage Rock Storage Facility (RSF) will require weekly inspections around the perimeter beginning in mid-May to identify any seepage. As will be noted in the following section, seepage was identified in 2013 at location ST-16. In the event that additional seepage is observed from the RSF, it must be reported to the Engineering and Environment Departments and samples must be taken to determine the water quality and source. A mitigation plan will be prepared and implemented if necessary.

2.2.2 VAULT RSF

Much like the RSF located near Portage pit, the Vault RSF will require some monitoring during the freshet period to ensure adequate water management. Weekly inspections around the RSF perimeter will be conducted to identify any seepage. In the event that seepage is observed, the Engineering and Environment Departments must be notified and samples taken to determine water quality. The sample monitoring will be in accordance with the Water License requirements. It is anticipated that there will be no water quality issues as primary drainage is towards the Vault Pit and Vault Attenuation Pond and the waste rock from the Vault Pit is primarily NPAG.

2.3 NORTH CELL TAILINGS STORAGE FACILITY

Water management around the North Cell Tailings Storage Facility (TSF) is required to maintain integrity of the tailings pond and to prevent any adverse environmental impacts. This section describes the infrastructure in place to control runoff water and reduce possible impact on both the tailings storage facility and the receiving environment.

2.3.1 Diversion Ditches

The East and West Diversion ditches were constructed in 2012 around the North Cell TSF and the Portage RSF. The diversion ditches are designed to redirect the fresh water from the northern area watershed away from the tailings pond and RSF and direct it to Second and Third Portage Lakes. As seen in Figure 2-3, seven zones associated with the dversion ditches have been identified where actions will be taken during or before freshet:

2. 1. AWAR culvert – Discharge to Third Portage Lake;
2. 2. West Diversion Ditch elbow;
2. 3. Northwest corner of North Cell TSF;
2. 4. East Diversion Ditch low point;
2. 5. East Diversion Ditch Outlet to NP-2 Lake;
2. 6. North portion of NPAG waste rock expansion; and
2. 7. Vault road culvert – NP-2 Lake exit to NP-1 Lake.

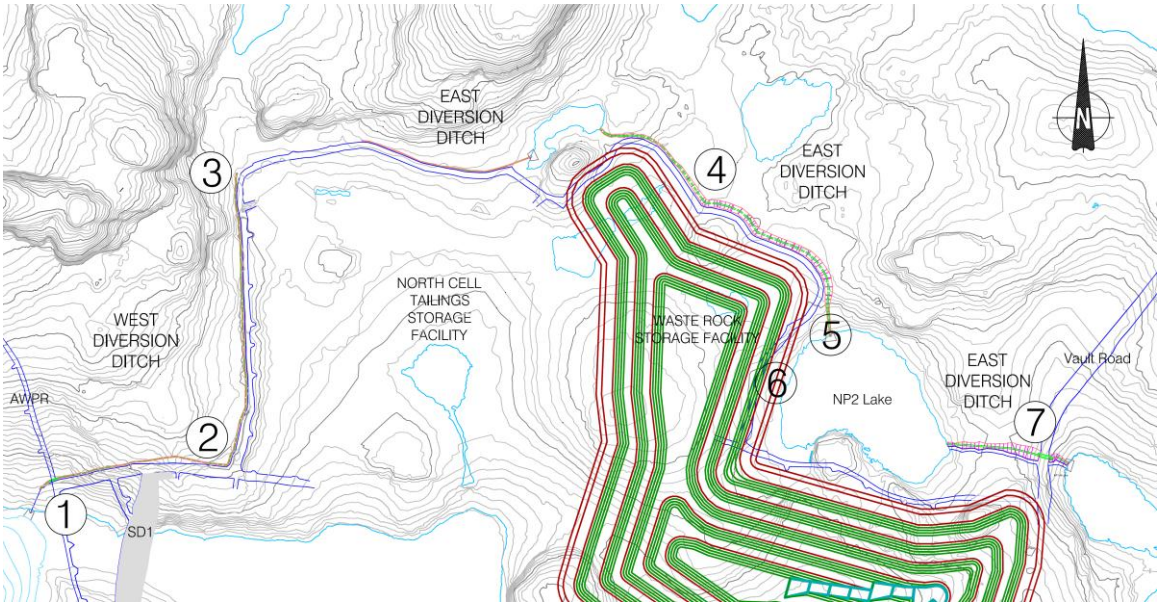


Figure 2-3: Location of the areas of interest for the 2015 diversion ditches freshet Action plan

2.3.1.1 AWAR culvert – discharge to Third Portage Lake

Ditch outflows are important to ensure proper flow of freshet drainage. The culvert under the AWAR (Figure 2-3 #1) is a critical section of the West Diversion Ditch. Snow removal must be performed to avoid ponding and damage to the ditch/trench structure as well as to maintain the integrity of the AWAR which, in turn, is critical to transportation at the Meadowbank mine site.

Figure 2-4 illustrates this culvert. Snow and/or ice must be removed using an excavator on each side of the culvert to allow water to flow through to prevent upstream ponding. The culvert may need to be steamed if blocked by ice. Before starting the cleaning operation, it is important to ensure that the electrical cable (5kV) location has been visually identified.

After flowing through the culvert the water discharges across the tundra into Third Portage Lake – see Figure 2-4 below. Snow and ice needs to be removed in early May to prevent any back up in the West Diversion ditch. This could increase water levels upstream in the ditch causing problems discussed in Section 2.3.1.2. If necessary silt curtains will be installed at the discharge area to Third Portage Lake to control elevated TSS during the freshet period.

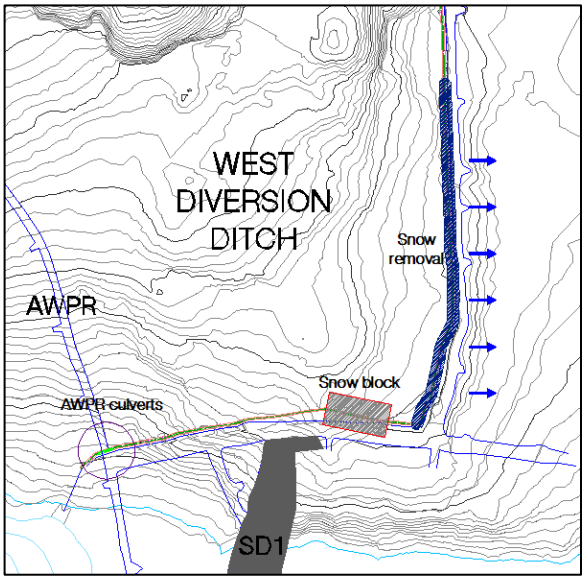


Figure 2-4: West diversion ditches area of interest

A turbidity barrier installed in 2014 has been left in place over the winter. Additional barriers can be installed after ice melt as a contingency. Daily inspections will be conducted starting in mid-May. Sample monitoring will commence when open water is present in accordance with the Water License (ST-6). Sampling frequency of ST-6 may be increased if TSS results are near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated. If a discharge of TSS occurs, the Environment Department will notify DFO.

2.3.1.2 West Diversion Ditch Elbow

One of the deepest sections of the West Diversion ditch is located in the corner next to the Saddle Dam 1 – see Figure 2-4 and Figure 2-3 #2 above. In 2013 a large accumulation of snow blocked the flow through this ditch at a location denoted by the red square. Water accumulated behind the blockage and raised upstream creating channels through the rockfill and into the North Cell TSF. In early May of each year, AEM will remove the snow accumulation to allow the water to flow freely preventing the water upstream from increasing in level and hydraulic head pressure. In addition, large flows can scour the ditch system causing sediment migration through the ditches which could impact Third Portage Lake. To prevent this, snow must be removed from the corner area with a long reach excavator in early May.

As a further precaution, AEM constructed an interception sump located at the west diversion ditch elbow location in 2014. The sump has a capacity of 3000 m³. The sump is designed to intercept water coming from the most critical parts of the West Ditch. Sample monitoring will determine if there is any seepage from the TSF or elevated TSS from the ditch. If water does not meet discharge criteria it will be pumped back to the North Cell TSF. These measures will prevent any contaminated water from reaching Third Portage Lake. This sump will also act as a settling pond

to prevent water with elevated TSS from reaching Third Portage Lake. Daily inspections will be conducted during the freshet. Sample monitoring will also be conducted if necessary. Figure 2-5 shows the North Cell interception/settling sump after the completion of the construction.

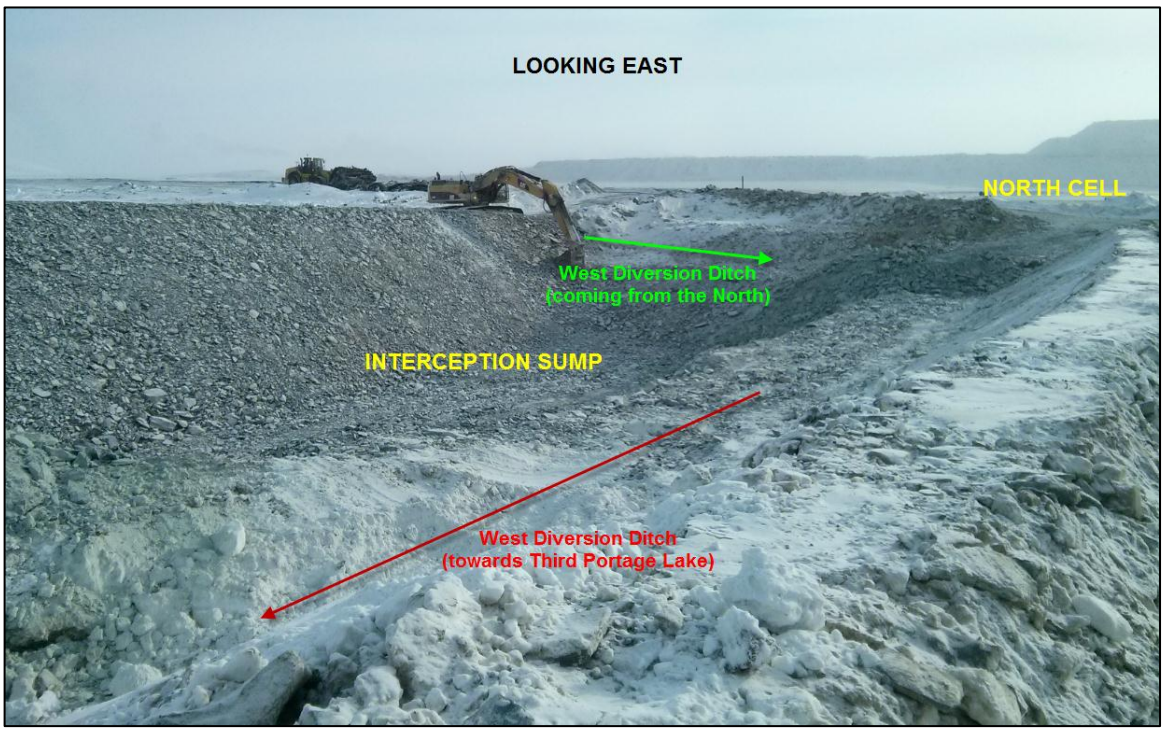


Figure 2-5: North Cell West Diversion ditch interception sump

2.3.1.3 Northwest Corner of North Cell TSF

The construction access road at the Northwest corner of the North Cell TSF (see Figure 2-6 and Figure 2-3 #3) is vulnerable to damage from the freshet water flow from the northern watershed (see watercourse flow in Figure 2-6 denoted by light blue dotted line). The start of the West Diversion ditch is also located in this area and is designed to collect most of the freshet flow – note arrows in Figure 2-6. In order to prevent the water from accumulating against the access construction road and possible overflow to the tailings pond, the snow and ice must be removed in early May from the areas indicated by the red circle in Figure 2-6. This is very important as the start of the West ditch is shallow, must manage a high initial flow rate and can plug easily (with snow). Also, note in the Figure 2-6 two areas where water ponded during the 2013 and 2014 freshet. As a contingency, a pump can be utilized to transfer this water to the North Cell TSF or the West Diversion ditch (non-contact water only). In addition, to prevent any contamination of Third Portage Lake, daily inspections will be completed and samples will be taken if AEM suspects that any seepage contamination is migrating out of the TSF (analysis for CN and metals). If water is contaminated with tailings, the water will pumped back to the TSF.

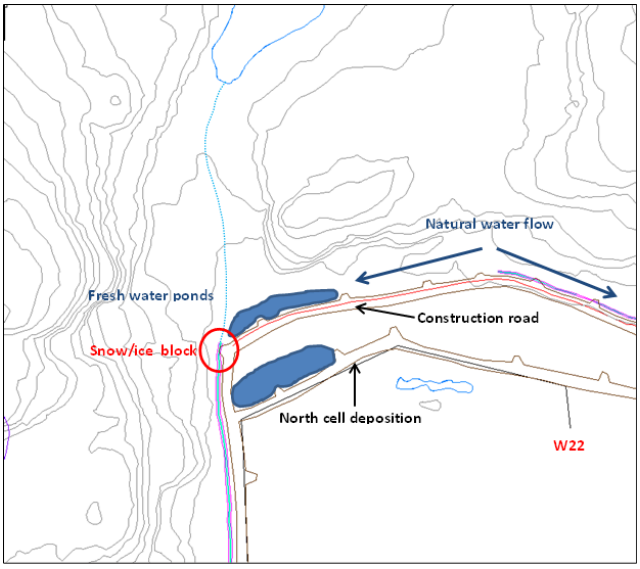


Figure 2-6: View of the northwest corner of the ditches

2.3.1.4 East Diversion Ditch Low Point

There is a low point located on the northernmost portion of the East Diversion ditch – see Figure 2-7 below and Figure 2-3 #4. Snow needs to be removed from this area, denoted by the blue arrow, to prevent watershed flow from following the historical watercourse (dotted line) and reaching the toe of the NPAG Waste Rock extension (RSF). Removing the accumulated snow in early May at a downstream location referenced by the blue arrow will allow the runoff to flow freely through the East Diversion ditch to NP-2 Lake. Daily inspections will be undertaken to ensure the watershed non-contact water flows freely in this section of the East Diversion Ditch.

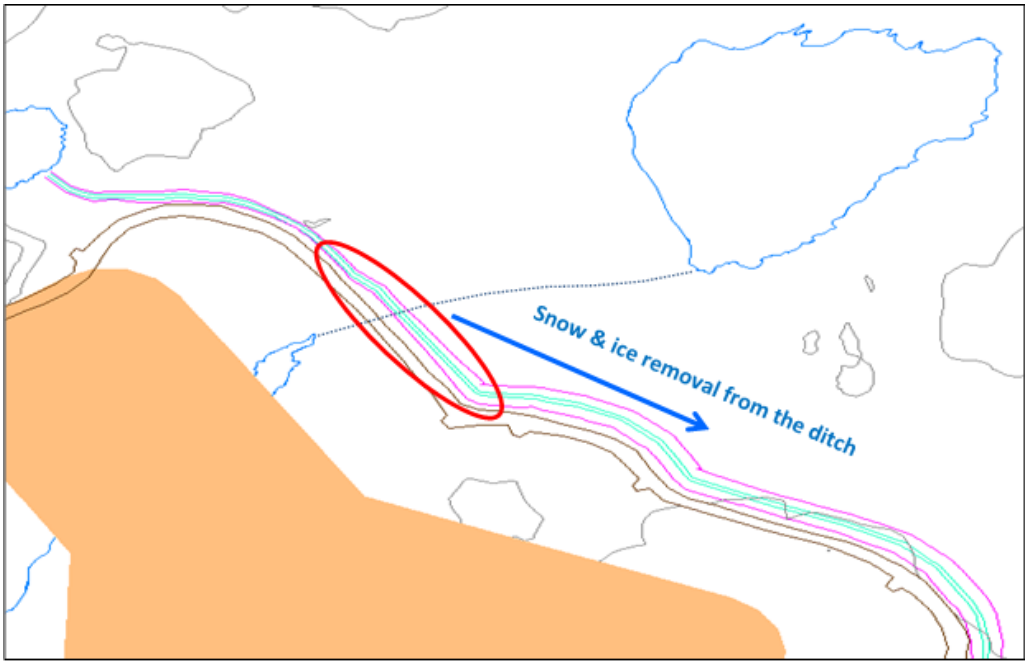


Figure 2-7: View of the north low area where a snow build up retained water in spring 2013

2.3.1.5 East Diversion ditch outlet to NP-2 Lake

This area of the East Diversion ditch, seen in Figure 2-8 and Figure 2-3 #5, is critical as it acts as the outflow of the North part of the East Diversion ditch into NP-2 Lake. This outlet must be cleared of obstructions – snow and ice in early May to promote drainage through the ditch and into NP-2 Lake. The presence of ice blocks will be mitigated using the steam machine to melt away the obstruction. Daily inspections will commence in early May and sample monitoring will be conducted monthly during open water in accordance with the Water License (location ST-5). Sampling frequency of ST-5 may be increased if TSS results are near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated. Turbidity barriers have been installed at the ditch outlet into NP-2 in 2013 to mitigate elevated TSS. If a discharge of TSS occurs, the Environmental Department will notify DFO.

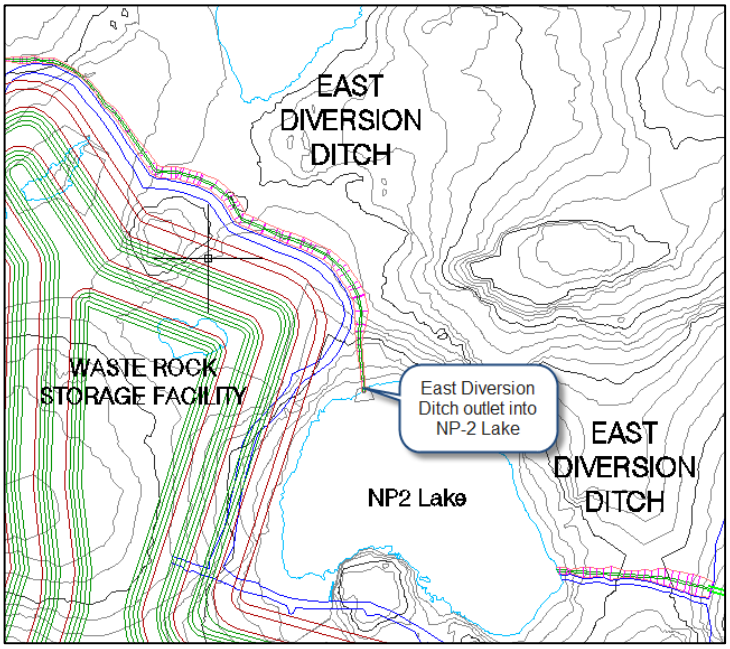


Figure 2-8: View of the East Diversion ditch outlet into NP-2 Lake

2.3.1.6 NP-2 Outlet and Vault Road Culvert

This area of the East Diversion ditch is critical as it acts as the outflow of NP-2 Lake through the Vault Road culvert (see Figure 2-3 #7). The culvert seen in Figure 2-9 connects the East Diversion ditch from Lake NP-2 to NP-1. Snow and ice must be removed from the area, including upstream at the exit of NP-2 Lake in early May to ensure that the outlet of NP-2 flows freely to NP-1 and ultimately to Dogleg Lake. Back up could cause upstream water raises in Lake NP-2 which could cause overflow into the RSF at ST-16. First, snow from the ditch between NP1 and the road (1) would be removed in early May. Next, any obstruction between the road and NP2 Lake (2) would be removed. If needed, the steam machine would be used to remove the ice and snow from inside the culvert (3) and ensure that any other ice obstructions were removed from the outlet of NP2 Lake (4) to allow free flow of melt water. Daily inspections will commence in early May and TSS sample monitoring will be conducted monthly. Sampling frequency may be increased if TSS results are near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated. A turbidity barrier (orange barrier #1) was installed in 2014 at the ditch outlet into NP-1 to mitigate the risk of elevated TSS (Figure 2-10). If a discharge of TSS occurs, the Environmental Department will notify DFO.

In June 2015, while conducting regular inspections as per the Freshet Action Plan, AEM staff observed elevated TSS in the water running under Vault Road (culvert) toward Lake NP-1. The flow was largely localized due to a large accumulation of snow in this area, significant snowmelt occurring due to spring freshet and recent heavy rain. After some additional melting of ice and snow it was clear that water with elevated TSS was flowing past the turbidity and silt barrier that

was in place from last year, onto the lake ice. A second turbidity barrier (yellow barrier #2) was installed just outside of the first barrier. Two additional barriers were also installed as a precautionary measure at the outlet of NP-1 (barrier #3) and at the inlet of Dogleg Lake (barrier #4) (Figure 2-11). The incident was of short duration and the turbidity barriers prevented migration of TSS to Dogleg Lake which is fish bearing. AEM also proceeded to raise the Vault road near NP-1 culverts (Figure 2-12). A different source of aggregate – NPAG from Vault was used (harder material) which will prevent an accumulation of fine material and will allow for water to runoff instead of accumulating or percolating through the road. For the next winter season there will be no additional snow from ploughing placed in this area.

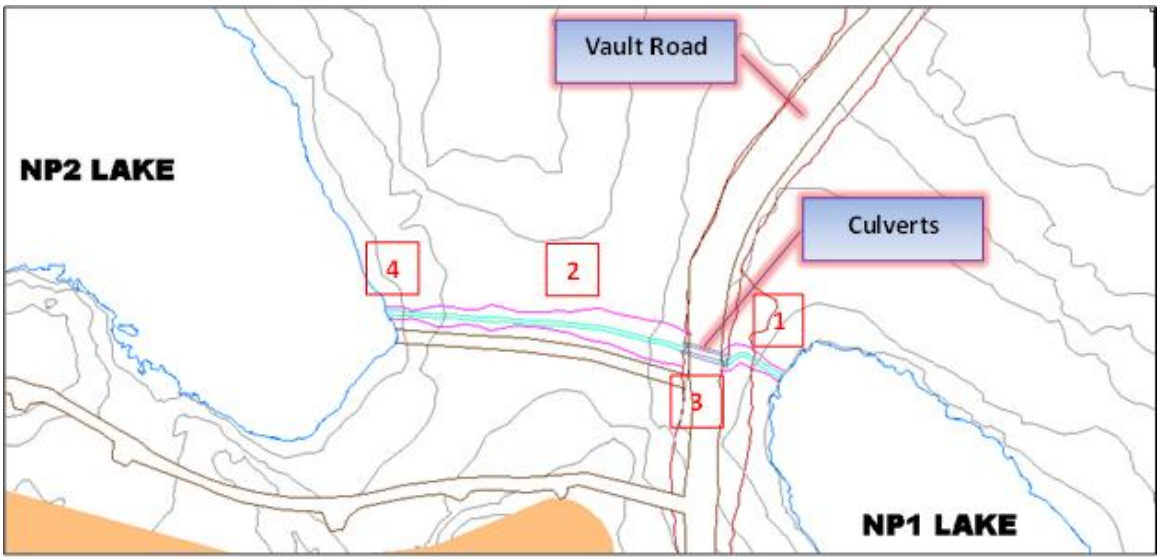


Figure 2-9: View of the diversion ditches at the Vault road area

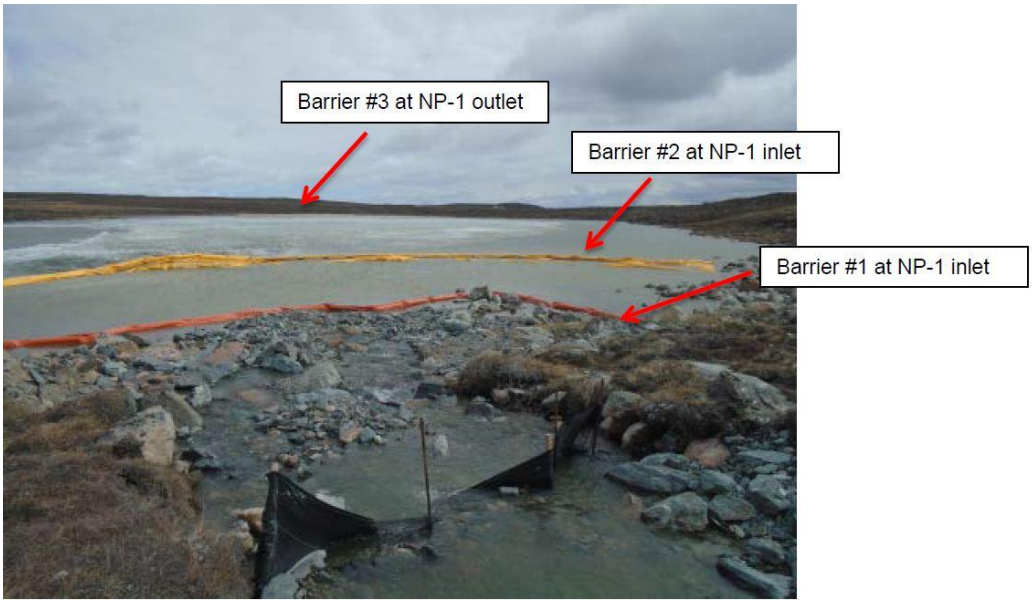


Figure 2-10:Turbidity barriers at inlet of NP1

Figure 2-11: Turbidity barriers at the inlet of Dogleg Lake

.

Figure 2-12: Vault Road repair

2.3.1.7 North Portion of NPAG Waste Rock Expansion

The northwestern area of the RSF, which consists entirely of NPAG material, extends towards the East Diversion ditch as shown in Figure 2-3 #6. Runoff from this area, while not anticipated to be contaminated could, if significant, discharge to NP-2 lake after crossing the tundra. A natural depression should capture most of the NPAG runoff. Daily inspections will be conducted by the Environmental Department. Sample monitoring will be undertaken when water is observed in order to determine water quality. Contaminated water must be kept from reaching NP-2 Lake. Ditching can be undertaken as a mitigation measure if required.

2.3.2 Saddle Dams

2.3.2.1 Saddle Dam 1

This dam, peripheral to the North Cell TSF, is critical to the normal operation of the North Cell TSF. Daily inspections starting mid-May will be required for Saddle Dam 1 (SD1) to ensure that water does not pool against the toe of the dike. A pumping station located along the toe of the dike was installed previously to mitigate the pooling of water at the toe. This pumping station must be operational once water is observed at the toe to pump the water to the TSF. The pumping system must be checked in early May to ensure proper operation. Monthly sampling will be conducted at this station (ST-S-2) during open water conditions in accordance with the Water License.

2.3.2.2 Saddle Dam 2

This dam, just South of SD1, is also critical to the normal operation of the North Cell TSF. Historically, this structure has not had any issues with water pooling at the toe, therefore monthly inspections starting mid-May will be required for Saddle Dam 2 (SD2) to ensure that water does not pool against the toe of the dike. If water is observed at the toe, a mitigation plan will be determined and implemented by the Geotechnical department.

2.4 VAULT ROAD CULVERT

The Vault road crosses over a connection between two water bodies, Turn Lake and Drill Trail Lake, at approximately km 2. A system of culverts was installed to allow flow to occur between the two waterbodies. Beginning in mid-May it will be important to complete daily inspections. In the case that excessive TSS is observed, samples will be taken and analyzed. In the case, where the TSS levels go beyond 30 mg/L, a report will be made to the DFO. Turbidity barriers will be installed as a mitigation measure if needed.

2.5 STORMWATER MANAGEMENT POND

The Stormwater Management Pond is a small shallow and fishless water body that can be seen in Figure 2-13 adjacent to Portage Pit. Treated sewage is discharged into this pond before being transferred to the active TSF. The quantity of water transferred each year is recorded. Weekly inspections will be undertaken to determine the commencement of pumping.

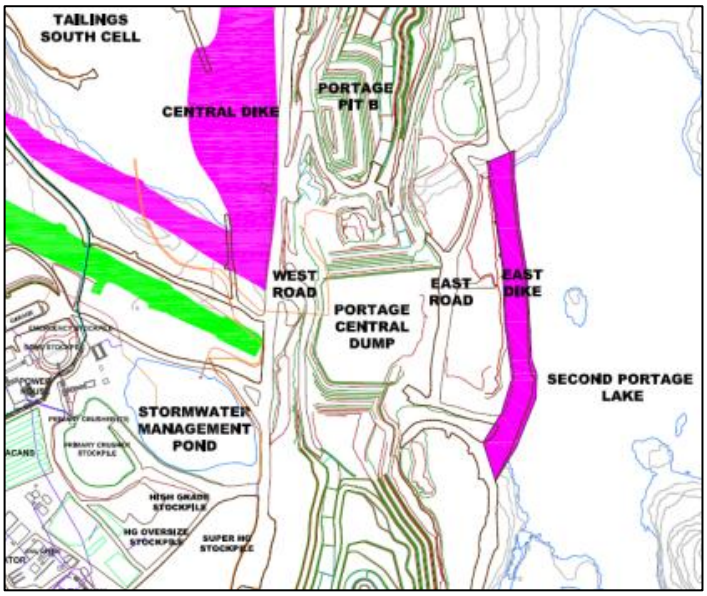


Figure 2-13: Portage Pit area with the Stormwater Management Pond

2.6 FUEL TANK FARMS

2.6.1 Meadowbank Tank Farm

Snow and ice accumulation within the fuel tank farm must be adequately managed to prevent overflow to the environment and/or damage to the fuel handing systems. The Site Service Department will advise the Environmental Department of their intent to pump the containment area once ice/snow begins to melt. Water samples will be taken in accordance with the Water License to ensure compliance prior to its release. A notice must be provided to the Inspector 10 days prior to this pumping activity. Once sample results have been obtained, the Environmental Department will advise the Site Service Department if pumping can begin. If sample results permit, the pumping may begin; to direct water to the tundra/ground in a way to prevent erosion. In the event that the water sample results do not meet discharge criteria the water can be pumped to the Stormwater Management Pond.

2.6.2 Baker Lake Tank Farms

Snow and ice accumulation within the fuel tank farms at Baker Lake must be adequately managed to prevent overflow to the environment and/or damage to the fuel handling systems. The Site Service Department will advise the Environmental Department of their intent to pump the containment area once ice/snow begins to melt. Water samples will be taken in accordance with the Water License to ensure compliance prior to its release. A notice must be provided to the Inspector 10 days prior to this pumping activity. Once sample results have been obtained, the Environmental Department will advise the Site Service Department if pumping can begin. If sample results permit, the pumping may begin; to direct water to the tundra but the flow rate shall be such to avoid erosion or damage to the tundra. **In the event that the water sample results do not meet discharge criteria the water cannot be pumped to the tundra.**

2.7 AWAR CULVERTS ON THE BAKER LAKE PORTION

Weekly inspections will be undertaken at all culverts along the AWAR to ensure that water during freshet is flowing freely and no erosion is occurring. If elevated TSS levels are observed sampling will occur and the results assessed. In addition snow and ice removal may be required to allow the water to flow as per design specifications.

2.8 MEADOWBANK ASSAY LAB

The Assay Lab needs to be advised of the extra sampling that will occur during the freshet period, well in advance. Consideration should be given to reducing the initial sampling after one month period if sample results are consistent or results indicate no elevated contaminant levels. The onsite laboratory, although not accredited, can provide indicative results quickly so that mitigation measures can be implemented in a timely manner.

3 INCIDENT RESPONSE

3.1 ST-16 SEEPAGE

In July 2013, it was noted that seepage from the Waste Rock Storage Facility (RSF) had migrated through a rockfill road at a seepage sump located on the north-east side of the RSF (see ST-16 on Figure 3-1). The seepage, which contained elevated copper, nickel, ammonia and cyanide entered NP-2 Lake. It was determined through investigation that the likely source of the contaminants was reclaim water from the North Cell TSF. This water migrated underneath the RSF through a former watercourse into the seepage sump area (ST-16). AEM took immediate measures to stop the seepage and implement corrective measures to prevent a recurrence. This included, keeping the sump area pumped to a low level, installation of an impermeable barrier (till plug) in the rockfill road, implementation of a comprehensive monitoring program and ensuring tailings deposition was enhanced in the North Cell to create beaches that would stop any water egress (this activity is continuous as it is part of AEM's Tailings Deposition Plan). A permanent pumping system was installed in 2014 in order to direct seepage back to the North Cell TSF. In addition, as mentioned previously (Section 2.3.1.6), snow will be removed from the ditches and culvert at the outlet of NP- 2 to NP-1 Lake to ensure freshet flows do not back up and overflow into the ST-16 seep location and that the north watershed non-contact runoff flows freely through to NP-1 Lake and further downstream (Dogleg Lake) Pumped volumes will be documented and daily inspections of the area will be undertaken. Please note that 2014 pump volumes are reportred in the AEM 2014 Annual Report within the Water Management Report and Plan (Section 3.1.9) and in Table 1 below.

Table 1: Water pumped from ST-16 Seepage back to TSF

	Volume (m^3)	
	2013	**2014**
January	0	0
February	0	0
March	0	0
April	0	0
May	0	14,591
June	0	9,294
July	2,091	3,810

August	2,900	3,386
September	1,364	1,088
October	227	0
November	0	0
December	0	0
Total	**6,582**	**32,169**

During the renewal process for the Meadowbank Type A Water License (2014 – 2015) the KIA requested additional monitoring related to this incident. The revised monitoring plan in NP-2 Lake as well as downstream lakes (NP-1, Dogleg and Second Portage Lakes) is attached in Schedule 1. A discussion and analysis of the 2014 monitoring results can be found in the AEM 2014 Annual Report (Section 8.1.4.2, pg 41 and Appendix G2). The water quality in NP-2 Lake has improved significantly and no impacts have been observed in the aforementioned downstream lakes.

As soon as the Lake and seep area are ice free the sample monitoring program will commence.

In the event that seepage water flows through the rockfill road reaching NP-2 Lake, the Environmental Department will notify authorities.

Also, in 2014, in accordance with the overall mitigation plan for this incident, tailings beaches were built along RF-1 and RF-2 before tailings deposition switched to the South Cell TSF on November 19 2014. Filters barriers were installed along RF-1 and RF-2 to prevent water egress from the North Cell (suspected source area). Coverplacement was installed in late 2014 and early 2015 along RF-2. Thermistors installed in 2013 indicate that freezeback is occurring along the seepage path. All the information collected in 2014 from the inspections, pumping, thermistors, and sampling results were compiled and submitted as progress reports to regulators. This report “Follow up AEM Report – Seepage Water From Waste Rock Storage Facility – Sample Location ST-16” can be found in Appendix G2 of the 2014 Annual report.

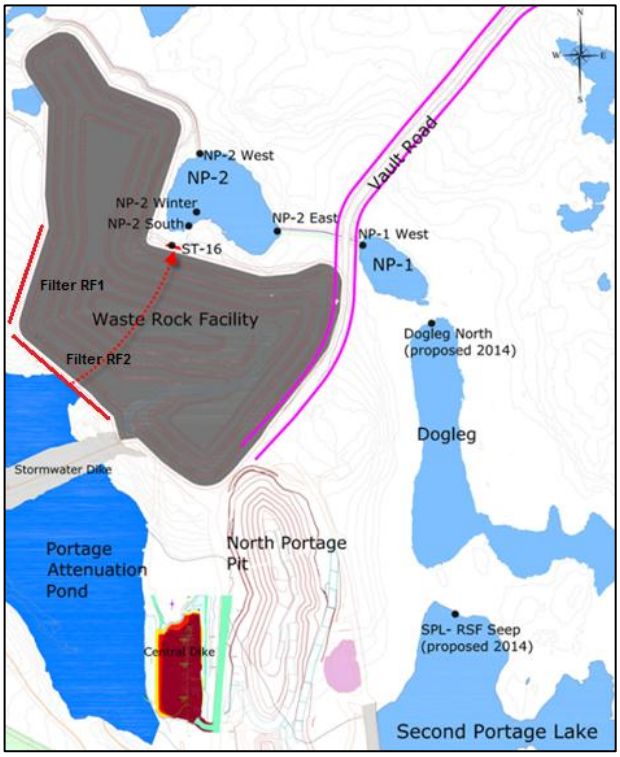


Figure 3-3-1: View of the RSF seepage observed at the ST-16 station with a red arrow representing the flow of the seepage. Red Lines represent installed filters and areas where tailings beaches were built up to minimize flow through.

3.2 MILL SEEPAGE

In November 2013, AEM observed seepage discharging at a location West of the site access road in front of the Assay Lab (see Figure 3-2). Initial sample results revealed elevated cyanide and copper which is indicative of mill processes. After an investigation, which included sampling, the source was determined to be seepage from several containment areas within the mill; the worst being the CIP tank overflow collection sump. Repairs to seal all the mill sumps and containment areas was completed in 2014 thus stopping the source of the seep. AEM hired Tetra Tech in December 2013 to propose a drilling delineation program and further steps necessary to control the seepage and prevent offsite migration to Third Portage Lake – see Figure 3-3 for the seep location. AEM completed the drilling program and based on the results constructed an interception/collection trench prior to the 2014 freshet (completed early May 2014).

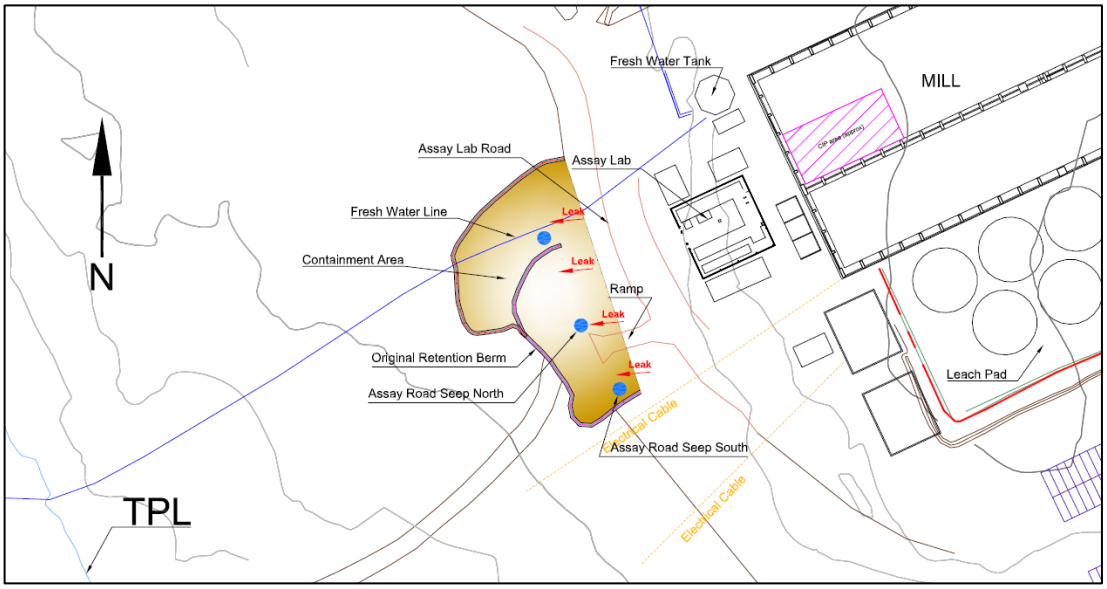


Figure 3-3-2: View of the mill seepage area and initial retention berm construction

The design of the trench can be seen in Figure 3-3. A pumping system was installed and all water collected is pumped back to the mill. Pumping begins as soon as water is evident and volumes are recorded monthly – See Table 2 below.

Table 2: Water pumped from Mill Seepage back to the mill

	Volume (m^3)	
	2013	**2014**
January	0	0
February	0	0
March	0	0
April	0	0
May	0	2,450
June	0	1,935
July	0	1,158
August	0	3,979

September	0	2,420
October	0	1,043
November	Ice	842
December	0	871
Total	**0**	**14,698**

In addition, a recovery/monitoring well, MW-203, located beside the Assay Lab upstream of the trench is continuously pumped back to the mill to intercept the seepage. 2014 pump volumes are reported in the AEM 2014 Annual Report within the Water Management Report and Plan and included in Table 2 above.

CN WAD (on site uncertified lab) levels in MW-203 have diminished significantly over the winter of 2015 as have the flow rates. This well will remain in operation.

As soon as the trench, monitoring wells and Third Portage Lake are unfrozen a comprehensive monitoring program will be implemented. This program is attached in Schedule 2. A complete discussion of the monitoring results for 2014 is included in AEM's 2014 Annual Report (Section 7, pgs 32-34). In summary, the results of monitoring indicate that the interception trench and initial containment berm were substantially successful in preventing any contaminants from reaching Third Portage Lake. The levels of contaminants decreased significantly during the monitoring period in the interception trench. The seepage appears to have been effectively contained and the source area has been repaired.

Daily inspections will be conducted of the pumping, collection systems and perimeter area and the pumped volumes will be recorded in 2015.

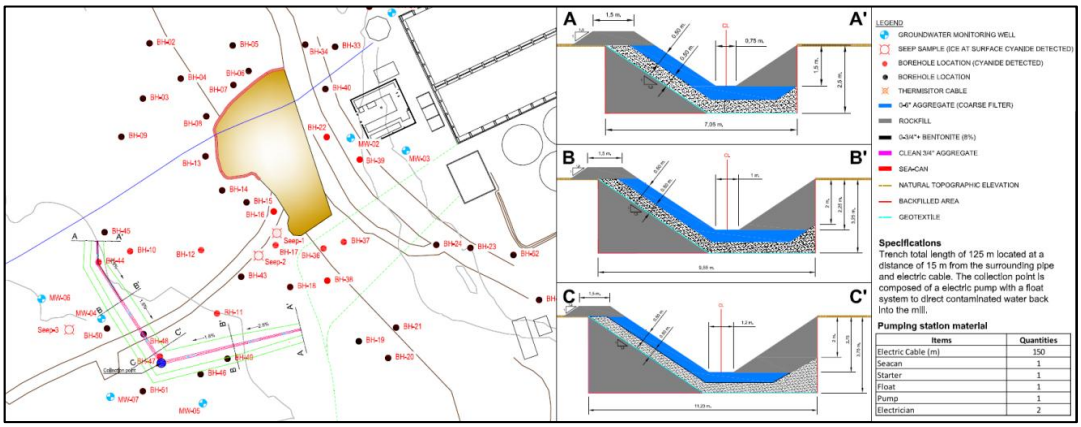


Figure 3-3: View of the mill seepage area and interception trench design

APPENDIX 1

2015 Freshet Action Plan Procedure

Section	Area of Concern	Role/Action	Responsbilities	Dates
2.1	**Mining Pits and Pit Walls**			
2.1	Mining Pit and Pit walls - General	1) Clean all ice, mud and snow on all permanent ramps, jump ramps, etc.	Mine Operations	Before May
		2) Check and service all pumps.	Dike/Dewatering and Maintenance	Before May
		3) Check that all piping systems starting from the different pits leading to the South Cell TSF are free of ice by validating pumping values (if pumping systems is active) and/or performing an air test in the pipe with a compressor.	Dike/Dewatering	Before May
2.1.1	**Goose Pit**			
2.1.1	Goose Pit	1) No further action in this area during the freshet period as mining is complete in Goose Pit. Water and/or ice will remain as part of the pit reflooding activity.	Engineering	N/A
2.1.2	**Portage Pit**			

2.1.2	Portage Pit	1) Runoff water accumulated in ponds GP-3, GP-4, GP-8 and Pond 8 will be pumped into Goose pit; 2) Runoff water accumulated in pit B will be pumped to the South Cell Tailings Storage Facility (TSF); 3) Runoff water accumulated in pit E will be pumped to the South Cell Tailings Storage Facility (TSF).	Geotech tech and Engineering	Before June
2.1.3	**Vault Pit**			
2.1.3 Vault Pit		1) The dewatering of Vault Lake was completed in 2014. During the freshet period water management consists of making sure all sumps are pumped to the Vault Attenuation Pond (former Pond D).	Mine Operations	May to Sept
		2) Set-up pumping from pond A & D to Vault Attenuation Pond (former Pond B & C) to prevent water from flowing into the Vault pit area.	Mine Operations	
		3) Notify Environmental Department before discharging any water to Wally Lake. **NOTE: Any discharge of contact water must be through the Diffuser.**	Water engineers and Engineering	Freshet/Summer 2015
		4) Inspect all piping and discharge diffuser	Dike/Dewatering	May
		5) Inspect and commission the WTP	Dike/Dewatering	May
2.2	**WASTE ROCK STORAGE FACILITY**			

2.2.1 Portage RSF Inspection	1) Weekly inspection around the RSF perimeter to identify any seepage.	Env. Department	May - as soon as freshet starts until freeze up
	2) If seepage observed notify Eng Department AND sample for Cn and Water License Parameters.	Env. Department	May - as soon as freshet starts until freeze up
2.2.2 Vault RSF Inspection	1) Weekly inspection around the RSF perimeter to identify any seepage.	Env. Department	May - as soon as freshet starts until freeze up
	2) If seepage observed notify Eng Department AND sample for Water License Parameters – ST-24.	Env. Department	May - as soon as freshet starts until freeze up
2.3 NORTH CELL TAILINGS STORAGE FACILITY			
2.3.1 North Cell Tailings Storage Facility (Diversion Ditch areas)			
2.3.1.1 AWAR Culvert - West Diversion ditch exit to TPL	1) Snow and/or ice must be removed with an excavator on each side of the culvert to allow water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
	2) If needed, steam to free any ice blockage.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20

	3) Before starting snow clearing operation, make sure the electrical cable location has been visually identified in the field.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
	4) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
	5) ST-6 sampling as per Water License and monthly inspection.	Env. Department	Monthly as soon as freshet starts (open water) and continue until freeze up.
	6) Increase frequency of ST-6 sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated, can use onsite assay lab for this (provide notice). Extra sample to Multilab if needed.	Env. Department	Depends on TSS result
	7) Have turbidity and silt barriers in place at TPL (2) and maintain.	Env. Department	May - before freshet starts and until water freezes up

		8) Report any discharge of TSS to DFO/NWB (grab > 30 mg/L).	Env. Department	May - as soon as freshet starts and until water freezes up
2.3.1.2	West Diversion Ditch elbow near SD1	1) Snow and/or ice must be removed with an excavator to allow water flow and prevent ponding upstream.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
		2) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
		3) Sample for TSS monthly (Multi Lab) and as needed for Turbidity - can use on site lab for TSS if necessary. Increase frequency of sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average).	Env. Department	May - until Freshet complete and after rain events
		4) If water exceeds Water License criteria (TSS - 30 mg/L (grab) and 15 mg/L (monthly average), contact Engineering to pump water to TSF and temporarily stop (dam) flow through ditch to prevent impact to TPL.	Env Dept/ Eng Dept if limits exceeded, Dikes/Dewatering if pumping needed	May - as soon as freshet start and until water freeze up
2.3.1.3	Northwest corner of North Cell TSF (West Diversion ditch)	1) Snow and/or ice must be removed with an excavator to allow water flow to enter West Diversion Ditch.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May

	2) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
	3) Sample if suspect Tailings water - analyse for Cn, Copper, Iron - can use onsite lab for CN WAD as indicator.	Env. Department	May - until Freshet complete and after rain events
	4) If tailings water present - water to be pumped back to TSF, contact engineering and dikes/dewatering.	Env. Dept Eng. Dept if limits exceeded, Dikes/Dewatering if pumping needed	May - as soon as freshet start and until water freeze up
	5) Tailings beach to be maintained in North TSF.	Water engineers to ensure tailings deposition	All year
2.3.1.4 East Diversion Ditch low point (E 638418, N7216815). **(area where former pipe was through road)**	1) Snow removal to allow free water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
	2) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events

2.3.1.5	East Diversion ditch outlet to NP-2 Lake	1) Snow and/or ice must be removed with an excavator on each side of the culvert to allow water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
		2) If needed, steam to free any ice blockage.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
		3) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
		4) ST-5 sampling as per Water License and monthly inspection (keep record).	Env. Department	Monthly as soon as freshet starts and until water freezes up
		5) Increase frequency of ST-5 sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated, can use on site assay lab for this (provide notice). Extra samples to Multi lab if necessary.	Env. Department	Depends on TSS result
		6) Install turbidity barriers in NP-2, if needed, and maintain.	Env. Department	May - before freshet starts and until freeze up or water clears

		7)	Report any discharge of TSS to DFO/NWB (grab > 30 mg/L).	Env. Department	May - as soon as freshet starts and until water freezes up
2.3.1.6	East Diversion Ditch - NP2 Oulet and Vault Road culvert.	1)	Snow and/or ice must be removed with an excavator on each side of the culvert and upstream at the exit of NP-2 Lake to allow water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
		2)	If needed, steam culvert to free any ice/snow blockage.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
		3)	Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
		4)	Install turbidity barriers in NP-1, if needed, and maintain - see # 5 below.	Env. Department	May - before freshet starts and until freeze - up
		5)	Sample for TSS monthly (Multi Lab) and as needed for Turbidity. Increase frequency of sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average) - use on site assay lab as this location is not regulated. Multi Lab to verify levels >30 mg/l - install turbidity barrier for elevated levels	Env. Department	May - until Freshet complete and after rain events

2.3.1.7	North portion of NPAG Waste Rock Expansion	1) Daily inspection - keep record	Env. Department	May until runoff complete
		2) Sample for ST-S-XX and ST-16 metals when water observed; sample upstream (background)in diversion ditch for same parameters and compare results (rush analysis). If results indicate potential for impact, ie results are > background, meet with engineering and determine necessity of ditching	Env. Dept + Eng Dept assistance if ditches needed	May until runoff complete
		3) Prevent **contaminated** contact water from reaching NP-2.	Env. Department	May until runoff complete
2.3.2	**Saddle Dams**			
2.3.2.1	Saddle Dam 1	1) Inspect pumping system	Dikes/Dewatering	Early May
		2) Daily inspection - keep record	Eng Dept and Dikes/Dewatering	May and until water freezes
		3) Start pumping to TSF when water observed. Keep volume pumped out.	Eng Dept and Dikes/Dewatering	After May and until water freezes
		4) ST-S-2 sampling as per Water License.	Env. Department	Monthly as soon as freshet starts and until water freezes

2.3.2.2	Saddle Dam 2	1) Monthly Inspection - keep record.	Geotech engineer and Engineering	May until water freezes
2.4	**VAULT ROAD CULVERT**			
2.4	Vault road culvert from Turn Lake to Drill Trail Lake (~km 2 on Vault road)	1) Daily inspection - keep record	Env. Department	May - until Freshet complete and after rain events
		2) Install turbidity barriers, if needed, and maintain	Env. Department	May - until freshet complete and after rain events
		3) Sample monitoring for TSS, if excess turbidity observed - use onsite assay lab and Multi Lab to verify levels >30 mg/l.	Env. Department	May - until freshet complete and after rain events
		4) Report any discharge of TSS to Drill Tail to DFO (grab > 30 mg/L).	Env. Department	May - until freshet complete and after rain events
2.5	**STORMWATER MANAGEMENT POND**			
2.5	Stormwater Management Pond	1) Pump Stormwater to applicable TSF in Spring/Fall - pumped volume must be kept.	Site Services and Dike/Dewatering	When required in Spring and/or Fall

2.6 FUEL TANK FARMS			
2.6.1 Meadowbank Tank Farm	1) Site Service to advise Env Dept in advance of intent to pump once ice melts in containment area	Sites Servies and Env. Department	Probably mid-June and September
	2) Sample water in accordance with Water License to ensure compliance with limits prior to release.	Env. Department	Probably mid-June and September
	3) Provide notice to Inspector 10 days prior to pumping.	Env. Department	Probably mid-June and September
	4) Advise Site Services if pumping can begin based on sample results.	Env. Department	Probably mid-June and September
	5) Pump to tundra/ground or Stormwater Mgt Pond (note pumping to Stormwater Mgt Pond does not requi:re compliance with limits - at Meadowbank only). **NOTE: The water cannot be pumped out to the tundra if it does not meet the Water License criteria.**	Site Services	Probably mid-June and September
2.6.2 Baker Lake Tank Farms	1) Site Service to advise Env Dept in advance of intent to pump once ice melts in containment area.	Sites Servies and Env. Department	Probably mid-June and

			September
	2) Sample water in accordance with Water License to ensure compliance with limits prior to release.	Env. Department	Probably mid-June and September
	3) Provide notice to Inspector 10 days prior to pumping.	Env. Department	Probably mid-June and September
	4) Advise Site Services if pumping can begin based on sample results.	Env. Department	Probably mid-June and September
	5) Once approval given by Env Dept, Site Services can pump to tundra but must avoid erosion during pumping, ie., low flow, the volume must also be determined by Site Services personnel **NOTE: The water cannot be pumped out to the tundra if it does not meet the Water License criteria.**	Site Services	Probably mid-June and September
2.7	**AWAR CULVERTS ON THE BAKER LAKE PORTION**		
2.7 AWAR Culverts on the Baker Lake Portion	1) Weekly inspection of culverts along AWAR to Baker Lake.	Env. Department	May 2015

		1) Sample for TSS and Turbidity if elevated TSS observed.	Env. Department	May - until freeze up
		2) Notify Site Services if severe erosion/scouring observed - for repair action.	Env. Department	May - until freeze up
		3) Install turbidity barriers if required.	Env. Department	May - until freeze up
2.8	**ASSAY LAB**			
2.8	Meadowbank Assay Lab	1) The Assay Lab needs to be advised of the extra sampling that will occur well in advance of the freshet.	Env. Department	May 2015
		2) Consideration should be given to reducing the initial sampling after an initial one month period. If we are managing the water as planned (i.e. on site) there is no need to require extra sampling.	Env. Department	May 2015
3.0	**INCIDENT RESPONSE**			
3.1	**ST-16 Seepage**			
3.1	ST-16 Seepage	1) Check Piping from pump to discharge area at North Cell TSF.	Engineering and Dikes/Dewatering	Early May

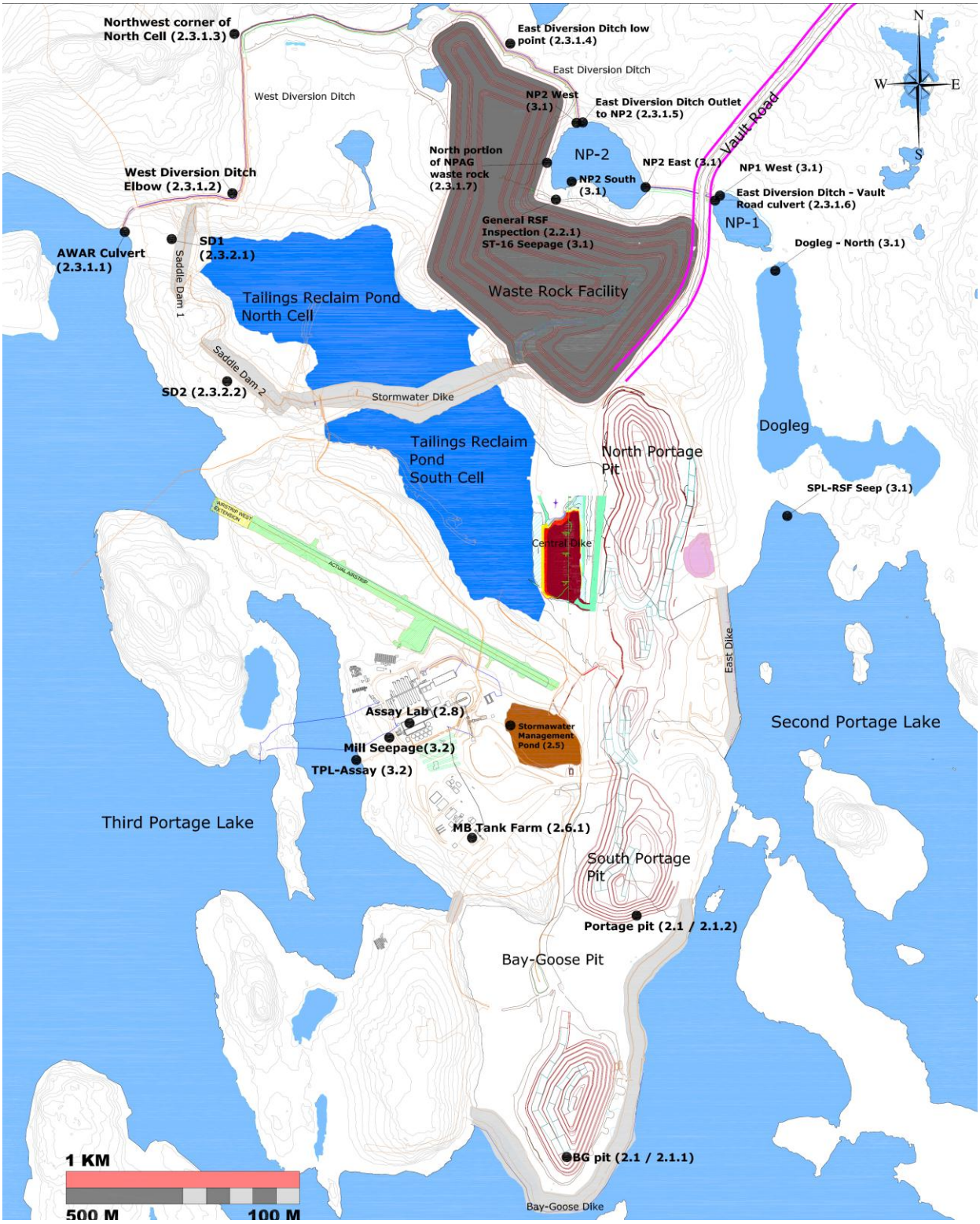
2) If the snow accumulation is judged to be too great, then snow must be removed.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
3) Daily inspection - keep record.	Env. Dept, Eng Dept and Dikes/Dewatering	May - as soon as freshet starts until freeze up
4) Notify Eng. Dept and Dikes/Dewatering when water present and pumping can start. **Water level to be maintained, as a minimum, below the till plug elevation. Water should not pond against the Till plug for extended time periods - ie < 2 - 3 hours. For emergencies the mine water trucks can be requested. Start pumping.**	Env. Department	May/early June - as soon as free water present and ice has melted until freeze up
5) Water sampling program starts when water present in accordance with attached Schedule 1.	Env. Department	May/early June - as soon as water present until freeze up
6) Any seepage through rockfill road to NP-2 must be reported to Env Dept and authorities.	Env. Dept, Eng Dept and Dikes/Dewatering	May/early June - as soon as water is present until freeze up
7) Thermistor Monitoring.	Env. Department	Ongoing throughout the year

		8) Submit progress/update report to regulators.	Env. Department	Annual Report2015
3.2	**Mill Seepage**			
3.2	Mill Seepage	1) Pump water from the trench to the mill - volumes documented.	Env. Dept with assistance from Site Services	Start May/early June when water present until freeze-up
		2) Daily inspection of pumping, collection systems, bermed areas and perimeter area – keep record. **For emegencies the mine water trucks can be requested.**	Env. Department	Start May/early June when water present until freeze-up
		3) Monitoring Program – in accordance with attached Schedule 2, commences when water present and ice has melted.	Env. Department	May/early June as soon as water present until water freeze

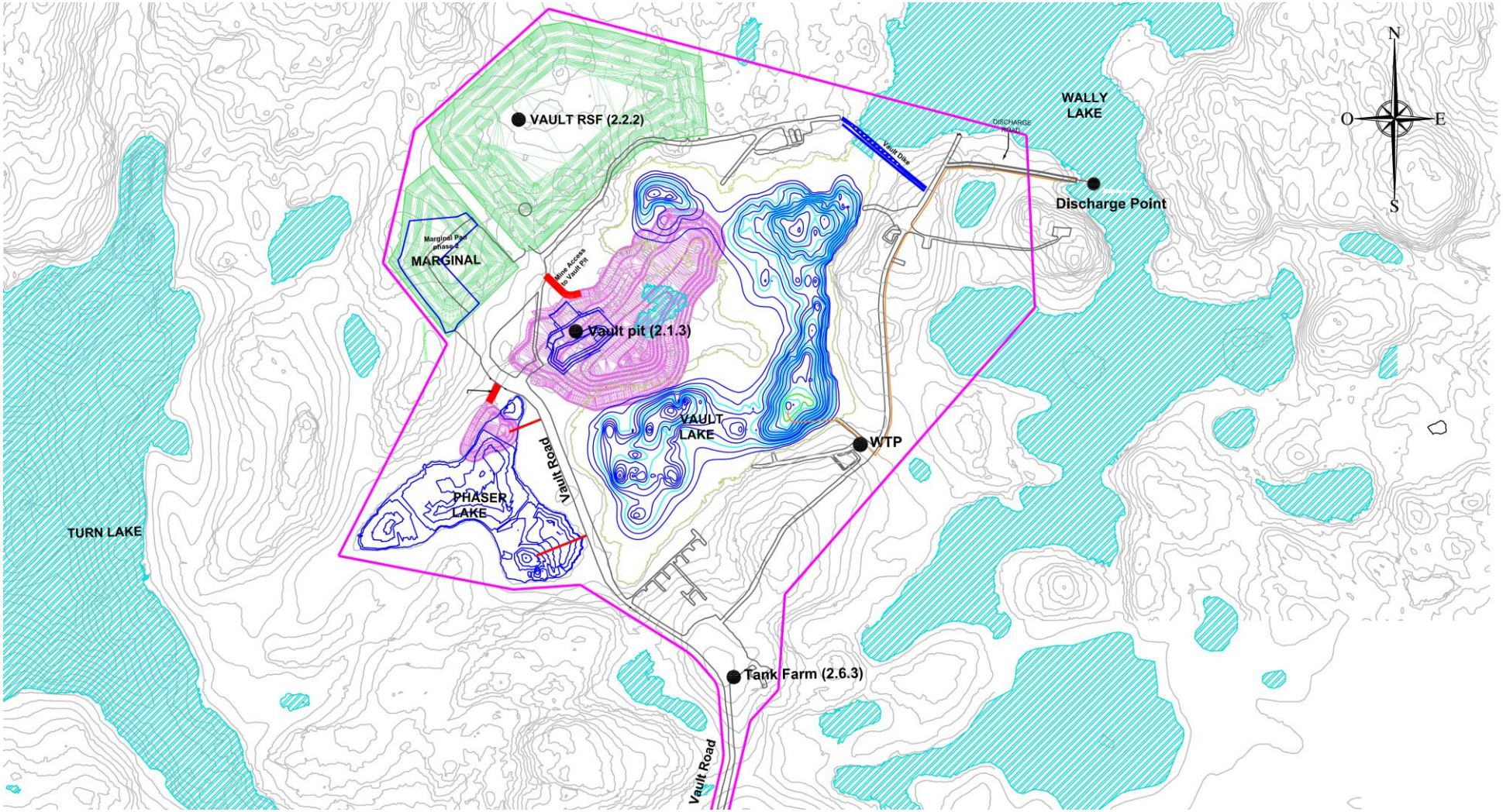
APPENDIX 2

2014 Monitoring Locations and Areas of Concern for the Freshet Action and Incident Response Plan

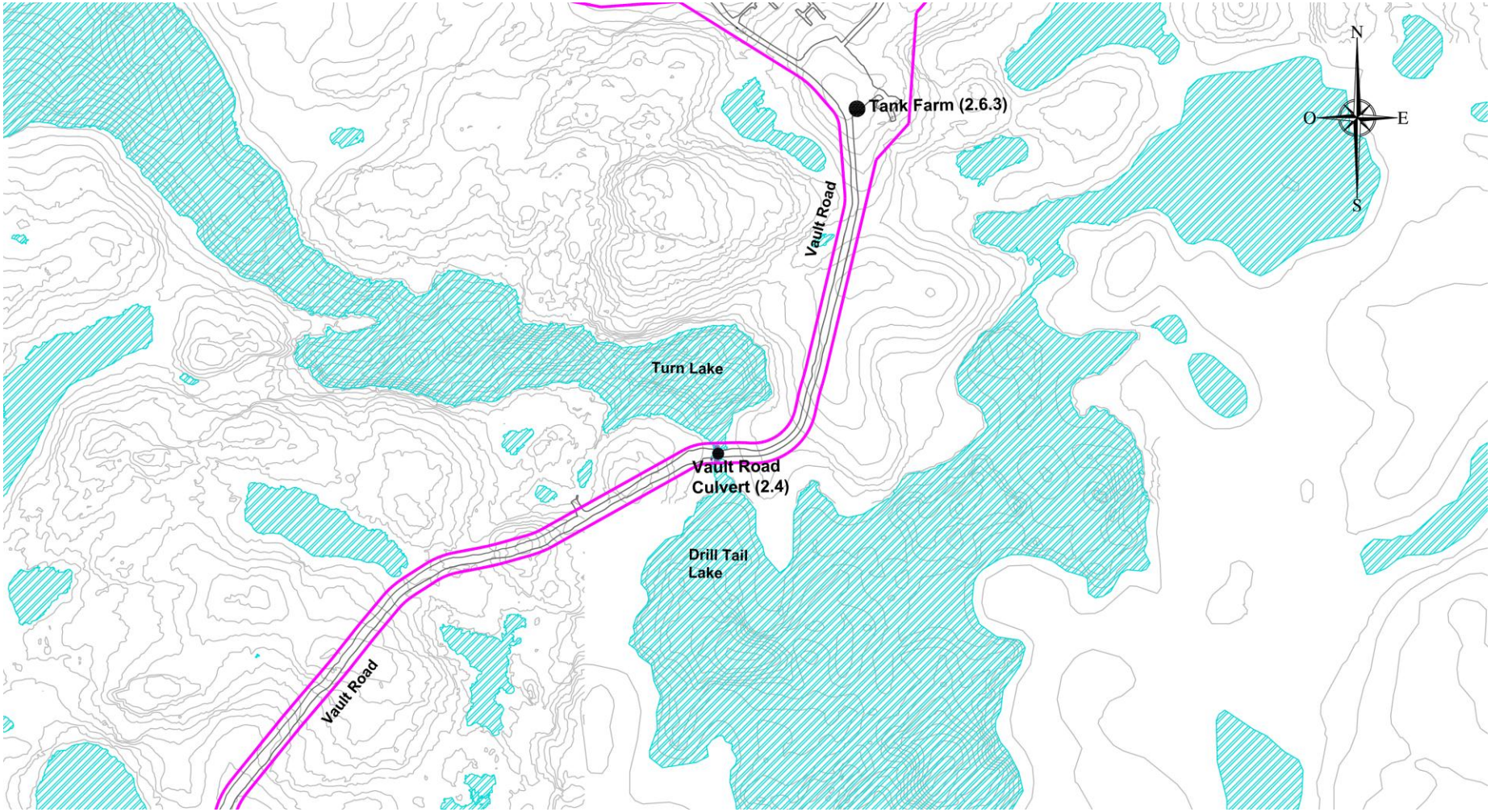
Meadowbank Areas of Concern and Monitoring Locations


Northwest corner of North Cell (2.3.1.3)
East Diversion Ditch low point (2.3.1.4)
East Diversion Ditch
West Diversion Ditch
NP2 West (3.1)
East Diversion Ditch Outlet to NP2 (2.3.1.5)
Vault Road
N
W
E
S
North portion of NPAG waste rock (2.3.1.7)
NP-2
NP2 East (3.1)
NP1 West (3.1)
West Diversion Ditch Elbow (2.3.1.2)
NP2 South (3.1)
East Diversion Ditch - Vault Road culvert (2.3.1.6)
General RSF Inspection (2.2.1)
ST-16 Seepage (3.1)
NP-1
AWAR Culvert (2.3.1.1)
SD1 (2.3.2.1)
Saddle Dam 1
Dogleg - North (3.1)
Tailings Reclaim Pond North Cell
Waste Rock Facility
Saddle Dam 2
SD2 (2.3.2.2)
Stormwater Dike
Tailings Reclaim Pond South Cell
North Portage Pit
Dogleg
SPL-RSF Seep (3.1)
Central Dike
East Dike
Assay Lab (2.8)
Second Portage Lake
Stormawater Management Pond (2.5)
Mill Seepage(3.2)
TPL-Assay (3.2)
Third Portage Lake
MB Tank Farm (2.6.1)
South Portage Pit
Portage pit (2.1 / 2.1.2)
Bay-Goose Pit
BG pit (2.1 / 2.1.1)
Bay-Goose Dike
1 KM
500 M
100 M

Vault areas of concern


VAULT RSF (2.2.2)
WALLY LAKE
Vault Dike
DISCHARGE PIPELINE
Discharge Point
N
O
E
S
Marginal Pad phase 2
MARGINAL
Mine Access to Vault Pit
Vault pit (2.1.3)
VAULT LAKE
WTP
Vault Road
PHASER LAKE
TURN LAKE
Tank Farm (2.6.3)
Vault Road

Vault Road areas of concern


Tank Farm (2.6.3)
Vault Road
Turn Lake
Vault Road
Culvert (2.4)
Drill Tail
Lake
Vault Road
N
O
E
S

SCHEDULE 1

ST-16 Seepage Monitoring Program

ST-16 Seepage Monitoring Program (May/early June - as soon as water present until freeze up)			
Parameters	**Laboratory**	**Station**	**Frequency**
pH, Conductivity, Turbidity, Colour, Hardness, Bromide, Thiosulfate, Fluoride, Thiocyanate, Alcalinity, Ammonia-nitrogen, Total Ammonia, Nitrite, Nitrate, TDS, Chloride, Sulfate, Ortho-Phosphate, TOC, TSS, Dissolved Oxygen (DO), Total Kjeldahl Nitrogen (TKN), Mg, K, Dissolved and total metal: Al, Ag, As, Sb, Ba, Be, B, Cd, Cu, Cr, Co, Fe, Pb, Li, Mn, Hg, Mo, Ni,Se, Sr, Tl, Sn, Ti, U, V, Zn, and Chlorophyll A (Lake site), CN tot / CN Wad, Total P	Multilab	ST-16 NP-2 South NP-2 West NP-2 East NP-1 Dogleg SPL	Monthly
CN Free	SGS	ST-16 NP-2 South NP-2 West NP-2 East NP-1 Dogleg SPL	Monthly
CN Wad	Assay Lab	ST-16 NP-2 South	2x/week initially and 1x/week after 1 month

SCHEDULE 2

Mill Seepage Monitoring Program

Mill Seepage Monitoring Program (May/early June - as soon as water present until freeze up)			
Parameters	**Laboratory**	**Station**	**Frequency**
CN Total Cu Fe	Multilab	Trench Original Sump MW 4-5-6-7-8	Monthly
CN Free	SGS	Trench Original Sump MW 4-5-6-7-8 TPL-Assay	Monthly
pH, Conductivity, Turbidity, Colour, Hardness, Bromide, Thiosulfate, Fluoride, Thiocyanate, Alcalinity, Ammonia-nitrogen, Total Ammonia, Nitrite, Nitrate, TDS, Chloride, Sulfate, Ortho-Phosphate, TOC, TSS, Dissolved Oxygen (DO), Total Kjeldahl Nitrogen (TKN), Mg, K, Dissolved and total metal: Al, Ag, As, Sb, Ba, Be, B, Cd, Cu, Cr, Co, Fe, Pb, Li, Mn, Hg, Mo, Ni,Se, Sr, Tl, Sn, Ti, U, V, Zn, and Chlorophyll A (Lake site), CN tot / CN Wad, Total P	Multilab	TPL-Assay	Monthly
CN WAD	Assay Lab	Trench Original sump MW 2-3-8-201-202-203	2x/week initially and 1x/week after 1 month

APPENDIX E – 2014 AMMONIA MANAGEMENT PLAN

AGNICO EAGLE

MEADOWBANK GOLD MINE

AMMONIA MANAGEMENT PLAN

MARCH 2015

EXECUTIVE SUMMARY

AEM is committed to continue the sample monitoring program, which includes monitoring for Ammonia in all mine pit sumps, seeps, etc., in accordance with the site Water License, implement a comprehensive, regular inspection program related to explosives management within the mine pits, conduct regular inspections at the explosives manufacturing facility (Dyno Nobel) to ensure all explosive products are stored in locked, sealed containers prior to use and continue to perform continuous review of analysis results such that mitigation measures can be implemented when increasing trends of ammonia are determined. It is important to note that AEM has not exceeded any ammonia discharge criteria (Water License or MMER) to date.

This technical note provides guidance for monitoring ammonia levels at the mine site, as part of the conditions applying to waste disposal and management listed in the water license (NWB 2008) for this water quality parameter.

DOCUMENT CONTROL

Revision				Pages Revised	Remarks
#	Prep.	Rev.	Date		
00	SNC		February 2013	All	
01	AEM	1	March 2015	13	Table 1 update
				16	Add section 6

Prepared By: _____

Environmental Department

Approved by:

_____

Environmental Department

TABLE OF CONTENTS

1 INTRODUCTION 5

2 EXPLOSIVE MANAGEMENT AND BLASTING PRACTICES 7
2.1 Site description 7
2.1.1 Explosive Storage 7
2.1.2 Roads 7
2.1.3 Pits 7
2.2 AMMONIA PATHWAYS 7
2.3 EXPLOSIVES AND BLASTING 8
2.3.1 Explosive Products 8
2.3.2 Procedures and Practices 9
2.4 MONITORING 9

3 MILL EFFLUENT 11
3.1 SITE DESCRIPTION 11
3.2 AMMONIA PATHWAY 11
3.3 MONITORING 11

4 WATER MANAGEMENT 13

5 REPORTING 15

6 INSPECTION 16

7 REVIEW OF AMMONIA MANAGEMENT PLAN 17

8 REFERENCES 18

List of Appendix

APPENDIX 1 ENVIRONMENT FIELD STATIONS – MINE SITE VIEW

APPENDIX 2 SPILL CONTROL AND LOADING PROCEDURE PLAN

APPENDIX 3 DYNO NOBEL EMERGENCY RESPONSE PLAN – MAGAZINE, PLANT AND WORK SITE

APPENDIX 4 MSDS FOR BULK EMULATION AND PRESPLIT

APPENDIX 5 EMULSION PLAN / BLAST AREA INSPECTION SHEET

1 INTRODUCTION

The previous version of the Water Management Plan (WMP) for the Mine was presented in 2009 (Doc. 833), updating the first edition of the WMP, support document (Doc. 500) to the Type-A Water License Application for the Mine. The WMP was then updated in 2011 (Doc. 1270). This technical note was produced as an appendix to the 2012 WMP update and covers the ammonia management plan for the mine site. The Ammonia Management Plan is being updated at this time in response to concerns raised during the Water License renewal process (January, 2015 - NWB Technical Meetings – Baker Lake). These concerns were in regard to ammonia loading to mining infrastructure, i.e., the Tailings Storage Facility (TSF) from cyanidation, the use and management of exposives and sewage management. In addition, there was a request for loading calculations of ammonia to the receiving environment. It should be noted that there is no further discharge of mine contact water to Third Portage Lake from the Portage Attenuation Pond. The onsite CREMP program takes into account the overall ammonia levels in Third Portage Lake and to date AEM has not reached any level of concern (no trigger levels have been reached for ammonia).

As a result of these concerns AEM is committed to continue the sample monitoring program, which includes monitoring for Ammonia in all mine pit sumps, seeps, etc., in accordance with the site Water License, implement a comprehensive, regular inspection program related to explosives management within the mine pits, conduct regular inspections at the explosives manufacturing facility (Dyno Nobel) to ensure all explosive products are stored in locked, sealed containers prior to use and continue to perform continuous review of analysis results such that mitigation measures can be implemented when increasing trends of ammonia are determined. It is important to note that AEM has not exceeded any ammonia discharge criteria (Water License or MMER) to date.

This technical note provides guidance for monitoring ammonia levels at the mine site, as part of the conditions applying to waste disposal and management listed in the water license (NWB 2008) for this water quality parameter.

Ammonia is a naturally occurring nitrogen compound found in the environment. However, there are two sources at the mine site that can contribute to the mobilization of ammonia in the groundwater or surface runoff:

1. Blasting of ammonium-nitrate (AN) explosives is typically the primary source of ammonia in areas of mining operations. AN readily absorbs water and dissolves easily, thereby mobilizing ammonia in either groundwater or surface runoff.

2. In gold mine operations using a cyanidation process to extract the gold from the ore, the cyanide in solution is oxidized to cyanate (CNO^-) using a sulfur dioxide (SO_2) air process before discharge to the Tailings Storage Facility. The cyanate can then hydrolyze to ammonia in the Tailings Storage Facility reclaim pond.

Ammonia dissolved in water exists in equilibrium of interchanging un-ionized (NH_3) and ionized (NH_4^+) forms. The equilibrium is influenced by pH, temperature, and ionic strength (salinity) where the amount of un-ionized ammonia is favoured as the pH becomes more basic or as the water temperature or salinity increases. Un-ionized ammonia can readily pass across the gill

surface and enter into the bloodstream of fish, while ionized ammonia passes with greater difficulty. Once inside the fish, both forms of ammonia can cause toxic effects (CCME, 2010). Furthermore, it should be noted that ammonia oxidizes to nitrite (NO_2) and nitrate (NO_3), the former being particularly toxic to fish and humans. Both nitrite and nitrate are regulated by the CMME for the Protection of Aquatic Life.

This ammonia management plan (AMP) proposes monitoring of blasting practices for the assessment of explosive quantity used and blast performance, and monitoring of water quality to determine ammonia levels in waters within the mine site. The monitoring results can be used to review and adjust blasting practices or water management if ammonia levels need to be reduced.

In addition to ammonia, monitoring of nitrate and nitrite is also considered in the AMP, as both water quality parameters are signature compounds of AN explosives. NO_3 is listed with a discharge level threshold in the conditions applying to waste disposal and management in the water license (NWB 2008).

2 EXPLOSIVE MANAGEMENT AND BLASTING PRACTICES

2.1 SITE DESCRIPTION

2.1.1 Explosive Storage

Storage of explosive products will be located at the mine site emulsion plant area. The explosive products arrive by barge at the Baker Lake marshalling area. They are then transported by ground to the emulsion plant located at the Meadowbank mine site.

The emulsion plant area is located approximately four kilometers north of the mine plant and camp site, and is accessible from the All Weather Access Road (AWAR). This area consists of an emulsion plant for the preparation of bulk emulsion explosives, two buildings for the storage of AN, and four explosive magazines along the access road to the plant.

Explosive products at the storage facilities are packed in sea containers, which limit the possibility of spillage. The products are only removed from these containers prior to use at the mine site emulsion plant area. Surface areas are graded to collect water runoff within the storage facilities.

2.1.2 Roads

The AWAR is a restricted access road constructed and operated by AEM for ground transportation between the Meadowbank mine site and Baker Lake. This road is used to transport explosive products from the Baker Lake site facilities to the emulsion plant area at the mine site. In preparation for blasting operations, explosive products are transported from the emulsion plant area to the appropriate blasting locations via local site roads and the Vault Haul Road.

Spillage control protocols, procedures and handling of spilled material, and explosive management for both storage and transport have been established by Dyno Nobel Inc. (Dyno) and are provided in Appendix 2. Explosive products and spills on the AWAR are also referenced in the Meadowbank Spill Contingency Plan.

2.1.3 Pits

The development sequence of the mine site is provided in Section 3 of the 2014 Mine Waste Rock and Tailings Management Plan. Explosives are used for the excavation of waste rock and mining of the ore at the Portage, Goose and Vault pits.

2.2 AMMONIA PATHWAYS

Ammonia not fully detonated within the in-pit blasting operations mobilizes through several pathways on the mine site. Water from drainage runoff is the primary mechanism of mobilization for ammonia residuals remaining within the pits. This water is collected at pit sumps and then has been pumped to the Portage Attenuation Pond, which became the South Cell TSF Reclaim Pond on November 2014. Blasting residuals are also expected to be attached to waste rock and ore materials, which are transported from the open pits to their respective storage and processing facilities. Residuals from waste rock may be washed off by precipitation and be ultimately

conveyed to the South Cell TSF (former Attenuation Pond), or the Vault Attenuation Pond. Residuals from the ore may be carried in the tailings to the Tailings Storage Facility. All of these pathways (mine sumps, Vault Attenuation, South Cell TSF are monitored in accordance with the Water License).

2.3 EXPLOSIVES AND BLASTING

Based on experience at other open pit mines in the Canadian Arctic, the largest potential source of ammonia in mine water will be from explosive residue from blasting. Depending on the wetness of the site, water may leach explosives from blastholes prior to the blast. Other forms of ammonia released from AN are explosives flowing into cracks and fissures in the rock and not detonating, or leading to an incomplete detonation of the explosive column and misfired blastholes. An AN based emulsion is used as a blasting agent at the Meadowbank site. This material is designed to repel water thus minimizing the potential for ammonia to impact mine water.

Blasting operations on site include monitoring of explosive quantities and blast design, procedures and practices. Combined with water monitoring, the compilation of these data is used to assess blasting performance. The results of this assessment are used to adjust blasting practices as needed to:

a) Optimize the use of explosives; and

b) Increase the completion and efficiency of explosive detonations.

Any modifications to blast design are intended to decrease the amount of ammonia that may become available for mobilization in mine water.

This section summarizes the explosive products and blasting design parameters, procedures and practices employed at Meadowbank. Associated monitoring is also discussed.

2.3.1 Explosive Products

Explosive products used at the mine site include bulk explosives (bulk emulsion), packaged explosives, cast boosters, detonating cords, non-electric delay detonators and non-electric lead lines. The material safety data sheets (MSDS) for these products are provided in Appendix 4. Of these products, the greatest potential for water contamination comes from the bulk explosives. Presently, Meadowbank uses emulsion as the primary bulk explosive for its blasting operations.

Bulk emulsions typically contain some or all of the following components:

- Ammonium, sodium and/or calcium nitrate;
- Fuel and/or mineral oil;
- Methylamine nitrate;
- Emulsifiers; and
- Ethylene glycol.

Although bulk emulsions are water resistant, contaminants can be leached from the product if it is left in contact with standing or flowing water for extended periods of time. The performance of the explosive, and hence the potential for post-blast contaminations, deteriorates with the length of time that the emulsion remains in the blasthole after it has been loaded (i.e., sleep time). Blast

procedures currently in use are designed to minimize sleep time so that standing or flowing water is not in contact with the bulk emulsion for extended periods of time.

2.3.2 Procedures and Practices

Quality control procedures are in place to verify AN content in bulk explosives. Quality control procedures for the emulsion occur at the plant and density tests are done at the blast site (on the trucks). Loading procedures specify that blastholes be loaded with emulsion from the bottom of the blastholes to provide a continuous explosive column. Details on the explosive quality control and loading procedures have been established by Dyno and are provided in Appendix 2.

The primary factors that may reduce the amount of ammonia available for mobilization in mine water are:

- Explosives handling
- Completeness of detonation

Bulk emulsion spillage during blasthole loading could (as bulk emulsion is resistant to water) be a source of ammonia that could be carried by water collected in the pits. Spillage control protocols, procedures and handling of spilled material, and explosive management for storage and transport, as well as the emergency response plan, have been established by Dyno and are provided in Appendix 2 and 3.

Incomplete detonation results in higher ammonia residue on the blasted rock. Evidence of incomplete detonation is often observed as an orange fume after a blast and sometimes an orange pigment on the blasted rock. Explosives that have failed to detonate may be observed in the muckpile. Muckpiles are routinely inspected by Meadowbank staff for signs of incomplete detonation.

2.4 MONITORING

Monitoring of explosive handling and blasting is as follows:

a) Explosive quantities: Records of explosive quantities used for in-pit blasting are kept for each blasting event and will be conserved throughout the mine life. Furthermore, a record of blast location (i.e., pit and elevation), blast date, and bulk explosive type and name used (emulsion, with the corresponding ratio of AN over emulsion) is kept for all events.

b) Design parameters: Blast design parameters, as well as changes in the blast design parameters from the standard are recorded and dated.

c) Loading instructions: Loading instruction forms are completed for each blast event and provide a record of the as-loaded parameters for all blastholes in the blast pattern including:
    - Hole depth
    - Collar height
    - Priming (single or double)

- Other observations made by the blast crew (e.g., wetness of holes, use of liners, collapsing holes or difficulty loading)

d) Video footage: Videos are taken of each blast. This practice provides a visual, qualitative record of the results of each blast and provides insight into potential problems such as incomplete detonation (e.g. orange fumes) and misfires, as well as areas of poor muckpile heave and forward movement.

e) Blast audits: Blast audits are conducted on a monthly basis to ensure that best practices are being followed in the field (audits may be adjusted to a lesser frequency if low ammonia levels are consistently observed, or conversely may be adjusted to a higher frequency if high ammonia levels are consistently observed).

An additional monitoring technique commonly used is the measurement of the Velocity of Detonation (VOD), which has been shown to be directly related to the volumetric fraction of the explosive that has been consumed. This technique will be implemented if poor or incomplete detonation is consistently suspected.

3 MILL EFFLUENT

3.1 SITE DESCRIPTION

The mill effluent consists of tailings produced at the mill that is pumped as slurry and deposited in the Tailings Storage Facility (TSF) where the tailings particles are allowed to settle and consolidate. The reclaim water is pumped back to the mill for re-use. Prior to discharge of the mill effluent to the TSF, the effluent is sent to the cyanide destruction process. The cyanide destruction process at Meadowbank uses the sulfur dioxide (SO_2) and air process to oxidize weak acid dissociable cyanide (CN-WAD) to a less toxic form: cyanate (CNO^-) based on the following reactions:

$$SO_2 + O_2 + H_2O + \text{CN-WAD} \rightarrow CNO^- + H_2SO_4$$

The process can also use sodium metabisulfite ($Na_2S_2O_5$) instead of sulfur dioxide in case there are operating issues with the dosing of sulfur dioxide gas in the process. This ensures that chemicals required for the cyanide destruction process (either SO_2 or $Na_2S_2O_5$) are always available.

3.2 AMMONIA PATHWAY

Cyanate produced from the oxidation of CN-WAD can readily hydrolyze to ammonia (NH_3) and carbon dioxide (CO_2) based on the following reaction:

$$CNO^- + H^+ + H_2O \rightarrow NH_3 + CO_2$$

Thus, the mill effluent provides an ammonia loading to the TSF reclaim water.

During the operation of the TSF, the reclaim water will be pumped to the mill for re-use in a closed loop system. Consequently, there will be no discharge of reclaim water to the environment during this period. Furthermore, it is expected that the ammonia concentration will gradually increase in the TSF reclaim pond over time, even though (1) there may be some slight attenuation of ammonia due to microbial/algae activity in the summer and (2) ammonia may oxidize to nitrite and nitrate, particularly near the top of the pond where oxygen is most present.

The Water Quality Forecasting – Update based on the 2014 Water Management Plan Report (SNC, 625618-0000-40ER-0001) provides a forecast of the concentration for ammonia in the TSF reclaim pond during the life of the mine. Furthermore, the report provides a forecast of the ammonia concentration in the Portage and Goose Island Pit once flooding activities has started.

3.3 MONITORING

Concentrations of ammonia, nitrate and nitrite are parameters that are monitored on a monthly basis as part of this sampling campaign of the TSF reclaim water at station ST-21.

In the Water Quality Forecasting – Update based on the 2014 Water Management Plan Report (SNC, 625618-0000-40ER-0001), a maximum ammonia concentration in the TSF reclaim water is evaluated in order to meet the CCME guidelines for the Protection of Aquatic Life in the Portage and Goose Island Pits once flooding activities are completed. If this concentration is exceeded before the end of the flooding operation, measures could be undertaken to lower the ammonia

concentration, as well as nitrate and nitrite if required, in the TSF reclaim pond prior to the transfer of TSF reclaim water to the pits.

Ammonia treatment technologies that could be further investigated, if the need arises, include:

i) Biological nitrification / denitrification during the summer months.

ii) In-situ volatilization of ammonia during the summer months.

iii) Ammonia removal by snow making.

4 WATER MANAGEMENT

Water quantity and quality monitoring assist in the monitoring of ammonia loadings from explosive residuals, as well as ammonia concentration found in the Tailings Storage Facility reclaim pond. The Meadowbank water quality and flow monitoring plan (AEM 2015) and water license (NWB 2008) includes monitoring stations that are used for the monitoring of ammonia loadings. The stations that specifically monitor for ammonia are listed in Table 1 and are shown in the Figures in Appendix 1.

Table 1 Water Monitoring Station Included under the Meadowbank Water License

Station	Description	Phase	Parameters	Frequency
ST-9	Portage Attenuation Pond prior to discharge through Third Portage Lake Outfall Diffuser	Early operation	Ammonia, nitrite, nitrate	Prior to discharge and Weekly during discharge
			Water Volume	Daily during periods of discharge
ST-10	Vault Attenuation Pond prior to discharge through Wally Lake Outfall Diffuser	Late operation	Ammonia, nitrite, nitrate	Prior to discharge and Weekly during discharge
			Water Volume	Daily during periods of discharge
ST-16	Portage Rock Storage Facility	Late operation	Ammonia	Monthly during open water
		Closure	Ammonia, nitrite, nitrate	Bi-annually during open water
ST-17	North Portage Pit Sump	Operation	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge
	Portage Pit Lake	Late operation	Ammonia, nitrite, nitrate	Monthly during open water
		Closure	Ammonia, nitrite, nitrate	Bi-annually during open water
ST-19	South Portage Pit Sump	Early operations	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge
	Third Portage Pit Lake	Late operations	Ammonia, nitrite, nitrate	Monthly during open water
ST-20	Goose Island Pit Sump	Early operations	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge

	Goose Island Pit Lake	Late operations	Ammonia, nitrite, nitrate	Monthly during open water
		Closure	Ammonia, nitrite, nitrate	Bi-annually during open water
ST-21	Tailings Reclaim Pond	Early (North Cell) and late (South Cell) operation	Ammonia, nitrite, nitrate	Monthly during open water
ST-23	Vault Pit Sump	Late operations	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge
ST-24	Vault Rock Storage Facility	Late operation	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
		Closure	Ammonia, nitrite, nitrate	Monthly during open water
ST-25	Vault Attenuation Pond	Late operation	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water

In addition to the monitoring listed in Table 1, the following actions are undertaken as part of the AMP:

- If runoff or seepage is detected at the rock storage facility, water samples collected at the Portage or Vault Rock Storage Facility during late operation will also be analyzed for nitrate and nitrite to complete the suite of signature compounds found in explosive residuals.
- Tailings slurry volumes and density from the mill pumping facility to the TSF are recorded on a monthly basis.
- The records of water volumes pumped from the Portage Pit sumps include the destination: South Cell TSF (former Attenuation Pond).
- The records of water volumes pumped from the Portage or Vault Attenuation Pond will include the destination: Third Portage Lake, Wally Lake or other future destination.

Sampling frequency at the pit sump will also be increased if high variability is identified in observed constituent concentrations as a result of the blasting schedule.

5 REPORTING

Reporting of ammonia concentrations at the sampling stations listed in Table 1 is included as part of the requirement of the water license (NWB 2008). The reporting frequency is provided in AEM (2009b), and includes:

- Brief monthly reports of the compiled water quality monitoring results, sent to the Nunavut Water Board (NWB), the AANDC Water License Inspector and to the Kivalliq Inuit Association (KIA); and

- An annual report submitted to the NWB, KIA, Aboriginal Affairs and Northern Development Canada, Nunavut Impact Review Board, Government of Nunavut, and other interested parties. This report summarizes monitoring results for each sampling station, annual seep water chemistry results, annual groundwater monitoring results, receiving water monitoring results, spills and any accidental releases, measured flow volumes, effluent volumes and loadings, and results of QA/QC analytical data.

Mine operation personnel reviews on a monthly basis the data gathered from the sampling stations in Table 1 and from the monitoring action proposed under the AMP. If the data indicates that further studies and/or significant changes to the water management infrastructure are required to assess or control ammonia concentrations, AEM will notify the Nunavut Water Board as early as practical. Results of these further studies and/or changes to the AMP monitoring actions will be transmitted to the Nunavut Water Board for review.

6 INSPECTION

On a weekly basis, the environment department will conduct inspection in the blasting area to ensure that the Dyno Nobel loading procedures are being implemented (this will minimize blasting residues). In addition inspections will be undertaken at explosive product storage facilities (Dyno Nobel) to ensure that explosives products are stored in sealed containers and there is no spillage. If any non-conformities are observed follow up action will be undertaken andcorrective measure will be put in place. See Appendix 5 for copy of the AMP inspection form.

7 REVIEW OF AMMONIA MANAGEMENT PLAN

Review of the results of the site water quality and AMP monitoring during the year may provide new information, and/or indications that changes to the AMP are necessary. When revisions are warranted, an updated AMP will be submitted to the Nunavut Water Board for review.

8 REFERENCES

AEM (2015), Meadowbank water quality and flow monitoring plan. January 2015.

CCME (2010), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Ammonia.

Golder (2009). Updated Water Management Plan. Agnico-Eagle Mines. July 2009

Golder (2011), Updated Water Management Plan, Agnico-Eagle Mines, July 2011

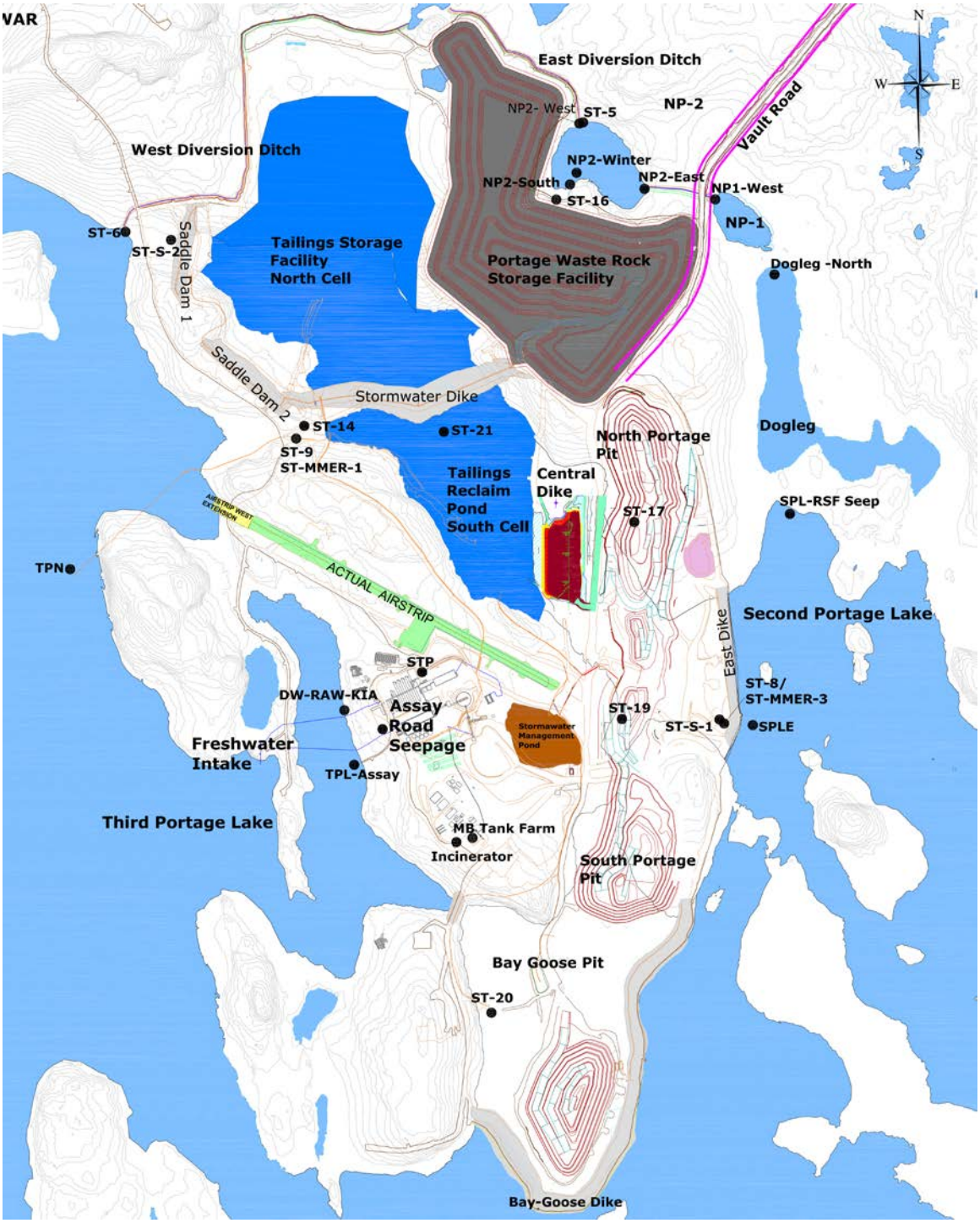
NWB (Nunavut Water Board License) (2008). Water License No: 2AM-MEA0815. Agnico- Eagle Mines Ltd. June 2008.

SLI (2012). Water Management Plan 2012. Agnico-Eagle Mines. Document No. 610756- 0000-40ER-0001, Rev. 02. March 2013.

SLI (2012). Water Quality Forecasting for the Portage Area 2012-2025. Agnico-Eagle Mines. Document No. 610756-0000-40ER-0002, Rev. 01. March 2013

APPENDIX 1

ENVIRONMENT FIELD STATIONS – MINE SITE VIEW


VAR
East Diversion Ditch
NP2- West
ST-5
NP-2
Vault Road
West Diversion Ditch
NP2-Winter
NP2-South
NP2-East
NP1-West
ST-16
NP-1
ST-6
ST-S-2
Saddle Dam 1
Tailings Storage Facility North Cell
Portage Waste Rock Storage Facility
Dogleg -North
Saddle Dam 2
Stormwater Dike
ST-14
ST-21
ST-9
ST-MMER-1
North Portage Pit
Dogleg
Tailings Reclaim Pond South Cell
Central Dike
ST-17
SPL-RSF Seep
TPN
ACTUAL AIRSTRIP
Second Portage Lake
East Dike
STP
ST-8/
ST-MMER-3
DW-RAW-KIA
Assay Road Seepage
ST-19
ST-S-1
SPLE
Stormwater Management Pond
Freshwater Intake
TPL-Assay
Third Portage Lake
MB Tank Farm
Incinerator
South Portage Pit
Bay Goose Pit
ST-20
Bay-Goose Dike
N
W
E
S

APPENDIX 2

SPILL CONTROL AND LOADING PROCEDURE PLAN

Dyno Spill Control and Loading Procedure Plan

1) All trucks are washed inside shop to contain any residue that may have contacted trucks. The water from the washing of the trucks and or the shop floors themselves is then picked up by the AEM e vacuum and disposed of in the onsite Stormwater Management Pond.

2) A.N. Prill is brought to the Emulsion Plant site in 20 ft Seacans and is stored in the Seacans on the A.N. Pad for the site till it is needed. It is then taken out of the Seacan /s and brought into the Plant for use. Sometimes enough product for the next batch is stored outside to speed up Batching time when it is necessary. A.N. Prill is not left outside if weather looks like it is going to be damp or raining to prevent the leaching of Prill through the Tote bags and on to the ground surface.

3) Any A.N. spills that occur are promptly cleaned up and disposed of in 1 of 2 ways:
    i. Any contaminated prill is put into containment barrels or buckets inside Plant, depending on amount, and put into the next Ansol batch to be made.
    ii. Any contaminated Prill is put in Barrels or Buckets (depending on amount) and then transferred from barrels to buckets for the Emulsion Truck Operators to take to the Blast Pattern and placed into the boreholes after they have been loaded (disposal via blast).

   Any spills that are too difficult (some of our drummed Products) to take care of in this manner are placed in Metal Drums or HAZMAT bins etc. with absorbing materials, sealed and sent to AEM HAZMAT AREA (for shipment south).

4) Emulsion waste (with contaminants) is also either contained in drums or bins until it can be transferred into buckets and taken to Blast patterns and placed into boreholes for disposal (disposal via blasting).
   Any non contaminated Emulsion is put back through the system and on to Trucks.
   When Trucks need to be de-contaminated or process lines of trucks or plant need to be cleaned out, the excess water is strained through a Sack (this allows the water to go through, but contains the Emulsion) to minimize nitrites in our plant sump containment.

5) When an Emulsion Truck has completed loading on a blast pattern the remaining emulsion is flushed out of the loading hose by running water through the hose (water holding tank on trucks) until water discharges out the end of the hose into the borehole.
   This does not completely remove all of the Emulsion out of the Hose; there is still a residue amount left in the hose. Thus, when the Truck operator starts up on the next blast pattern, the hose is put into the borehole and the Operator primes the hose and all the residue Emulsion is contained in borehole and disposed of when hole/s are blasted.

APPENDIX 3

DYNO NOBEL EMERGENCY RESPONSE PLAN – MAGAZINE, PLANT AND WORK SITE

DYNO
Dyno Nobel
Groundbreaking
Performance

EMERGENCY RESPONSE PLAN

QAAQTUQ

Agnico Eagle Meadowbank (Baker Lake)
Nunavut

For Dyno Nobel Canada Inc.

Magazine, Plant and Work Sites

This Emergency Response Plan (ERP) addresses incidents and potential incidents involving the manufacturing, handling and storage of explosives and related products in Dyno Nobel Canada Inc.' magazines, plants and worksites. This ERP has been developed for Dyno Nobel Canada Inc. and all of it's wholly-owned subsidiaries (DNX Drilling). Actions detailed within this plan are compulsory, under the approval and authorization of DNCI's Regional Operations Managers.

"This document, as presented on Dyno Nobel's database, is a controlled document and represents the version currently in effect. All printed copies are uncontrolled documents and may not be current".

Note: Information provided within this document may be privileged and is not intended for general distribution.

Original Date of Publication: 15 October 2003, as amended site specific, December 19, 2011

Publication/ Amendment Date	Changes To Prior Edition	Pg.
15 Oct 03	**New document**	All
26 Apr 04	**Amendment # 1**	
	Renumbering of Appendices 6 – 13	App. 7 – 14
	Miscellaneous Typos & Amendment Dates	All
17 March 08	**Amendment #2**	
	Updated Contact information	
	Addition of definitions	
	Included Calling and responding emergency procedures	
	Addition Duties of Key personnel	
	Addition of response to Natural disasters	
	Addition of visitor and contractors access control -	
	Replaced the Appendices and renumbering	
	Included a Emergency Report form	
	Addition of Nitric acid, Aluminum and Diethylene glycol and CFE	
	Addition of alternate methods of communication	
	Addition of Reportable Substance list	
	Miscellaneous Typos & Amendment Dates	All
August 18, 2010	**Amendment #3**	
	Updated Scope and ERP Outline	
	Added Sign-off sheet for Annual Fire Department Review	
	Added Appendix for Employee Training sign-off	
	Updated Reporting Incidents Flowchart	
	Updated procedure for Raw Material Truck Spills	
	Updated Bomb Threat Checklist	
September 29, 2011	Amendment #4	
	Updated contacts and phone numbers	
November 15, 2011	Amendment #5	
	Amended Appendix 8	
	Addition of Appendix 10	

Table of Contents

Section	Topic	Pg.
1.0	Scope	4
2.0	Related Documents	4
3.0	ERP Outline	4
4.0	Preparation and Planning	6
5.0	Training	7
6.0	Emergency Procedures and Lines of Authority	8
6.1	Duties Of Key Personnel	8
Table 6-1	Flow Chart	9
6.2	Fire & Explosives	13
Table 6-2	Fire Fighting Information	15
Table 6-3	Control Measures	16
Table 6-4	Evacuation Distances	17
6.3	Environmental Releases	18
Table 6-5	Environmental Release Procedures	20
6.4	Security	21
6.5	Bomb Threat	21
Table 6-6	Bomb Threat – Conversation Guidelines	21
6.6	Lines of Authority	22
7.0	Notification and Reporting	23
Table 7-1	Reportable Substances Quantity List	25
8.0	Decontamination	27
9.0	Work Site Closure / Shut Down	27
10.0	Response to Natural Disaster Preventive Measures	28
11.0	Work Site Start Up	29

Work Site Phone Numbers and Magazine / Plant Details

Appendix 1 DNCI Emergency report form
Appendix 2 DNCI Corporate Contacts
Appendix 3 ERA Contact List
Appendix 4 Management and Site Contact list
Appendix 5 Site Specific Information
Appendix 6 Bomb Threat Checklist

Appendix 7 New/Transferred Employee or Annual Refresher Form
Appendix 8 Annual Fire Department Review Form / Debrief Form
Appendix 9 TDG Regualtion Class Quantity Emission Limit

1.0 SCOPE

This document provides a Work Site Emergency Response Plan covering fire/explosion, spills, security breach, bomb threat, evacuation and prescribed actions that employees must take to ensure employee and public safety in the event of an emergency. The general reference to DNCI's "Work Sites" throughout this document includes magazines, plants and miscellaneous work locations.

The Emergency Response Plan appearing on Dyno Nobel Canada Inc.' database is a controlled document. Uncontrolled copies of this ERP are provided to customers and associates who own the land on which DNCI's worksite is located, plus applicable municipal and regulatory authorities. As well, uncontrolled copies are issued to all Company employees and are placed in all central offices and Company delivery vehicles.

2.0 RELATED DOCUMENTS

The following documents also relate to emergency situations that can arise and should be held at each Work Site:

- Federal, Provincial and Municipal regulations, standards and guidelines
- Corporate Policies plus MSA Standards & Procedures
- Standard Operating Procedures (SOP's)
- Dyno Nobel General and Specialized Work Rules
- Material Safety Data Sheets
- Prime Contractor's / Customer's ERP
- Transportation ERAP #2-1037
- Crisis Communication Plan

3.0 ERP OUTLINE

3.1 The following materials are covered by this ERP:
Fuel Oil
ATF Hydraulic Fluid
Ammonium Nitrate Prills and Solution
Sodium Nitrite
Sodium Thiocyanate
ANFO
Emulsion

Packaged Explosives
Detonators
Acetic acid
Diethylene glycol
Aluminum
Enviro CFE

3.2 The following situations are addressed in this ERP:

- Fire / Explosion
- Storage Tank Failure
- Spills from Product Delivery Trucks
- Spills from Raw Material Delivery Trucks
- Process Spills
- Shut down due to weather, floods, lightning, fires, explosions and other threats to the security and operation of DNCI's facilities, equipment and material.
- Bomb Threats
- Quantities of spills and reportable to Dyno Nobel and authorities

3.3 This ERP covers:

Preparation	Reporting
Training	Waste Disposal Permits
Lines of Authority	Containment
Notification	Inspection
Decontamination	Maintenance

3.4 The following definitions apply to this plan:

DNCI Corporate contact : A DNCI corporate employee who is assigned to receive Emergency Calls at all times from the answering service.

ER Advisor: Emergency Response Advisor (ERA), who will normally be the applicable General Manager, Area Manager, or Technical Advisor who will liaise with First Responders.

OSC: (DNCI) On Scene Coordinator, the Senior DNCI employee at an incident site who manages and controls DNCI resources in support of First Responders and incident recovery.

ERT: Emergency Response Team, DNCI personnel dispatched to an incident site to assist First Responders and conduct incident recovery under the direction of the OSC.

4.0 PREPARATION AND PLANNING

4.1 In order to provide competent emergency response at Dyno Nobel Canada Inc.' magazines, plants and worksites, first responders (local fire departments and mine rescue personnel) must be thoroughly briefed on an annual basis of the potential hazards involved in a Dyno Nobel Canada Inc. worksite fire. To this end, Work Site Supervisors must take fire department plus mine safety and security representatives on an annual magazine / plant tour to view:

Explosives Storage Areas	Evacuation (Meeting) Area
Bulk Emulsion Equipment	Communications Equipment
ANFO Blending Area	Facility Layout
Fire Fighting Equipment Sites	(Waste) Burn Facilities

A record of each explosives worksite tour and the names of the first responder representatives attending are to be documented and kept on file.

Annual Fire Department Review Form (Appendix 9)

4.2 All DNCI employees shall review this ERP on an annual basis and participate in ERP drills / exercises when scheduled.

4.3 All worksite accidents involving fire, explosion, reportable spills/emissions, breaches of security and bomb threats are to be reported to applicable authorities and senior management. As per incident reporting procedure

4. 4 Spill procedures for each of the materials listed in section 3.1 are outlined in Table 6-3. All procedures specify: Method of Cleanup, Method of Disposal and Protective Clothing. Based on the procedures presented in Table 6-3, worksite supervisors must ensure that adequate clean-up equipment and materials are readily available and in good condition.

4.5 Worksite information for each of DNCI's facilities is contained in the attached appendices. The ERP is revised whenever significant changes are made.

4.6 Current Material Safety Data Sheets (MSDS) are to be kept at each Work Site for all hazardous materials that are stored and handled at the Work Site. Copies of current product MSDS' are also made available to customers and landowners. Obsolete MSDS' will be replaced as new ones are issued.

4.7 Each Work Site will hold and maintain in good repair, appropriate fire fighting and spill control equipment for potential emergencies. Fire extinguishers, hoses and other fire fighting equipment are to be visually inspected on a monthly basis to ensure Magazine, Plant, Work Site and delivery vehicle readiness.

5.0 TRAINING

5.1 All employees will complete training on the contents of this Plan during their "new hire" orientation and review the plan annually.

5.2 A trained person is considered to have reviewed all related documents (Section 2.0), to have been instructed on the use of related equipment and procedures, and to have discussed with their Supervisor or trainer, questions and issues of concern.

5.3 Training records, including certificates for training completed, are to be kept onsite in the Employee's Training Record.

5.4 The Magazine, Plant or Work Site Supervisor/Manager will certify their employees as having received training by signing the training form. In signing the training form, the Supervisor / Manager will have satisfied themselves that trained employees are able to:

- Recognize fire and explosive hazards for the materials and processes to which they are exposed /involved with;
- Competently use Fire Fighting / Fire Protection Equipment (Note: employees should receive refresher training in the use of fire extinguishers at least every three years)
- Competently use applicable personal protective equipment (PPE) when handling hazardous substances;
- Recognize and be familiar with substances which become hazardous wastes when spilled; and

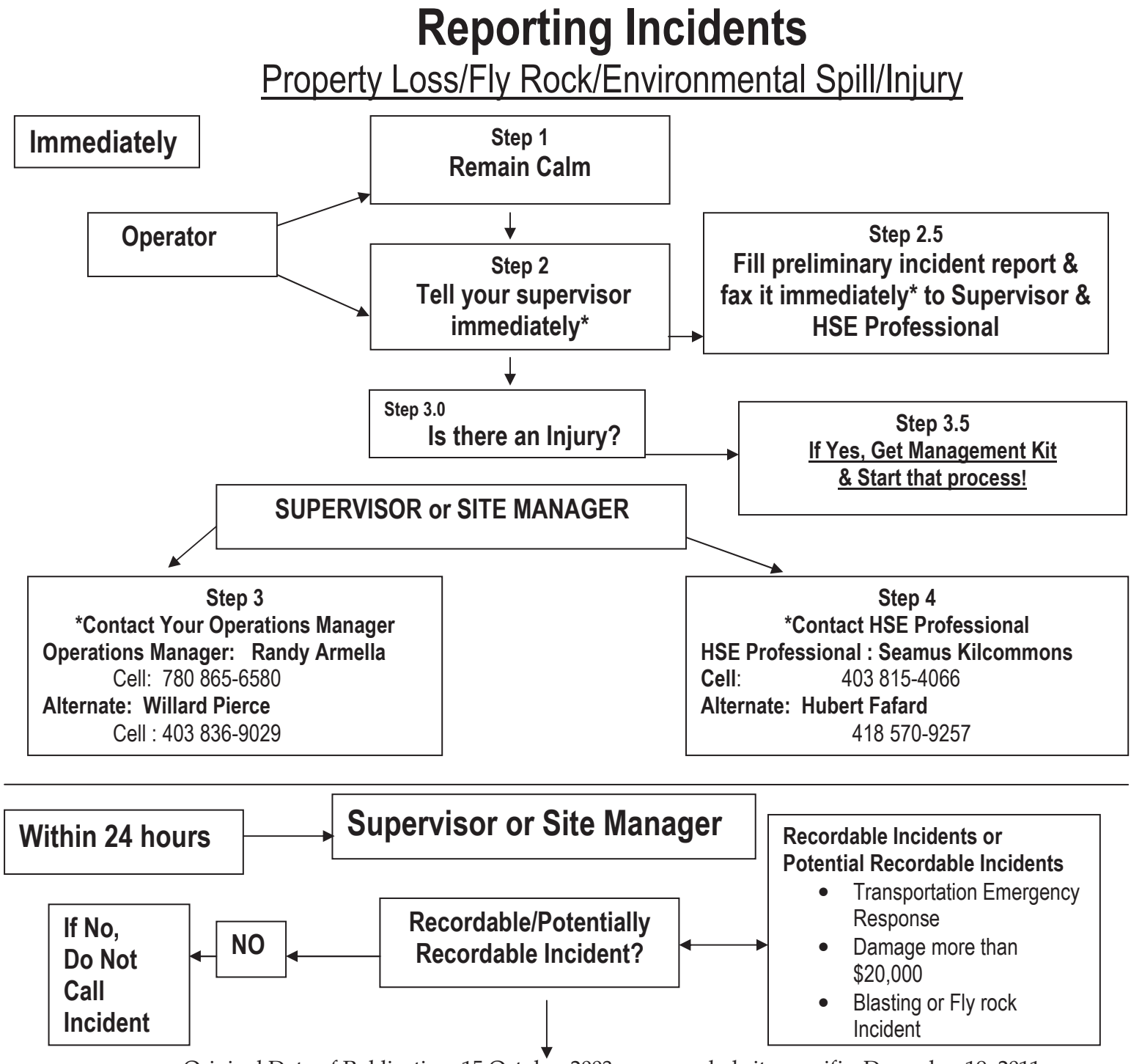
- Follow SOP's and use established work practices to minimize the potential for fires, explosions, environmental releases and other accidents.
- Worksite Managers / Supervisors will ensure that all contractors receive a worksite orientation before commencing work or being left unaccompanied in the worksite. Following the orientation process, the contractors will be required to sign off on the Contractor Checklist acknowledging training in the applicable areas including the site emergency response plan.
- All Plant & Magazine sites will have in place, a continuous (24 hour) access control system to control the entrance, presence and exit of visitor and contractors and their equipment and materials
- Employees must be trained on Reportable Quantities to the Government in the unlikely event of a spill.
- All employees are aware of evacuation routes, muster point location, and all-clear notice procedure.
- New/Transferred employee or Annual Refresher sign-off form located in Appendix 8

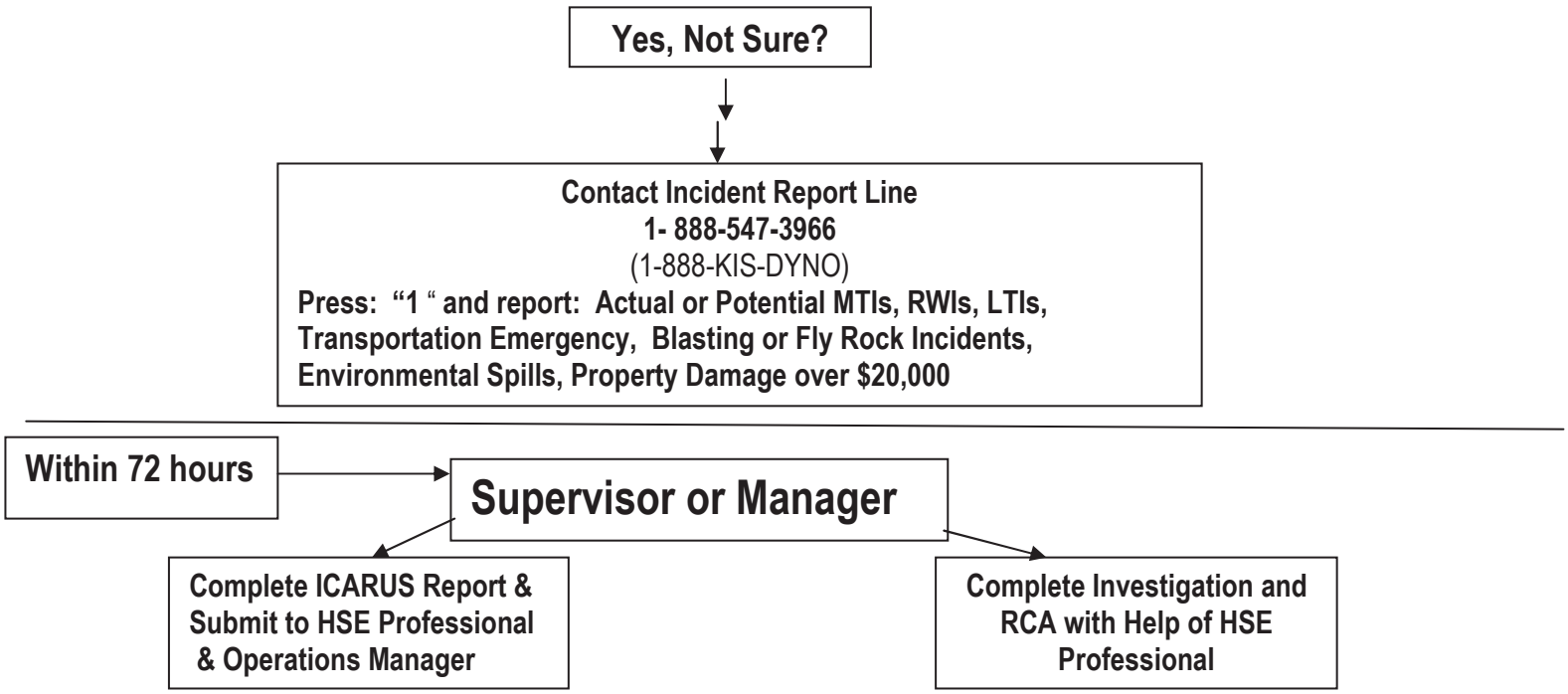
6.0 EMERGENCY PROCEDURES AND LINES OF AUTHORITY

6.1 GENERAL

Reporting Incidents Flow Chart (continued on next page)

Table 6-1
Emergency Response Flow Chart





SITE SUPERVISOR/DELAGATE
EXPERIENCING EMERGENCY / POTENTIAL EMERGENCY

- **CALL FOR EMERGENCY ASSISTANCE**
  In the event of an emergency, accidental release or imminent accidental release involving explosives, eliminate potential sources of detonation where possible (eg. turn off the ignition of a vehicle), call **911** (or the local police number) for immediate assistance, **call the site Supervisor/ Area Manager** and initiate the site's Emergency Response Plan. If normal phone systems are down other methods of communication can include two way radios, satellite phones, pager, e mail and vehicle satellite tracking systems.

- **WARN PUBLIC WITHIN EVACUATION DISTANCES IF RISK OF DETONATION**
  Should there be explosive detonations, or the risk of detonations due to the presence of fire or other detonating factors, advise the First Responders (or anyone within the immediate vicinity if First Responders are not at the scene) of the risk and applicable safety distances per Table 6-4, page 17 (liaise with Emergency Response Advisor (ERA) if time permits). Help organize perimeter guards to prevent people from entering the evacuation zone.
  Note: See ERP, page 17 Table 6-4 for Evacuation Procedures.

- **ASSIST LOCAL AUTHORITIES**
  Assist First Responders and Local Authorities in eliminating the emergency situation, and liaise with DNCI's On-Call Employee / ERA until relieved by the Company's Emergency Response Team (ERT).

TO RESPOND TO AN EMERGENCY CALL

DNCI Corporate contact instructions:

Upon receiving a call for emergency response assistance, keep a log of all subsequent communications and actions, and do the following:

1. Immediately obtain the name and callback number of the caller, in case the telephone line is lost.

2. Obtain information as fully and accurately as possible following the emergency report form (see appendix 1).

3. Call an ER Advisor for the applicable Region (see appendix 2) and report the emergency situation. In turn, the ER Advisor will phone the emergency scene caller, establish ongoing contact, assess the emergency, determine what Company resources and/or contracted emergency response services are required and organize an Emergency Response Team – ERT to proceed to the emergency scene if required.

4. Assist the Emergency Response Advisor (ERA).

5. Liaise with Company Executive / Senior Managers.

Emergency Response Advisor (ERA) instructions:

1.Call the Branch/Plant Supervisor nearest the emergency scene plus provincial & federal authorities (see applicable appendix to Annex D) to advise them of the situation and the need for an emergency response.

2. Designate, assemble and dispatch an Emergency Response Team (ERT), made up of Groups 1 & 2 personnel (see ERAP pg. 16 and Annex D) under the leadership of an On Scene Coordinator (OSC), if required.

3. Authorize the dispatching of additional resources, communications, transportation and contracted services as necessary.

4. Contact and instruct the designated Emergency Response Team (ERT) to proceed to the emergency scene with the required vehicles and equipment.

5. Liaise with the Person in Charge of the Emergency) and/or Local Authorities to obtain a situation update.

6.Advise Local Authorities as appropriate, regarding the properties, hazards and handling procedures for the explosives involved in the emergency. In particular, advise the Local Authorities of appropriate evacuation distances per Table 6-4 pg. 17.

7. Continue to consult with the Local Authorities as appropriate, plus the Company's On-Scene Coordinator (OSC), to stabilize and eliminate the emergency.

8. Refer to **Regional Manager** *Tom Medak or Cory Redwood .(see appendix2))* for any media requests in accordance to the Crisis Communication Plan (CCP). Media contacts shall be through Regional Manager designated for the area.

9. Contact the explosives supplier and / or transporter (if other than DNCI) to advise them of the emergency and to request their assistance if/as required.

ON-SCENE CO-ORDINATOR (OSC)

- The On-Scene Coordinator (OSC) is the Company's representative and local authority in charge of all company actions and resources at the emergency scene. Once the OSC arrives at the emergency scene, the ERA will transfer communication with First Responders/Local Authorities to the OSC. In turn, the OSC will liaise with the ER Advisor as required. Throughout the Company's emergency response, the OSC will ensure that First Responders and Company personnel (employees and contractors) observe all safety and regulatory standards and procedures.
- The OSC may revise / adjust the composition of the Emergency Response Team (ERT) and supporting resources as required. The OSC may, in consultation with the ER Advisor, contract commercial services to assist in addressing and resolving the emergency situation.

- The OSC will oversee the Company's local involvement with emergency services, government (municipal & provincial) and public interests until the emergency is fully resolved. Post-emergency activities (clean-up, restoration, etc.) under the direction of the Environment Manager may be delegated to an appropriate Branch, Plant or Area Manager. **EMERGENCY RESPONSE TEAM (ERT)**

- Selected emergency response personnel will take their direction to assemble and proceed to the emergency scene from the ERA or their representative. Team members will immediately report to the On-Scene-Coordinator.

- The primary role of the ERT is to provide a competent and trained / certified workforce plus specialized equipment and material to assist First Responders / Local Authorities in the stabilizing and elimination of an 'explosives emergency', and to retrieve / recover, repackage and remove to safe and secure storage, non-detonated explosives.

- While at the emergency scene, ERT members will take their direction from the Company's OSC and remain available until released by the OSC.

NOTE:

ONLY INDIVIDUALS WHO HAVE RECEIVED TRAINING AS REQUIRED UNDER THE TRANSPORTATION OF DANGEROUS GOODS (CLEAR LANGUAGE) REGULATIONS, OR WHO ARE WORKING UNDER THE DIRECT AND CONTINUOUS SUPERVISION OF AN EMPLOYEE WHO HAS BEEN TRAINED FOR CLASS 1 DANGEROUS GOODS UNDER TDG, MAY PARTICIPATE IN SITE CLEAN-UP ACTIVITIES SUCH AS PICKING UP, REPACKAGING AND TRANSPORTING EXPLOSIVE MATERIAL.

6.1.1 In any emergency the Work Site Supervisor/Manager or their delegate must take certain actions, including the following:

- Call local fire/emergency authorities (at mine sites, also call Mine Fire, Safety and Security if different and give relevant information).
- Account for all employees and visitors. Arrange for Rescue of anyone who may be trapped, without endangering oneself or others.
- Notify Dyno Nobel Canada Inc. ERA's so that necessary arrangements can be made for technical / administrative support, including accident reporting and investigation plus continued/alternate production. The following information should be provided and refer to appendix 1:

What Occurred	Time of Occurrence
Action Taken	People Contacted
Status of Situation	Anticipated Follow-up

6.2 FIRE & EXPLOSIVES

6.2.1. There are three categories of fire that may involve explosives:

I. Fires Directly Involving Class 1 Explosives and Blasting Agents

- **DO NOT FIGHT THE FIRE.** Instruct all fire fighters on the scene not to fight fire with explosives.

- Shut off power at main breakers if possible. At mine sites, call Mine Security or Fire/Rescue. At all other DNCI locations call local Fire/Rescue personnel.
- Evacuate all personnel from the Work Site to the safe meeting place as outlined in the Work Site Appendix.
- Set up a communications base at the meeting place and guard
- against anyone entering the area.

II. **<u>Fires Involving Components For Manufacture of Blasting Agents</u>**

Bulk blasting agents may be in the form of emulsion or ANFO. ANFO is a mixture of prilled ammonium nitrate and fuel oil.

Under conditions of large mass, intense heat, confined dust / vapor buildup, and the right mixture combination of the basic ingredients, emulsion and ANFO will explode. The probability of explosion with ammonium nitrate (AN) alone is very small, but increases when under intense heat and confinement. Table 6-1 includes recommended fire fighting procedures for each of these substances.

III. **<u>Fires Involving Dyno Nobel Canada Inc. Trucks</u>**

In cases where the Dyno Nobel Canada Inc. delivery trucks are in a building that is on fire, if there is no explosives and safe to do so, may be moved provided access to the truck and exit from the building is not barred by flames or smoke, with available fire extinguishers with caution only if the fire is small and not in the storage compartment.

Fires on re-pump or other bulk explosive delivery vehicles shall not be fought if the fire involves the explosives compartment. Fire fighting measures should be taken immediately to prevent any fire such as a tire, electrical or cab fire from reaching the explosives compartment.

Fires on other transport vehicles may be fought with caution. Fires that cannot be controlled sufficiently to avoid involvement of the vehicle's fuel compartment shall be left and personnel evacuated to a safe distance.

6.2.2. When a fire is small and does not involve any explosive agents, it may be fought with plant extinguishing equipment. If the fire is widespread and intense, all

personnel, including visitors and contractors should be evacuated to the meeting area outside the main gate.

Table 6 - 2
FIRE FIGHTING INFORMATION

MATERIAL	RECOMMENDED FIRE-FIGHTING METHODS	SPECIAL CONSIDERATION
Ammonium Nitrate Prill – Odorless white to light tan crystaline solid	Use flooding amounts of water in early stages of fire. Keep upwind. AN is an oxidizing agent which supports combustion and is an explosive hazard if heated under confinement that allows high-pressure buildup. Ensure good ventilation and remove combustible materials if it can be safely done. Evacuate to designated area if fire cannot be controlled.	Toxic oxides of nitrogen are given off during combustion. Fire fighters require self-contained positive pressure breathing apparatus. Avoid contaminating with organic materials. Many powdered metals such as Al, Sb, Si, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, Sn, Zn and brass react violently and explosively with fused AN below 200˚C Sensitivity to detonation increases when heated.
Ammonium Nitrate Solution- Colorless/Odourless Liquid – white paste like solid when cooled	Use flooding amounts of water in early stages of fire. Cool containing vellels with with flooding quantities of water until after fire is out	Material will not burn, but thermal decomposition may result in flammable/toxic gases being formed. These products are nitrogen oxides and ammonia. (NO,NO_2 NH_3). Product may form explosive mixtures when contaminated and comes in contact with organic materials. Explosive when exposed to heat or flame under confinement. Avoid temperatures over 210°C (410°F) A self contained breathing apparatus should be used to avoid inhalation of toxic fumes
Acetic Acid – Colourless liquid with a pungent odour	Use dry chemicals, CO_2, Alcohol foam or water spray	Isolate and restrict area access, stay upwind. Water run-off and vapour cloud may be corrosive.
Sodium Thiocyanate – White solid - odourless	Use extinguishing media most appropriate for the surrounding fire	Wear self contained breathing apparatus – MSHA/NIOSH approved or equivalent, and full protective gear. During a fire, irritating or highly toxic gases may be generated by thermal decomposition or combustion.
Sodium Nitrite – Oxydizing agent - white to light yellow crystals- faint odour	Flammability class – not regulated. Flood with water only – Isolate materials not involved in the fire and cool containers with flooding quantities of water until well after the fire is out.	Self contained apparatus should be worn in a fire involving Sodium Nitite.Thermal decomposition will cause reddish brown nitrogen oxides to be released.
Fuel Oil (No. 2 diesel) Dyed or pale yellow liquid with petroleum odor; and/or ATF Fluid	Use water spray to cool fire-exposed surfaces and to protect personnel. Shut off fuel from fire. Use foam, dry chemical or water spray to extinguish fire. Avoid spraying water directly into storage container due to danger of boil-over.	Avoid strong oxidizing agents.

Explosive emulsions, ANFO, packaged explosives and firing devices.	**Fire involving explosive materials must never be fought. Evacuate the incident scene. Do not confine (ventilate to prevent / reduce pressure build-up if safe to do so).**	Explosion hazard.
Enviro CFE	Dry chemical, foam, water spray (fog). Use water spray to cool exposed surfaces and containers	OIL FLOATS ON WATER. Do not use direct or heavy water stream to fight fire. Use organic vapour respirator or self-contained breathing apparatus to fight fire.

Table 6 - 3
CONTROL MEASURES FOR FIRE

MATERIAL	RECOMMENDED FIRE-FIGHTING METHODS	SPECIAL CONSIDERATION
Acetic acid	Small fire: type ABC dry chemical or CO_2 fire extinguisher. Large fire: water fog or foam.	May react violently with oxidizers and nitric acid. May react with aluminum powder and give off highly flammable hydrogen gas.
Aluminum	Small fire: type D fire extinguisher, dry sand. **Never use water**.	May react with oxidizers (nitrate and perchlorate) and acids. Avoid contact with water. Highly flammable hydrogen gas may be released.
Diethylene glycol	Small fire: type ABC dry chemical or CO_2 fire extinguisher. Large fire: water fog.	Keep away from oxidizers (nitrates and perchlorate). Explosion hazard if heated under confinement.

EVACUATION PROCEDURES

Advise the first emergency responders at the scene (police or fire) of the need to evacuate using the guidance in the Emergency Response Plan. Employees at the scene should assist local emergency services to the best of their ability to accomplish this. For incidents within a worksite such as a mine, quarry or construction operation, in most cases access is radio controlled. The quickest way of alerting people, therefore, is by site radio. Clearly state your location, situation and call for assistance in evacuating the area.

DO NOT FIGHT EXPLOSIVES FIRES. EVACUATE THE AREA AND LET THE FIRE BURN ITSELF OUT.

THE MINIMUM EVACUATION DISTANCE IS AS OUTLINED IN TABLE 6-4 (Pg. 17) FOR ALL DIRECTIONS (which is based on a higher traffic / risk / population density within the area, without benefit of protective features such as berms and hills. (**Transport Canada requires 1,600 meters for situations that involve high-risk surroundings**) upon determining actual quantity of explosives refer to Table 6-4 as per ERD quantity of distances.

Table 6 - 4
EVACUATION DISTANCES
Based On Amount of Explosives Present

Explosive Quantity		**Metric Distance**		**English Distance**
250 kg		70 Meters		230 Feet
500 kg		100 Meters		320 Feet
1,000 kg		150 Meters		500 Feet
2,000 kg		240 Meters		800 Feet
5,000 kg		400 Meters		1,300 Feet
7,000 kg		450 Meters		1,450 Feet
10,000 kg		480 Meters		1,550 Feet
20,000 kg		700 Meters		2,300 Feet
40,000 kg		800 Meters		2,640 Feet
60,000 kg		870 Meters		2,860 Feet
80,000 kg		960 Meters		3,150 Feet
100,000 kg		1040 Meters		3,420 Feet
120,000 kg		1100 Meters		3,610 Feet
>120,000 kg		1600 Meters		5,250 Feet

6.3 ENVIRONMENTAL RELEASES

6.3.1 Procedure For Fuel Oil Storage Tank Failure

- Assess the magnitude of the leak.
- If the leak is slow and the source can be determined, take the appropriate action to prevent further leakage.
- Transfer fuel from storage tank into drums if necessary.
- Collect spilled material, including contaminated soil, with absorbent pads or inert solid absorbent and store in drums labeled for disposal.
- If the leak is large and further leakage cannot be prevented, allow the dyke to fill. Transfer to drums, label for reuse or disposal, and store.
- Inspect empty tank to identify failure/cause of leak and repair tank.

6.3.2 Procedure For Raw Material Truck Spills

- Identify the material involved, assess the magnitude of the spill or leak and assist the driver to take appropriate action to stop the leak, taking care to prevent run off and/or entry into any water course or drainage system near the spill site.
- For AN prill, shovel spilled material into drums, label for reuse or disposal, and store. Use a non-sparking shovel to transfer spilled material into lined drums.
- For spilled fuel, contain by dyking with earth. Collect spilled fuel with absorbent pads or solid inert absorbent, transfer into drums, label and store for disposal.
- Remove contaminated soil for disposal in conformance with Environment Canada standards.

6.3.3 Procedure For Process Spills

- Identify the material involved and assess the magnitude of the spill or leak, taking care to prevent run off and/or entry into any watercourse or drainage system near the spill site.
- For AN prill, shovel spilled material into drums, label for reuse or disposal, and store.
- For spilled fuel, contain by dyking with earth. Collect with absorbent pads or solid inert absorbent, transfer into drums, label, and store for disposal.
- In the case of leaking bags of ANFO, sweep or shovel the spilled material into a clean drum or other suitable container, label for reuse or disposal, and store.
- Remove contaminated soil for disposal in conformance with Environment Canada standards.

- Have any process equipment (pumps, process lines, parts, gauges, etc.) involved in a leak or spill inspected and repaired or replaced. Re-inspect and test if necessary after repair is affected.

6.3.4 **Procedure For Emulsion Tank Failure**

- Assess the magnitude of the leak.
- If the leak is slow and the source can be determined, take the appropriate action to prevent further leakage.
- Transfer remaining emulsion from leaking storage tank into another storage tank, a tanker trailer if available, or into drums as necessary.
- Collect spilled material using double diaphragm pump(s) and store in labeled drums for reuse or disposal at the mine.
- If the leak is large and further leakage cannot be prevented, allow the room to fill. Transfer to drums, label for reuse or disposal, and store.
- Inspect empty tank to identify failure/cause of leak and repair or replace the tank

6.3.5 **Procedure For Fire**

- In the event of a raw material or product fire, take care to protect all persons from exposure to smoke and gaseous emissions from the fire.
- Potential toxic gaseous emissions from fires involving explosive materials include:

  Oxides of Nitrogen
  Carbon Monoxide
  Cyanide Gas

- All fires must be reported to local authorities and Mine Site Security as soon as possible.
- Self contained breathing apparatus is required for fighting a fire in the plant.
- Follow procedures outlined above for any spills and leaks resulting from fire when it is safe to do so

Table 6 – 5
ENVIRONMENTAL RELEASE PROCEDURES

MATERIAL	SPILL AND LEAK PROCEDURES	WASTE DISPOSAL
Ammonium Nitrate Prill (odorless white to light tan crystalline solid)	Remove source of heat and ignition. Sweep or shovel spill into a clean, non-combustible container. Wash remaining trace residues with water. Wear rubber gloves and safety glasses to minimize contact with skin and eyes.	Re-use if possible or give it to a farmer as a fertilizer. If not possible, dispose of as-is in approved. Remove as much as possible the spilled material as a solid.
Ammonium Nitrate Solution-Colorless/Odourless Liquid – white paste like solid when cooled	Small spill - Dike and contain spilled material. Ensure spilled material does not enter sewers, wells or water courses. Allow to solidify. Use appropriate tools to place in container for disposal. Larger spill - Dike and contain spilled material. Ensure spilled material does not enter sewers, wells or water courses. Notify downstream water users. Allow to solidify. Use appropriate tools to place in container for disposal.	Call for assistance for disposal. Ensure disposal complies with regulatory requirements and regulations.
Fuel Oil (dyed or pale yellow liquid with petroleum odor)	Eliminate any source of ignition. Prevent spills from entering watercourses or drainage systems. Contain with sand or earth. Recover with pump or inert absorbent material into clean container. Wear safety glasses and rubber gloves to prevent contact with the eyes and skin.	Dispose of recovered material in approved landfill or other waste disposal facility.
ANFO (Ammonium Nitrate Fuel Oil)	This material is an explosive. Remove all sources of heat and ignition. Transfer into clean plastic container with a plastic shovel. Label drums. Wear rubber gloves.	Recycle product, if possible. If not practical, explode it inside a borehole or burn it in an authorized burning ground.
Emulsion	This product is a blasting agent. Remove all sources of heat and ignition. Prevent spills from entering watercourses or drainage systems. If large amount of emulsion is involved, contain spill with earth or sand found locally. Recover spilled material with a diaphragm pump. Use of a diaphragm pump also requires an air compressor. Limitation of the pump suction is approximately 2.5 meters, pump discharge is approximately 8 meters. Use a screening device on pump suction hose. Out of area spills will require taking two pumps and extra hose. Transfer the product into a tanker trailer or clean 200 liter drums. If small amount of emulsion is involved, transfer material into a clean plastic container with a plastic shovel. Label tanker trailer or drums. Wear rubber gloves and rubber boots.	Recycle product, if possible. If not practical, explode it inside a borehole or if large amount is involved, demulsify it with liquid detergent.

Enviro CFE	Eliminate any source of ignition. Prevent spills from entering watercourses or drainage systems. Contain with sand or earth. Recover with pump or inert absorbent material into clean container. Wear safety glasses and rubber gloves to prevent contact with the eyes and skin.	Dispose of recovered material in approved landfill or other waste disposal facility.
Sodium Thiocyanate – White solid - odourless	Ensure adequate ventilation whe handling Sodium Thiocyanate. Keep containers closed when not in use. Wear appropriate PPE – eye protection, gloves and appropriate clothing to prevent skin exposure.	Vacuum or sweep up material and place into a suitable disposal container. Avoid run off into storm sewers and ditches which lead to waterways. Not regulated as a hazardous material. Chemical waste generators must consult appropriate hazardous waste regulations to ensure complete and accurate classification.
Sodium Nitrite – Oxydizing agent - white to light yellow crystals- faint odour	In the event of a spill or leak, contact the vendor (403-263-8660) for advice. Wear respirator, protective clothing and gloves. Vacuuming is the recommended method to clean up spills. Do **not** sweep or use compressed air for clean up. Recover spilled material on non-combustible material, such as vermiculite. Use non-sparking tools and place in covered containers for disposal. Any recovered material mau be used for it's intended purpose , depending on contamination.	Dispose of the waste material at an approved hazardous waste treatment/disposal facility.
Acetic Acid – Colourless liquid with a pungent odour	Wear appropriate PPE – evacuate downind areas as required to prevent exposure and to allow fumes and vapours to dissipate. Prevent entry into sewers or streams. Dike if needed. Eliminate all sources of ignition. Neutralize the residue with sodium carbonate or crushed limestone. Absorb win an inert dry material and place in an appropriate container for disposal. Flush area with water to remove trace residue.	Waste disposal must be done in accordance with provincial and federal regulations. Empty containers must be recycled or disposed of through an approved waste management facility.

6.4 SECURITY

6.4.1. In the event of a breach of security at a Dyno Nobel Canada Inc. Work Site, a call is to be made to the RCMP / local Police Department at the discretion of the Supervisor/Manager, or their delegate. In the case of a breach of security, Dyno Nobel Canada Inc.' HSE, Regulatory Affairs and Executive / Senior Management shall also be informed immediately and provided with the same information as outlined in Section 6.1

6.4.2. Any person(s) apprehended during the course of a serious security breach shall be detained until the Police arrive (note: employees are not to put themselves at undue risk by attempting to apprehend or restrain a potentially violent person).

6.5 BOMB THREAT

6.5.1. The safety of employees and the public is of primary concern. A person receiving a bomb threat over the telephone should attempt to remain calm and keep the caller talking by asking the questions listed in Table 6-6 (ERP pg. 20). Recording (writing) as much information about the caller and their comments is also very important for future reference. If possible, alert a co-worker to the situation while talking to the caller.

6.5.2. The police / mine security should be advised of the bomb threat as soon as possible. Unless there is good reason to the contrary, all personnel should evacuate the Work Site and await the arrival of the police / first responders at the designated meeting area. Suspicious objects should be reported but not tampered with and other people should be prevented from entering the Work Site until the local authority has authorized a return to the Work Site. Employees should be prepared to assist local authorities in their search / inspection of the Work Site as necessary.

Table 6 - 6
CONVERSATION GUIDELINES IN THE EVENT OF RECEIVING A BOMB THREAT

See Appendix 7

6.6 LINES OF AUTHORITY

6.6.1 Based upon the information available at the time of the incident, the Work Site Supervisor/Manager, in consultation with others (such as DNCI Senior Management, Mine/local authorities and/or Dyno Nobel advisors), will evaluate the incident and proceed with appropriate steps to implement this ERP. A decision on when to return to the scene of a serious incident will be made in like fashion, subject to approval by public authorities overseeing the incident.

6.6.2 The Work Site Supervisor/Manager will have overall responsibility for the implementation of this ERP and the supervision of all Company activities. Public authorities and the site owner have ultimate authority regarding the resumption of normal production activities.

7.0 NOTIFICATION AND REPORTING

7.1 Any incident that activates this ERP shall be documented on the DYNO Incident (Cintellate) Report. The Corporate Emergency Response Advisor must also be notified and in turn will advise the:

HSE Manager Vice President Operations
Area Manager

It is the responsibility of the HSE Manager or his delegate to report the incident to DYNO's HSE Management Team. A major incident involving a fire with emissions and/or a hazardous material spill shall be reported to a provincial Environment Officer under the direction of the Environmental Manager. Major incidents shall also be reported to the Chief Inspector, Explosives Branch, Natural Resources Canada; a Provincial/Territorial Safety Officer; and as applicable, an Emergency Measures Official.

Any incident which involves a spill at a Mine Site shall be immediately reported to the Mine Site Environmental Representative, and followed up with a copy of the incident report when complete.

7.2 Spills and Releases – Reportable and Significant Classifications

1) Determine if the spill/release is reportable
All environmental incidents are to be input into Cintellate. Reportable spills/releases are not only input into Cintellate, but the investigation and corrective action sections of Cintellate must be completed. To assist in determining if a spill/release is reportable, a listing of common materials with assigned reportable quantities is referenced (see Appendix 5, Reportable Substance List). The reportable quantities utilize the most stringent "reportable quantity" in Canada. Even if the spill/released material is recovered, the media impacted by the spill/release may be reportable to authorities (e.g., a portion of a spill reaching a source of drinking water or wetland). In addition, a spill/release is reportable if the amount equals or exceeds the Dyno Nobel Default Threshold.

2) Determine if the spill/release is significant

- Significant spills/releases are disclosed in the company's annual report. Significant spills/releases trigger time-critical internal actions as required by the company's procedures (crisis communication, internal investigation, etc)

The following table is provided to assist in making these determinations:

Reporting of Environmental Spills

Is the spill reportable?

- Yes if above a Reportable Quantity
- Yes if oil sheen is visible or sludge/emulsion is deposited beneath water surface
- Yes if water quality standards are exceeded
- Yes if from a UST exceeding 25 gallons or result in a sheen

Is the spill significant?

- Yes if authorities implement a national contingency plan
- Yes if "sensitive" environmental features have been impacted
- Yes if neighbors are evacuated
- Yes if authorities and/or neighbors file complaints and/or demand response activities
- Yes if financial impact is >US$100K
- Yes if media coverage is adverse.

7.3 Internal investigation reports will include:

- Name, work address, and phone number of the investigating (reporting) individual
- Identification and quantity of the released substance
- Time, duration, and location of the release
- Nature and quantity of injuries, property damage, production loss, administrative penalty and/or legal liability
- Precautions taken during the incident
- Relevant environmental conditions
- Corrective actions taken at the time of the incident
- Recommended corrective actions to prevent future occurrence

7.4 Senior Management shall be immediately informed by telephone of any major incident that requires Government notification as per Dyno Nobel's reporting procedures.

7.5 Major incidents involving explosive material shall also be reported to the Chief Inspector, Explosives Branch, and Natural Resources Canada by the applicable Regulatory Affairs Coordinator.

Table 7 – 1
REPORTABLE SUBSTANCE QUANTITY LIST

Material Released	Reportable to Authorities		Dyno Nobel Default Threshold (Proposed)
	If Recovered	If Unrecoverable/ Abandoned / Disposed	
AN Solution	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	44 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
AN Prill	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	45 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
SN Prill	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
Acetic Acid	453 Kg (1,000 lbs)	454 Kg (1,000 lbs)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
Sodium Nitrite	45 Kg (100 lbs)	45 Kg (100 lbs)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 1mg/L-N)	Report if released to Drinking Water (DW std at 1mg/L-N)	
Fuel Oil	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	225 Kg (500 lbs); 261 L (69 gallons)
	State Regulations - Varies from Any Amount to specific Trigger Amounts	State Regulations - Varies from All Spills to specific Trigger Amounts	
	95 L (25 gallons) from UST	96 L (25 gallons) from UST	
Mineral Oil	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	225 Kg (500 lbs); 261 L (69 gallons)

	State Regulations - Varies from Any Amount to specific Trigger Amounts	State Regulations - Varies from All Spills to specific Trigger Amounts	
	95 L (25 gallons) from UST	96 L (25 gallons) from UST	
Emulsifier Agents	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	225 Kg (500 lbs); 261 L (69 gallons)
	State Regulations - Varies from Any Amount to specific Trigger Amounts	State Regulations - Varies from All Spills to specific Trigger Amounts	
Granular Aluminum	Not Reportable	Not Reportable	225 Kg (500 lbs)
ANFO	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	45 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
	Reportable if sheen on surface of pond, stream, etc.	Reportable if sheen on surface of pond, stream, etc.	
Emulsion	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	44 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	
Ethylene Glycol	2250 Kg (5000 lbs)	2250 Kg (5000 lbs)	225 Kg (500 lbs)
Sodium Thiocyanate	45 Kg (100 lbs)	45 Kg (100 lbs)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 1mg/L-N)	Report if released to Drinking Water (DW std at 1mg/L-N)	

8.0 DECONTAMINATION

8.1 DNCI's Standard Operating Procedures and safety rules establish work practices that minimize employees' direct and indirect contact with hazardous substances.

8.2 Equipment, rubber boots, gloves and clothes that have been contaminated can be washed with soap and water. Wash water should be collected and disposed of in an approved manner with other contaminated material.

9.0 WORKSITE CLOSURE / SHUT DOWN

9.1 **Plant Shutdown (use appropriate lock-out/tag-out procedures)**

- In the event that a plant is shut down due to weather, flood, or other adverse situation, the Plant Manager / Supervisor or his delegate will ensure that all non-essential power is shut off. The Plant Manager / Supervisor will secure all valves and flow devices so as to prevent accidental opening.
- The Plant Manager / Supervisor shall determine if any raw material or raw material storage will be contaminated or at risk of fire/explosion, and take steps to move the material or isolate it from the contamination / hazard source.
- If the power and/or gas will create a dangerous situation the Plant Manager / Supervisor will cut the outside supply of power, thereby isolating all plant equipment.
- The Plant Manager /Supervisor will advise local Mine authorities of the plant shutdown and preventative actions taken.
- All sensitive documents must be secured.

9.2 **Magazine Closure (use appropriate lock-out/tag-out procedures)**

- In the event that a magazine is closed due to weather, flood, or other adverse situation, the Supervisor/Manager or his delegate will ensure that all non-essential power is shut off. Also, the Supervisor/Manager will ensure that all magazines and compound gates are locked before leaving the site.
- The Supervisor/Manager shall determine if any products or raw materials will be contaminated and take steps to move the material or isolate it from the contamination source.
- If power and/or gas will create a dangerous situation the Supervisor/Manager will cut the outside supply of power, thereby isolating all magazine equipment.

10. RESPONSE TO NATURAL DISASTER

Hurricanes, tornadoes, floods, slides, forest fires, and earthquakes, have the ability to damage or destroy everything in their path. Yet much of the damage or destruction associated with such phenomena is the result of some secondary event, e.g. fallen power lines, ruptured tanks valves, pipes etc. If reasonable warning of an approaching disaster is received, efforts can be made to minimize damage by taking specific preventative measures. These measures are outlined in the following procedures.

1.Consult the Site Supervisor for guidance and proceed according to his direction. **SEE SITE SPECIFIC POTENTIAL HAZARDS APPENDIX 10**
2. If so directed, notify key personnel regarding the action being taken.
3. Collect important files, records and papers for safekeeping.
4. Open main electrical breaker to cut off all power to the site. (The main breaker is marked for easy identification).
5. Secure all buildings and equipment and lock the site gate.
6. Evacuate the site taking mobile equipment to safety.
7. Post Guards on site access routes to monitor the activities of unauthorized personnel.
8. A report of the incident must be submitted to the Area Manager within 24 hours.

10.1 PREVENTIVE MEASURES

10.2 Waste Disposal Permits

If nitrate waste is generated, a disposal permit must be obtained and kept up to date if the product will be disposed of off-site, or in mine tailings. Permits to dispose of other collected waste in the event of spills or leaks (such as described in Section 6.3) must also be obtained in consultation with mine / provincial environmental representatives

10.3 Liquid Containment

All fuel / oil storage tanks must be dyked according to the provisions of Federal and/or Provincial regulations (eg. National Fire Code, Environmental Protection Act), or have a double-walled tank.

A plan must be in place and materials on hand to create a dyke in the event of a large fuel or solution leak or spill or other emergency spill situation.

10.4 Inspection

All site emergency storage areas and equipment must be inspected monthly by qualified personnel, monthly for physical condition and serviceability,

and the results recorded according to quality and safety standard operating procedures.

All recommendations/orders made by NRC Explosives Branch inspectors, Fire Marshals and insurance inspectors must be responded to and acted upon accordingly. Copies of their reports are to be forwarded to DNCI's HSE representative for the region.

10.5 **Maintenance**
All preventive and breakdown maintenance must be carried out and recorded in accordance with standard operating procedures.

11.0 WORK SITE START UP (Restoration of Business)

11.1 Before startup, the condition prompting the shutdown / closure must be over / corrected (i.e. flood, fire, explosion or blizzard).

11.2 All decontamination procedures must be followed and the site cleared and cleaned of any environmental waste hazards.

11.3 All repairs to plant equipment involving safety shutdowns and essential operating machinery must be completed.

11.4 All electrical circuits, plumbing and piping must be tested.

11.5 The Work Site Supervisor / Manager will ensure that all lockout and tag-out procedures have been followed and signed off.

11.6 The Work Site Supervisor / Manager will start up the facility by turning on individual switches to the components that have been shutdown.

11.7 Operational checks will be done to ensure that all equipment is functioning at safe working pressures and voltage.

11.8 The Work Site Supervisor / Manager will give the verbal "all clear" before workers will be allowed to return to work.

11.9 The Work Site Supervisor / Manager or one of their delegates will cancel / remove all roadblocks, terminate evacuation activities, and notify employees to return to normal activities.

APPENDIX 1

Basic Investigation Report

(Factual Report not prepared Under Legal Professional Privilege)

Incident Title	

Incident No.	
Incident Date	
Site	
Department / Location	
Report Author	
Report Date	
Investigation Manager	
Investigation Team Members	
Report Distribution	

Who was involved? **name, job, title**
When did it happen? **date & exact time**
Where did it happen? **The exact location**
What was the person doing at the time? **What product or equipment was involved**
What went wrong? **Not your opinion, only factual information. Eg: an operator fell off a ladder, the hose broke; spill / quantity**
What happened? **Describe the sequence and timing of events**
Immediate Control Actions **What first aid treatment was given and or actions taken (valve turned off, electricity isolated) immediately after the incident to make the situation safe**
Interim Control Action **The interim corrective actions to prevent re-occurrence**
5-Why Analysis - Consolidate the information above into a flow chart Double click on chart to enter visio and update as required

Contributing factors **What factors combined to make the situation unsafe – in descending order of importance**
Root Cause **What were the root causes identified in the 5Why analysis – in descending order of importance**

Corrective Action	**Who**	Due Date

Comments

APPENDIX 2

DNCI Corporate contact

Name	Position	Cell number
Benoit Choquette	Environmental Manager - Canada	(514) 246-6285
Seamus Kilcommons	H&S Manager Western Canada	(403) 815-4066
Tim Marles	H&S Advisor Artic	(403) 723-7540
Willard Pierce	Regional Manager West/ Central Canada	(403) 836-9029
Hubert Fafard	H&S Manager Eastern Canada	(418) 570-9257
Greg Brown	Sales Manager Western	(403) 512-5127
Ralph Olson	Operations Manager of Western Canada	(250) 713-8720
Randy Armella	Bulk Operations Manager	(780) 865-6580
Rick Chopp	H&S Manager – Central Canada	(705) 498-2855
Pierre St Georges	Regulatory Affairs Coordinator	(613) 677-1051
Cory Redwood	General Manager Western Canada	(867) 444-8533

APPENDIX 3

DNCI Emergency Response Advisors (ERA) per area

Name	Position	Cell number	Area (West, Central or East)
Tom Medak	Mgr, Bulk operations	(403) 818-4434	West / Arctic
Dennis Wall & Doug Robertson	Meadowbank Operations Supervisors	(867) 793-4610 opt 2 ext 6804 Cell (867) 222-3930	Arctic
Seamus Kilcommons	H&S Manager Western Canda	(403) 815-4066	West
Tim Marles	H&S Advisor Arctic	(403) 723-7540 office	Artic
Tyrone McClean	Operations manager, Manitoba and Saskatchewan	(204) 687-0046	Central
Corey Rachuk	Plant Supervisor – Flin Flon	(204) 687-0028	Central
Joss Forget	Operations Manager Northern Ontario	(705) 471- 8745	East
David Roy	Manager Plant operations	(418) 570-5604	East
Francois Lambert	Operations Manager	(514) 212-3490	East
Daniel Roy	Dyno Consult , Ste-Sophie	(514) 213-5889	East

APPENDIX 4
SITE: QAAQTUQ / Meadowbank Operations

MANAGEMENT AND WORK SITE CONTACT LIST

NAME	TITLE	BUSINESS PHONE	2 WAY RADIO	CELL PHONE
Dennis Wall	Site Supervisor	(867)793-4610 opt#2 ext 6804		(867) 222-3930
Doug Robertson	Site Supervisor	((867)793-4610 opt#2 ext 6804		(867) 222-3930
Tom Medak	Bulk Manager	(403) 236-9160		(403) 818-4434
Tim Marles	H&S Advisor Arctic	403 723-7540		TBA
Seamus Kilcommons	H&S Manager	(403) 236-9160		(403) 815-4066
Benoit Choquette	Environmental Manager	(450) 818-7176		(514) 249-6285
Pierre St George	Regulatory Affairs Coordinator	(613) 632-5844		(613) 677-1051

Agnico-Eagle Mines Ltd. – Meadowbank WORK SITE CONTACT LIST

NAME	TITLE	BUSINESS PHONE	2 WAY RADIO	CELL PHONE
Meadowbank Mine		(867)793-4610		
Julie Belanger	Agnico-Eagle	(867)793-4610 ext 6721		

EXTERNAL CONTACT NUMBERS

ORGANIZATION/CONTACT	LOCATION	PHONE NUMBER
NT Oil & Chemical Spills	Iqaluit, NU	(867) 979-8130
Environment Canada, NT	Yellowknife, NT	(867) 669-4700
NRC / Explosives Branch	Ottawa	(613) 995-5555
RCMP	Baker Lake, NU	(867) 793-1111 or (867)-793-0123
RCMP 'G' Division	Yellowknife, NT	(867)669-5100

APPENDIX 5

Area Office Address:
Agnico-Eagle Mines Ltd. - Meadowbank
PO BOX 540
Baker Lake, Nunavut
X0C 0A0

Type of Facility:
Bulk Explosives Site

Customer/Client Information:
Customer: Agnico-Eagle
Contact:
Title:

Evacuation and Emergency Meeting Place Upon Evacuation:
As identified on site orientation forms (Designated Muster Points)

Emergency Shutdown switch location:

"ONLY A CERTIFIED PERSONELLE ARE TO ACTIVATE THIS SWITCH"

Magazine and Plant Site Address:

Agnico-Eagle Meadowbank Mine

NRC License:

Site Plan and Evacuation Route:
Posted in site offices – site specific orientations required

Site Rescue Plans:
Site Supervisor or designate to conduct review of attendance sheet. If employees, visitors or contractors are unaccounted for, Site Supervisor will advise mine LPO of unaccounted persons and last known location. Site Supervisor shall attend last known location with mine rescue team and jointly determine potential hazards of re-entering area to locate unaccounted for persons. Site Supervisor and Rescue team entering the evacuated area must don all required PPE due to unknown potential dangers that may have come about. Proper fire retardant suits, SCBA and/or other PPE as determine by the site to protect rescuers from becoming overcome by physical, chemical or other hazards. If determined safe to enter site and/ or buildings, a counter clockwise sweep of the area is to be conducted.

Medical Emergencies: In the unlikely event of a medical emergency, the site shall ensure that it is compliant to OH&S Code. As per legislation requirements, the site shall have adequate first aiders and equipment to attend to individuals as required.

All incidents, first aid/ medical treatment/property damage/near miss or other, shall be in compliance with HSE MS Standard 9.2, which meets or exceeds legislative requirments.

Site First Aiders:	LOCATION	PHONE NUMBER
TBA		
Security (Mine Emergency Services –fire, EMS)		

Emergency Equipment On Hand:
Fire Extinguishers, Spill Kits, First Aid Kits, non-sparking shovels as outlined in site plan.

Delivery Vehicles:			Carrying
		(EVC/ETP)	Capacity
Unit #	Vehicle	TC Permit #	(80% of Max.)

APPENDIX 6
BOMB THREAT CHECKLIST

Exact time of call:
Exact words of caller:
QUESTIONS TO ASK
1- When is bomb going to explode?
2- Where is the bomb?
3- What does it look like?
4- What kind of bomb is it?
5-What will cause it to explode?
6- Did you place the bomb?
7- Why?
8- Where are you calling from?
9- What is your address?
10- What is your name?
CALLER'S VOICE (circle) 1- Calm Slow Crying Slurred 2- Stutter Deep Loud Broken 3- Giggling Accent Angry Rapid 4- Stressed Nasal Lisp Excited 5- Disguised Sincere Squeaky Normal
If voice is familiar, whom did it sound like?
Were there any background noises?
Remarks:

Person receiving call:	Telephone number call received at:
Date:	Report call immediately to:

APPENDIX 7

Dyno Nobel Inc.

JOB-SPECIFIC ORIENTATION CHECKLIST

(Modify as needed to meet site-specific needs)

Employee Name: Job Title:

Location: Hire Date:

CHECK COMPLETED ITEMS. FOR ALL ITEMS THAT ARE NOT APPLICABLE, ENTER "NA" ON THE LINE RETURN COMPLETED AND SIGNED CHECKLIST TO APPROPRIATE HR REPRESENTATIVE

1. JOB SPECIFIC ORIENTATION TO DNA WORK SITE(S)

a. ____ DN Safety & Quality Policy
b. ____ General Safety Rules
c. ____ Site Specific Safety Rules and Instructions
d. ____ Products and Services
e. ____ Tour of Site
f. ____ Rest Rooms, Lockers, Eating Areas
g. ____ Dress and Uniform Standards
h. ____ Personal Protective Equipment
i. ____ First Aid Procedures
j. ____ How to Report Near-Misses and Accidents
k. ____ Workers' Compensation and Return to Work
l. ____ Smoking Policy and Designated Areas
m. ____ Drug and Alcohol Policy
n. ____ Site Emergency and Evacuation Plans
o. ____ Fire Extinguishers
p. ____ DN Crisis Communication Plan
q. ____ Parking and Traffic Plan
r. ____ Security Issues
s. ____ Electrical Hazards
t. ____ Review Job Description
u. ____ Take 5 Program
v. ____ Site Specific SOPs

2. OCCUPATIONAL HEALTH AND SAFETY ACT - REGULATION (OHSA)

a. ____ Mobile Equipment (Forklifts/Bobcats)
b. ____ Review Site MSDS
c. ____ Confined Spaces
d. ____ Lockout/Tagout
e. ____ DNA Hearing Conservation
f. ____ Bloodborne Pathogens
g. ____ Worker's Rights

3. ENVIRONMENT CANADA

a. ____ Spill/Release Reporting
b. ____ Proper disposal of Waste
c. ____ Waste Minimization/Pollution Prevention
d. ____ Used Oil Management
e. ____ Drum/Container Management

4. TRANSPORTATION CANADA (TDG)

a. ____ Road Test
b. ____ TDG Transportation
c. ____ TDG Hours of Service Policy
d. ____ Pre and Post Inspections

5. NATURAL RESOURCES CANADA, EXPLOSIVES SAFETY AND SECURITY BRANCH

a. ____ Site Security Plans / Key Policy
c. ____ Inventory Accuracy
b. ____ Magazine Rules
d. ____ Guidelines for bulk explosive facilities

6. QUESTIONS AND SUMMARY

_
__
_ Ask employee if there are any questions or areas of employment not clearly understood. Advise employee what's next.
Comments
: _____

_____ _____ _____ _____ Employee
Signature Date Trainer/Supervisor Signature Date

Job Specific Orientation Page 1 of 1 Canadian Standard Revised 12/17/09

APPENDIX 8

ANNUAL FIRE DEPARTMENT REVIEW FORM

Information to be released to Emergency Services

From: Local Emergency Services

Subject: Emergency Response Plan for _____.

The following is a copy of the Emergency Response Plan that has been prepared by Dyno Nobel Inc. Has been received from _____ operations. The ERP has been discussed and being kept on file for future reference. If questions arise, we have been given the contact information for the _____ operations staff.

Signed:_____

Position:_____

Date:_____

EMERGENCY RESPONSE REPORT/DEBRIEF TEMPLATE (found in NEXUS Std 9.1)

Site:..... **Date**: ..... **Drill or Actual Event** (circle)

Emergency Call placed with: Mine Emergency ☐ 911 ☐

Supervisor/Manager Advised: ☐

Incident Details:

Sequence of Events

Time	Activity	By

Gaps Identified:

	Details of Gaps Identified	*Action Required
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

A report should be raised in SHAERS/ICARUS listing all gaps identified and action required.

Fax completed form to Health & Safety Advisor for your site

APPENDIX 9
Transportation of Dangerous Goods Regulation
Class Quantity Emission Limit

1	Any quantity that could pose a danger to public safety or 50 kg
2	Any quantity that could pose a danger to public safety or any sustained release of 10 minutes or more
3	200 L
4	25 kg
5.1	50 kg or 50 L
5.2	1 kg or 1 L
6.1	5 kg or 5 L
6.2	Any quantity that could pose a danger to public safety or 1 kg or 1 L
7	Any quantity that could pose a danger to public safety. An emission level greater than the level established in section 20 of the *Packaging and Transport of Nuclear Substances Regulations*
8	5 kg or 5 L
9	25 kg or 25 L

Table identified in Section 8.1(1) of Part 8 of the Transportation of Dangerous Goods Regulation Class Quantity Emission Limit

APPENDIX 10

Emergency Risk Assessment

Site Emergency Response Plan should be based upon a risk assessment of all types of probable emergencies and regulatory impact (as found in NEXUS Std 9.1)

Location Date Analysis Completed Completed by:

Emergency Type	Scenario(s)	Safeguards	Historical Frequency	Future Risk Potential	Loss Severity Rate	Probable Emergency 8+ to be in plan	Regulatory Notifications	Actions / Remarks
Bomb Threat								
Chemical Spill/Release								
Security								
Explosion								
Fire								
Loss/Theft of Explosives								
Equipment								
Process Loss/Interruption								
Catastrophic Injury/Illness								
Trespassing/Vandalism								
Extreme Temperatures								
Earthquake								
Hurricane								
Tornado								
Severe Flooding								
OFF SITE								
Blast Site Incident								
Fire (Forest/Brush)								
Neighboring Facility Incident								
Transportation Vehicle Accident								
Transportation Fire/Explosion Incident								
Transportation Chemical Spill								
Transportation Vehicle Breakdown								

Emergency Assessment Score Information **- Use to evaluate Emergency Type level of risk**

Historical Frequency	Score	Future Risk Potential	Score	Loss Severity Rate	Score	Probability Total A & B (8+) to be in plan
Several Time per Year	5	Several Time per Year	5	Catastrophic	5	
One Time per Year	4	One Time per Year	4	Major/Critical	4	12 or higher
Once Every 3-5 Years	3	Once Every 3-5 Years	3	Serious	3	8-11
Less than Once Every 10 Yrs	2	Less than Once Every 10 Yrs	2	Negligible- No Loss	2	Less and 8
Very Unlikely to Happen Ever	1	Very Unlikely to Happen Ever	1	No Loss Occurrence	1	

APPENDIX 4

MSDS FOR BULK EMULATION AND PRESPLIT

1. MSDS – Dyno Gold Lite Bulk Emulsion

2. MSDS – Detagel Presplit

Material Safety Data Sheet

Dyno Nobel Inc.
2650 Decker Lake Boulevard, Suite 300
Salt Lake City, Utah 84119
Phone: 801-364-4800 Fax: 801-321-6703
E-Mail: dnna.hse@am.dynonobel.com
FOR 24 HOUR EMERGENCY, CALL CHEMTREC (USA) 800-424-9300
CANUTEC (CANADA) 613-996-6666

MSDS # 1052
Date [redacted]

Supercedes
MSDS # 1052 03/21/05
Added Dyno® RG3

SECTION I - PRODUCT IDENTIFICATION

Trade Name(s): DYNO GOLD® C, DYNOGOLD® C EXTRA
DYNO GOLD® C LITE, DYNO GOLD® C LITE SUPER
DYNO GOLD® CS LITE
DYNO GOLD®, DYNO GOLD® LITE
DYNO GOLD® B, DYNO GOLD® B LITE
HD
1116, 1126P, 1136P, 1146P
IREMEX 362, IREMEX 562, IREMEX 762, IREMEX 764
RJ5
RG1-A
RUG-1 (Canada Only)
DX 5007; DX 5010
DX 5013; DX 5013G; DX 5013 PB
TITAN®XL1000
TITAN® 1000, TITAN® 1000 G, TITAN® PB 1000
DYNO® RG3

Product Class: Bulk Emulsion

Product Appearance & Odor: Translucent to opaque, viscous liquid. May be silvery in color. May have fuel odor.

DOT Hazard Shipping Description: As Transported:
Oxidizing Liquid, n.o.s. (Ammonium Nitrate) 5.1 UN3139 II
After Blending with Density Control Agent On-site:
Explosive, Blasting, Type E 1.5D UN0332 II

NFPA Hazard Classification: Not Applicable (See Section IV - Special Fire Fighting Procedures)

SECTION II - HAZARDOUS INGREDIENTS

Ingredients:	CAS#	% (Range)	ACGIH TLV-TWA
Ammonium Nitrate	6484-52-2	30-80	No Value Established
Sodium Nitrate[1*]	7631-99-4	0-15	No Value Established
Calcium Nitrate	10124-37-5	0-35	No Value Established
Fuel Oil	68476-34-6	0-10	100 ppm
Mineral Oil	64742-35-4	0-7	5 mg/m^3
Aluminum *	7429-90-5	0-5	10 mg/m^3

DYNO
Dyno Nobel

[1] Our source of Sodium Nitrate (Chilean) may contain perchlorate ion, which occurs naturally. Although Dyno Nobel does not analyze for the presence of perchlorate anion, based on published studies, the products listed above may contain between 0 and 300 ppm perchlorate.

* The hazardous ingredients marked with an asterisk are not found in the majority of listed products.

Ingredients, other than those mentioned above, as used in this product are not hazardous as defined under current Department of Labor regulations, or are present in deminimus concentrations (less than 0.1% for carcinogens, less than 1.0% for other hazardous materials).

SECTION III - PHYSICAL DATA

Boiling Point: Not Applicable
Vapor Density: (Air = 1) Not Applicable
Percent Volatile by Volume: <30

Evaporation Rate (Butyl Acetate = 1): <1

Vapor Pressure: Not Applicable
Density: 0.8 - 1.5 g/cc
Solubility in Water: Nitrate salts are completely soluble, but emulsion dissolution is very slow.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point: Not Applicable
Flammable Limits: Not Applicable
Extinguishing Media: (See Special Fire Fighting Procedures Section)
Special Fire Fighting Procedures: Do not attempt to fight fires involving explosive materials or emulsion explosive precursors. Evacuate all personnel to a predetermined safe location, no less than 2,500 feet in all directions.
Unusual Fire and Explosion Hazards: May explode or detonate under fire conditions. Burning material may produce toxic vapors.

SECTION V - HEALTH HAZARD DATA

Effects of Overexposure

Eyes: Can cause irritation, redness and tearing.
Skin: Prolonged contact may cause irritation.
Ingestion: Large amounts may be harmful if swallowed.
Inhalation: May cause dizziness, nausea or intestinal upset.
Systemic or Other Effects: *Perchlorate*: Perchlorate can potentially inhibit iodide uptake by the thyroid and result in a decrease in thyroid hormone. The National Academy of Sciences (NAS) has reviewed the toxicity of perchlorate and has concluded that even the most sensitive populations could ingest up to 0.7 microgram perchlorate per kilogram of body weight per day without adversely affecting health. The USEPA must establish a maximum contaminant level (MCL) for perchlorate in drinking water by 2007, and this study by NAS may result in a recommendation of about 20 ppb for the MCL.

Emergency and First Aid Procedures

Eyes: Irrigate with running water for at least fifteen minutes. If irritation persists, seek medical attention.
Skin: Remove contaminated clothing. Wash with soap and water.
Ingestion: Seek medical attention.
Inhalation: Remove to fresh air. If irritation persists, seek medical attention.
Special Considerations: None.

SECTION VI - REACTIVITY DATA

Stability: Stable under normal conditions. May explode when subjected to fire, supersonic shock or high-energy projectile impact, especially when confined or in large quantities.
Conditions to Avoid: Keep away from heat, flame, ignition sources and strong shock.
Materials to Avoid (Incompatibility): Corrosives (strong acids and strong bases or alkalis).
Hazardous Decomposition Products: Nitrogen Oxides (NO_x), Carbon Monoxide (CO)
Hazardous Polymerization: Will not occur.

SECTION VII - SPILL OR LEAK PROCEDURES

Steps to be taken In Case Material is Released or Spilled: Protect from all ignition sources. In case of fire evacuate area not less than 2,500 feet in all directions. Notify authorities in accordance with emergency response procedures. Only personnel trained in emergency response should respond. If no fire danger is present, and product is undamaged and/or uncontaminated, repackage product in original packaging or other clean DOT approved container. Ensure that a complete account of product has been made and is verified. Follow applicable Federal, State and local spill reporting requirements.
Waste Disposal Method: Disposal must comply with Federal, State and local regulations. If product becomes a waste, it is potentially regulated as a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR, part 261. Review disposal requirements with a person knowledgeable with applicable environmental law (RCRA) before disposing of any explosive material.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Ventilation: Not required for normal handling.
Respiratory Protection: None normally required.
Protective Clothing: Gloves and work clothing that reduce skin contact are suggested.
Eye Protection: Safety glasses are recommended.
Other Precautions Required: None.

SECTION IX - SPECIAL PRECAUTIONS

Precautions to be taken in handling and storage: Store in cool, dry, well-ventilated location. Store in compliance with Federal, State and local regulations. Keep away from heat, flame, ignition sources and strong shock.
Precautions to be taken during use: Avoid breathing the fumes or gases from detonation of explosives. Use accepted safe industry practices when using explosive materials. Unintended detonation of explosives or explosive devices can cause serious injury or death.
Other Precautions: It is recommended that users of explosives material be familiar with the Institute of Makers of Explosives Safety Library publications.

SECTION X - SPECIAL INFORMATION

The reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR 372 may become applicable if the physical state of this product is changed to an aqueous solution. If an aqueous solution of this product is manufactured, processed, or otherwise used, the nitrate compounds category and ammonia listings of the previously referenced regulation should be reviewed.

Material Safety Data Sheet

Disclaimer

Dyno Nobel Inc. and its subsidiaries disclaim any warranties with respect to this product, the safety or suitability thereof, the information contained herein, or the results to be obtained, whether express or implied, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND/OR OTHER WARRANTY. The information contained herein is provided for reference purposes only and is intended only for persons having relevant technical skills. Because conditions and manner of use are outside of our control, the user is responsible for determining the conditions of safe use of the product. Buyers and users assume all risk, responsibility and liability whatsoever from any and all injuries (including death), losses, or damages to persons or property arising from the use of this product or information. Under no circumstances shall either Dyno Nobel Inc. or any of its subsidiaries be liable for special, consequential or incidental damages or for anticipated loss of profits.

Detagel Presplit

Material Safety Data Sheet

5700 N. Portland, Suite 301 / Oklahoma City, OK 73112 / Phone: (405) 947-0765 / Fax: (405) 947-0768

SECTION 1 - PRODUCT INFORMATION

TRADE NAME:	Presplit
SYNONYM:	NA
CHEMICAL FAMILY:	Watergel Slurry High Explosive
FORMULA:	Mixture
CAS NUMBER:	None
UN/NA NUMBER:	UN0241
DOT HAZARD CLASS:	Explosive, Blasting, Type E, Class 1.1 D

SECTION 2 - HEALTH ALERT

DANGER - If misused or disposed of improperly, material could explode and cause death or serious injury.
DO NOT HANDLE WHEN IN DOUBT!!
See section VIII - Personal Protection
CHEM-TEL, INC. (800) 255-3924.

SECTION 3 - HEALTH HAZARD INFORMATION

EYE: May cause moderate irritation.
SKIN: May cause moderate irritation characterized my redness and/or rash.
INHALATION: Inhalation of decomposed products may irritate the respiratory tract. Prolonged exposure to these fumes may result in respiratory difficulties (shortness of breath, etc.) and possibly more severe toxic effects.
INGESTION: Swallowing large quantities may cause toxicity characterized by dizziness, bluish skin coloration, methemoglobinemia, unconsciousness, abdominal spasms, nausea, and pain.

SECTION 4 - EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: Flush with large amounts of water. Seek medical aid.
SKIN CONTACT :Remove contaminated clothing. Wash skin thoroughly with soap and water.
INHALATION: Remove from exposure. If breathing stops or is difficult, administer artificial respiration or oxygen. Seek medical aid.
INGESTION: Give 8-16 oz. of milk or water. Induce vomiting. Seek medical aid.

SECTION 5 - RECOMMENDED OCCUPATIONAL EXPOSURE LIMIT/ HAZARDOUS INGREDIENTS

EXPOSURE LIMIT (PRODUCT): None required for product. *React to form Hexaminedinitrate

HAZARDOUS INGREDIENTS:	PERCENT	EXPOSURE LIMIT	PPM	MG/M3
Ammonium Nitrate	<65%	NONE		
Sodium Nitrate	<20%	NONE		
Sodium Perchlorate	<7%	NONE		
Nitric Acid*	<5%	ACGIH - TLV	2	5
Hexamine*	<15%	NONE		
Aluminum	<7%	ACGIH - TLV		
Pentaerythritol Tetranitrate	<2%	NONE		

NOTE: All ingredients are present in a gelled slurry matrix and individual hazard may not be present in this formulation.

SECTION 6 - REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY: Heat (confinement); Stacking (burning).
INCOMPATIBILITY: Can react violently or explode, with reducing agents and organic materials. Avoid amines, strong alkalies & acids. ***HAZARDOUS REACTION / DECOMPOSITION PRODUCTS:*** At high temperatures, especially >374 F, may emit severe toxic fumes of nitrogen oxides. ***CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION:*** Not applicable.

SECTION 7 - FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT & METHOD: NA ***AUTO IGNITION TEMPERATURE:*** Explodes ***FLAMMABLE LIMITS (% BY VOLUME/AIR): LOWER:*** NA ***UPPER:*** NA ***EXTINGUISHING MEDIA:*** Water ***FIRE-FIGHTING PROCEDURES:*** When explosive is burning, ***EVACUATE AREA.*** Avoid breathing vapor. Don't disturb fire, as dusty cloud containing aluminum may form explosive mixture with air. ***FIRE & EXPLOSION HAZARDS:*** Dangerous when exposed to heat or flame. Can support combustion of other materials involved in a fire and is capable of undergoing detonation if heated to high temperatures, especially under confinement including being piled on itself in a burning fire. When heated to decomposition, highly toxic fumes may be emitted. Do not return to area of explosion until smoke and fumes have dissipated. Dry alkali or amine salts are explosive.

Detagel Presplit

Material Safety Data Sheet

SECTION 7 - FIRE AND EXPLOSION HAZARD INFORMATION (con't.)

Internally, product contains detonating cord, consisting of flexible cord with and explosive core of PETN (pentaerythritol tetranitrate) within a textile casing covered by a seamless polyethylene jacket. This portion, if removed from the cartridge, may explode when subjected to fire or shock. PETN crystals, if separated or spilled, are substantially more sensitive to initiation by impact and friction than other components of the product, and care should be taken to avoid shock, friction, and excessive heat.

SECTION 8 - PERSONAL PROTECTION INFORMATION

EYE PROTECTION: Safety goggles approved for the handling of explosives materials.
SKIN PROTECTION: Neoprene, natural rubber, polyethylene or polyvinyl chloride gloves. Use barrier creams, hand protection and protective clothing. ***RESPIRATORY PROTECTION:*** Not normally required. Mechanical filter or supplied air type respirator as required for concentrations exceeding the occupational exposure limit.
VENTILATION: Maintain adequate ventilation. Use local exhaust if needed.

SECTION 9 - PERSONAL HANDLING INSTRUCTIONS

HANDLING: Explosives should not be abandoned at any location for any reason. Do not handle during electrical storms.
STORAGE: Store in a cool, dry, well-ventilated area remote from operations. Storage area should be of non-combustible construction and in accordance with appropriate BATF regulations. Organic materials, flammable substances and finely divided metals should be stored separately. Flames, smoking and unauthorized personnel are prohibited where this product is used or stored. Protect against physical damage, static electricity and lightning.
WARNING: Use of this product by persons lacking adequate training, experience and supervision may result in death or serious injury. Obey all Federal, State, and local laws / regulations applicable to transportation, storage, handling, and use of explosives.
DISTANCE: Always stay from area of explosion or disposal sites. Stay behind suitable barriers.

SECTION 10 - SPILL & LEAK PROCEDURES

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED (IN ADDITION, SEE SECTION 8): Isolate area. Eliminate ALL sources of ignition. Avoid skin contact. Scrape up. Remove soiled clothing.
WASTE DISPOSAL - USE APPROPRIATE METHOD(S): Disposal of unexploded or deteriorated explosives material can be hazardous. Expert assistance is positively recommended in destroying explosives. Accidents can be prevented by thorough planning and handling in accordance with approved methods. Consult your supervisor, or the nearest SEC Regional Office for assistance. If improperly disposed of, material could explode and cause death or serious injury.

In all cases, follow facility emergency response procedures. Contact Facility Environmental Manager for assistance. Report any discharge of oil or hazardous substance that may enter surface waters to the National Response Center (800) 424 - 8802.

Observe all applicable local, state, and federal environmental spill and water quality regulations.

SECTION 11 - PHYSICAL DATA

BOILING POINT: NA ***BULK DENSITY:*** 1.25 g/cc ***MELTING POINT:*** NA ***%VOLATILE BY VOLUME:*** NA
VAPOR PRESSURE: NA ***EVAPORATION RATE (ETHER=1):*** NA ***SOLUBILITY IN WATER:*** Negligible with short term exposure
APPEARANCE/ ODOR: Odorless ,gray/white gel packaged in polyethylene cartridges ***DECOMPOSITION POINT:*** 200 C

SECTION 12 - COMMENTS

This product is classified as a Class 1.1D High Explosive and must be stored in a high explosive magazine. Storage should be in a well constructed, well ventilated, dry structure located to conform with local, state, and federal regulations. The area surrounding an explosive magazine must be kept clear of combustible materials for a distance of 50 feet. Magazine floors and containers must be properly cleaned. Normal operating conditions are assumed unless otherwise stated. If any given information is not clear or does not apply to your situation, STOP, store the material suitably, and seek correct help from your supervisors, Institute of Makers of Explosives or Slurry Explosive Corporation.

Disposal sites must be clear of people at the time of disposal.

NOTICE: The data and recommendations presented herein are based upon data which are considered to be accurate. However, SEC makes no guarantee or warranty, either expressed or implied, of the accuracy or completeness of these data and recommendations. For more detailed information on the hazards of this product, contact the Regulatory Compliance Department at the address below:

Slurry Explosive Corporation
P. O. Box 348
Columbus, Kansas 66725
(620) 597-2552

Revised 6-2001

APPENDIX 5

EMULSION PLAN / BLAST AREA INSPECTION SHEET

Environmental Inspection Report for the Emulsion Plant Area and the Loading of Blast Holes

---

Date: **Inspected By:**

Location: Emulsion Plant **Weekly Inspection**

In Compliance with	Subject	Conform	Non-conform	N/A	Comments
NWB Part B Item 15	Sign posted to inform of a waste disposal facility				
NWB Part D Item 29 MBK SCP NIRB Condition 26	Are there any visual spills?				
NWB Part F Item 19	All Hazardous Waste disposal is located 30m from the ordinary high water mark.				
NWB Part H Item 3	Resources in place to prevent any chemicals, petroleum products, or unauthorized Wastes from entering a water body.				
NWB Part H Item 4 Ammonia Management Plan	Is secondary containment for chemical storage provided.				
NWB Part I Item 9	Monitoring signs are posted in English, French, and Inuktitut.				
MBK SCP	Spill Kits Present				
NIRB Condition 26	Ensure that spills, if any, are cleaned up immediately and that the site is kept clean of debris, including wind-blown debris.				
NIRB Condition 25	Management and control waste in a manner that reduces or eliminates the attraction to carnivores and/or raptors.				

NIRB Condition 27 Ammonia Management Plan	Ensure the hazardous material are contained using environmentally protective methods based on practical best management practices				
	Are storage containers clearly labelled to identify Hazardous substance?				
Ammonia Management Plan	Are storage containers in good condition? Is there any visible damage or leaks? Can the doors be sealed shut?				
Ammonia Management Plan	Where necessary – Are containers with product stored in an upright position?				
Ammonia Management Plan	Do you see any potential environmental hazards posed by these HAZARDOUS containers/materials?				
BMP	Are there any additional environmental hazards/potential impacts that require attention?				
MINE ACT	Are there any Health and Safety issues that should be addressed to prevent injury to workers?				

Pit Location: **Blast Pattern#**

In Compliance with	Subject	Conform	Non-conform	N/A	Comments
NWB Part D Item 29 MBK SCP NIRB Condition 26	Are there any visual spills, including emulsion?				
Ammonia Management Plan	Is there presence of Emulsion outside of the holes that are being loaded?				
NWB Part F Item 19	All Hazardous Waste disposal is located 30m from the ordinary high water mark.				

NWB Part H Item 3	Resources in place to prevent any chemicals, petroleum products, or unauthorized Wastes from entering a water body.				
NWB Part H Item 4 Ammonia Management Plan	Is secondary containment for chemical storage provided?				
NIRB Condition 27 Ammonia Management Plan	Ensure the hazardous material are contained using environmentally protective methods based on practical best management practices				

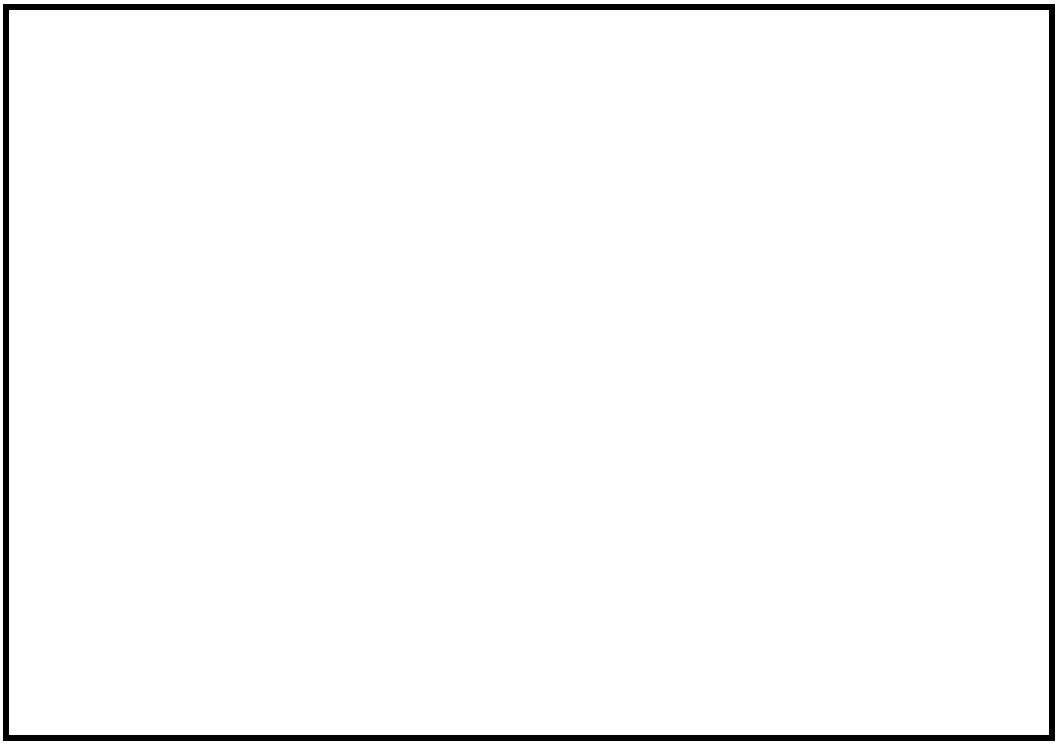
Comments/Recommendations:

Environmental Personnel Name:
Signature: _____

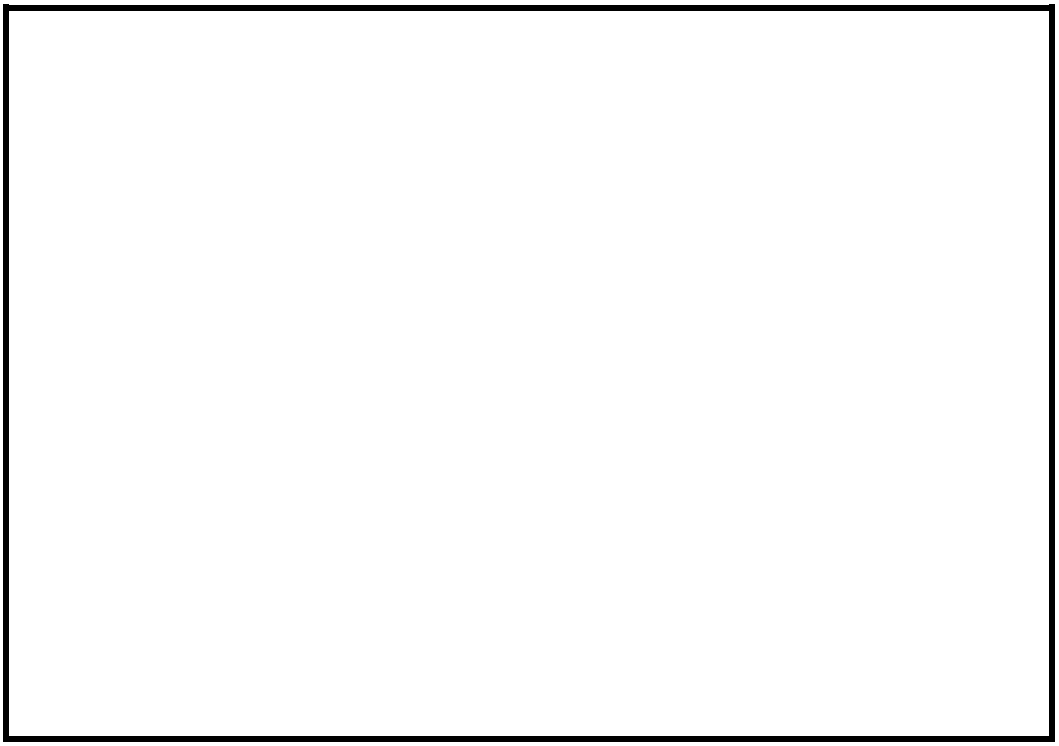
Actions Corrected:
_____
_____
_____
_____
_____

Site Service Supervisor Name: _____

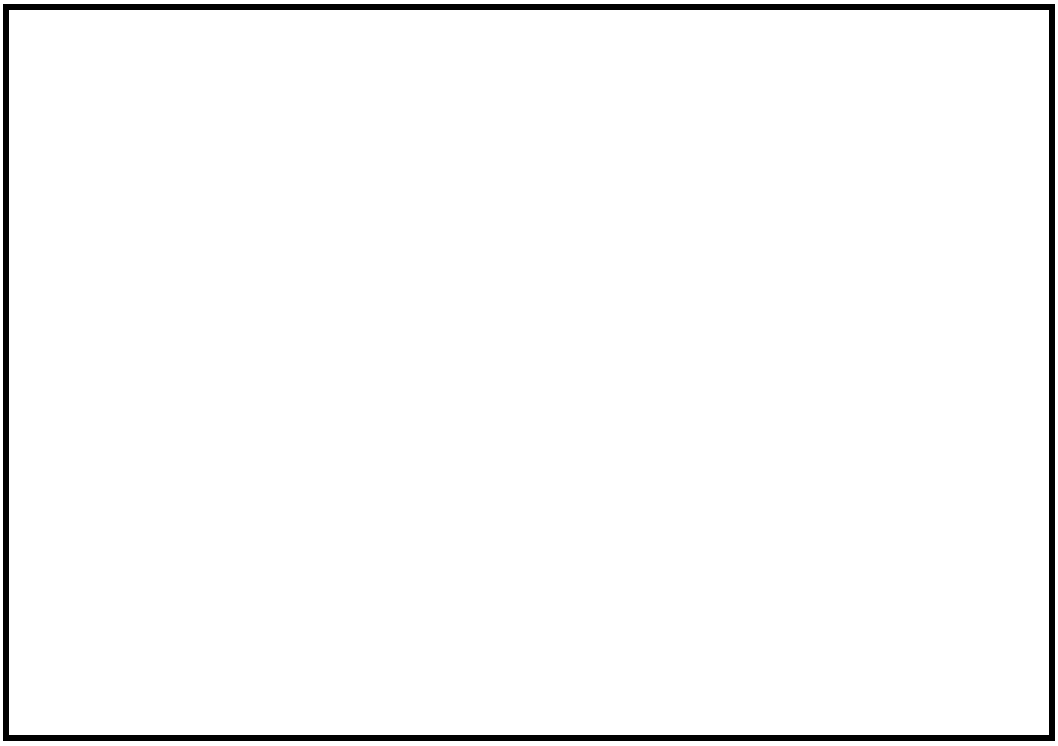
Signature: _____



Picture 1:



Picture 2:



Picture 3:

AGNICO EAGLE

MEADOWBANK GOLD MINE

FRESHET ACTION AND INCIDENT RESPONSE PLAN

OCTOBER 2015

EXECUTIVE SUMMARY

The purpose of this Action and Response Plan is to identify areas of concern around the Meadowbank mine site and the AWAR that need to be managed in an organized and timely manner during the annual freshet period to prevent adverse environmental and operational impacts. The Incident Response section of the Plan outlines specified actions that have and will be taken by AEM to manage and mitigate areas where environmental incidents have occurred, specifically seepage on the north-east side of the Portage Waste Rock Storage area, known as sample location ST-16 (2013) and seepage from the mill (inside) containment structures through the Assay Road southwest of the mill (Mill Seepage - 2013). Any future incidents that have the potential to affect off site water or land will be added and would include any specific mitigation and monitoring actions.

The freshet period typically occurs during the annual snow and ice melt sometime around mid-May and extending until the end of July. During this period excess water is created and must be managed through additional pumping and management practices at vulnerable areas around the site. Mitigation techniques, timeframes and specified roles and responsibilities are outlined in this document for each area of concern.

The main areas of concern are the mining pits and pit walls, the East and West diversion ditches, Vault Road culverts, the areas around the Portage Waste Rock Storage Facility (RSF) including the northern portions of the NPAG waste rock extension, Vault Waste Rock Storage Facility, Northwest corner of the North Cell TSF, Saddle Dam 1 corner, Saddle Dam 2 sump, AWAR culverts near the site and along the road to Baker Lake, RSF – ST-16 Seepage, Assay Road (Mill) Seepage and the Vault Pit area.

It is important that all dewatering and associated infrastructure be in good working order and adequate to receive the expected water flows associated with the freshet period; this includes but is not limited to pumps, ditch and sump maintenance, critical piping system installation and inspection, adequate resource allocation for preparative work and establishing a viable monitoring program for the areas of concern and incident response locations. A concise summary of the 2015 preparation works and roles and responsibilities is presented in the attached Appendix 1 (2015 Freshet Action Plan Procedures). Appendix 1 will be updated yearly to reflect changes in conditions at the Meadowbank site. Appendix 2 contains diagrams depicting the areas of concern and incident respose locations. Schedules 1 and 2 describe the monitoring programs for incident responses.

DOCUMENT CONTROL

Revision				Pages Revised	Remarks
#	Prep.	Rev.	Date		
01	AEM	Internal	April 2014	All	
02	AEM	Internal	May 2015	All	Comprehensive update from 2014 Plan
03	AEM	Internal	October 2015	All	Comprehensive update from May 2015 Plan

Prepared By: _____

Engineering and Environmental Department

Approved by:

_____

Engineering and Environmental Department

TABLE OF CONTENTS

1 INTRODUCTION 8

2 AREAS OF CONCERN 9

2.1 Mining Pits and Pit walls 9
2.1.1 Goose pit 9
2.1.2 Portage pit 9
2.1.3 Vault Pit 10
2.2 Waste Rock Storage Areas 11
2.2.1 PORTAGE RSF 11
2.2.2 VAULT RSF 12
2.3 North Cell Tailings Storage Facility 12
2.3.1 Diversion Ditches 12
2.3.1.1 AWAR culvert – discharge to Third Portage Lake 13
2.3.1.2 West Diversion Ditch Elbow 14
2.3.1.3 Northwest Corner of North Cell TSF 15
2.3.1.4 East Diversion Ditch Low Point 16
2.3.1.5 East Diversion ditch outlet to NP-2 Lake 17
2.3.1.6 NP-2 Outlet and Vault Road Culvert 18
2.3.1.7 North Portion of NPAG Waste Rock Expansion 21
2.3.2 Saddle Dams 21
2.3.2.1 Saddle Dam 1 21
2.3.2.2 Saddle Dam 2 22
2.4 Vault Road Culvert 22
2.5 Stormwater Management POND 22

2.6 Fuel tank Farms 23
2.6.1 Meadowbank Tank Farm 23
2.6.2 Baker Lake Tank Farms 23
2.7 AWAR Culverts on the Baker Lake Portion 23
2.8 Meadowbank Assay Lab 23

3 INCIDENT RESPONSE 24

3.1 ST-16 SEEPAGE 24
3.2 Mill Seepage 26

LIST OF FIGURES

Figure 2-1: View of Portage Pit E area with the associated sumps and trenches 10

Figure 2-2: View of Vault Attenuation pond its associated ponds 11

Figure 2-3: Location of the areas of interest for the 2015 diversion ditches freshet Action plan 13

Figure 2-4: West diversion ditches area of interest 14

Figure 2-5: North Cell West Diversion ditch interception sump 15

Figure 2-6: View of the northwest corner of the ditches 16

Figure 2-7: View of the north low area where a snow build up retained water in spring 2013 17

Figure 2-8: View of the East Diversion ditch outlet into NP-2 Lake 18

Figure 2-9: View of the diversion ditches at the Vault road area 19

Figure 2-10:Turbidity barriers at inlet of NP1 20

Figure 2-11: Turbidity barriers at the inlet of Dogleg Lake 20

Figure 2-12: Vault Road repair 21

Figure 2-13: Portage Pit area with the Stormwater Management Pond 22

Figure 3-3-1: View of the RSF seepage observed at the ST-16 station with a red arrow representing the flow of the seepage. Red Lines represent installed filters and areas where tailings beaches were built up to minimize flow through. 26

Figure 3-3-2: View of the mill seepage area and initial retention berm construction 27

Figure 3-3: View of the mill seepage area and interception trench design 28

List of Appendix

Appendix 1 - 2015 Freshet Action Plan Procedure
Appendix 2 - 2015 Monitoring Location for the Freshet Action Plan

List of Schedule

Schedule 1 – ST-16 Seepage monitoring program

Schedule 2 – Mill Seepage monitoring program

1 INTRODUCTION

The purpose of this Freshet Action and Incident Response Plan is to ensure that AEM can address and manage excess water associated with the freshet season at the Meadowbank site and to ensure AEM has implemented specific management and mitigation measures in response to environmental incidents with potential for off site impacts to water or land.

The freshet season is loosely defined as being a period of time from approximately May 15 – July 30; in some cases this period of time can extend up to early fall when freezing re-occurs (October 15). There are many areas around the site that are vulnerable to this excess water; the goal is to identify these areas and develop a clear plan with defined roles and responsibilities (among AEM Departments), and to manage the freshet flows.

In addition, several guiding principles are applicable to the formation of this plan. The highest priority principles are:

1) to ensure that mine contact water from runoff or seepage is managed to prevent adverse environmental impacts;
2) to ensure that the health and safety of AEM employees is protected, especially with respect to mining operations when excess water is present; and
3) to make sure the site is in compliance with the Nunavut Water Board (NWB) License, Part D, Item 19 and Part E, Item 10.

The plan will identify the areas of concern and discuss the potential risks as well as mitigation measures necessary to address the identified issues. Appendix 1 contains the actual defined 2015 procedures, the roles and responsibilities and associated timelines. AEM's intent is to update the Procedural Appendix on a yearly basis. For example, there may be additional mitigation measures for a defined problem area or in some cases a previously defined issue may be permanently rectified.

The main areas of concern are the mining pits and pit walls, the East and West diversion ditches, Vault Road culverts, the area around the Portage Waste Rock Storage Facility (RSF) including the northern portions of the NPAG waste rock extension, Vault Waste Rock Storage Facility, Northwest corner of the North Cell TSF, Saddle Dam 1 corner, Saddle Dam 2 sump, AWAR culverts near the site and along the road to Baker Lake, RSF – ST-16 Seepage, Assay Road (Mill) Seepage and the Vault Pit area.

Each area identified above will be discussed in detail below. All areas of concern are considered priorities based on the guiding principles.

2 AREAS OF CONCERN

2.1 MINING PITS AND PIT WALLS

All permanent ramps, jump ramps, ditches and sumps must be cleaned of all ice and snow before the month of May in order to contain any water resulting from the snow melt. All pumps must be checked and serviced before the month of May. In addition, a check must be completed confirming that all piping systems starting from the different pits leading to the attenuation pond or the South Cell TSF are free of ice by validating pumping values (if pumping systems are active) and/or performing an air test in the pipe with a compressor.

2.1.1 Goose pit

Mining in Goose pit was completed in April 2015. All pumping equipment has been removed from the pit. Runoff water that accumulates in the Goose pit will now form part of the Goose pit reflooding process.

2.1.2 Portage pit

Water management in the Portage pit has been simplified since the mining of pits B, C and D has been completed. However, infrastructure is in place to prevent runoff water from reaching Pit A and E.

- A pond and ditch system south of Pit E pushback is presented in Figure 2-1. Runoff water accumulated in ponds GP-3, GP-4, GP-8 and Pond 8 will be pumped into Goose pit;
- A pumping station located in pit B (not shown) will be used to manage runoff water affecting the active mining production area in pit A. The water will be pumped to the South Cell Tailings Storage Facility (TSF); and
- A pumping station located in pit E (not shown) will be used to manage runoff water affecting the active mining production area in pit E. The water will be pumped to the South Cell TSF.

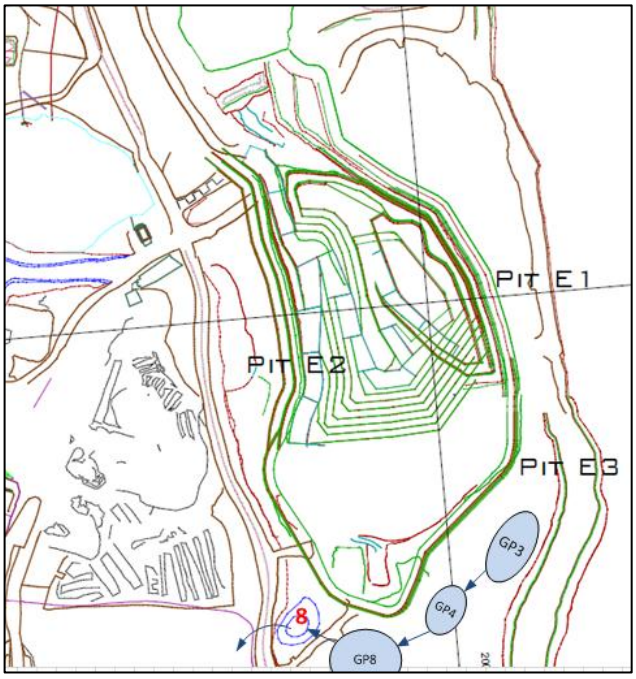


Figure 2-1: View of Portage Pit E area with the associated sumps and trenches

2.1.3 Vault Pit

Since the summer of 2014 (dewatering completed) Vault Lake is now used as an Attenuation pond. The light blue surfaces in Figure 2-2 represent four isolated ponds that form the Attenuation pond (A, B, C & D) used to collect contact water from Vault Pit. Runoff from the pit area and the waste rock storage area that flows into the active mining areas will be pumped to the Attenuation pond.

Discharge from the Vault attenuation pond to Wally Lake may require treatment at the Vault WTP if the water quality does not meet discharge criteria. The Actiflo treatment plant is designed to remove TSS. A diffuser was installed in Wally Lake to meet the Type A Water License requirement. The Environmental department must be notified ten days before discharging any water to Wally Lake to comply with notification and sampling requirements. All piping and the discharge diffuser must be inspected in April in order to have all installations in place to proceed with pumping and/or treatment activities during freshet. The WTP will also be inspected and commissioned to be ready for the pumping season.

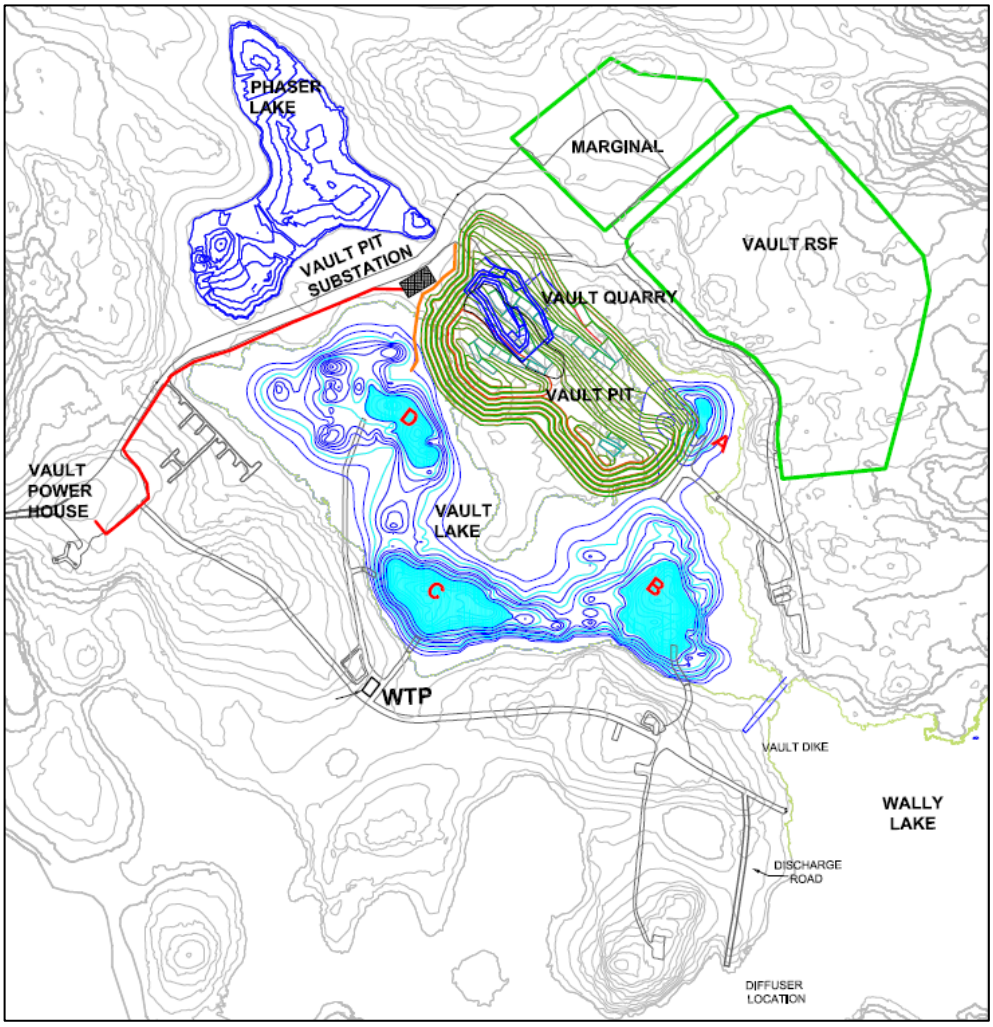


Figure 2-2: View of Vault Attenuation pond its associated ponds

2.2 WASTE ROCK STORAGE AREAS

2.2.1 PORTAGE RSF

The Portage Rock Storage Facility (RSF) will require weekly inspections around the perimeter beginning in mid-May to identify any seepage. As will be noted in the following section, seepage was identified in 2013 at location ST-16. In the event that additional seepage is observed from the RSF, it must be reported to the Engineering and Environment Departments and samples must be taken to determine the water quality and source. A mitigation plan will be prepared and implemented if necessary.

2.2.2 VAULT RSF

Much like the RSF located near Portage pit, the Vault RSF will require some monitoring during the freshet period to ensure adequate water management. Weekly inspections around the RSF perimeter will be conducted to identify any seepage. In the event that seepage is observed, the Engineering and Environment Departments must be notified and samples taken to determine water quality. The sample monitoring will be in accordance with the Water License requirements. It is anticipated that there will be no water quality issues as primary drainage is towards the Vault Pit and Vault Attenuation Pond and the waste rock from the Vault Pit is primarily NPAG.

2.3 NORTH CELL TAILINGS STORAGE FACILITY

Water management around the North Cell Tailings Storage Facility (TSF) is required to maintain integrity of the tailings pond and to prevent any adverse environmental impacts. This section describes the infrastructure in place to control runoff water and reduce possible impact on both the tailings storage facility and the receiving environment.

2.3.1 Diversion Ditches

The East and West Diversion ditches were constructed in 2012 around the North Cell TSF and the Portage RSF. The diversion ditches are designed to redirect the fresh water from the northern area watershed away from the tailings pond and RSF and direct it to Second and Third Portage Lakes. As seen in Figure 2-3, seven zones associated with the dversion ditches have been identified where actions will be taken during or before freshet:

2. 1. AWAR culvert – Discharge to Third Portage Lake;
2. 2. West Diversion Ditch elbow;
2. 3. Northwest corner of North Cell TSF;
2. 4. East Diversion Ditch low point;
2. 5. East Diversion Ditch Outlet to NP-2 Lake;
2. 6. North portion of NPAG waste rock expansion; and
2. 7. Vault road culvert – NP-2 Lake exit to NP-1 Lake.

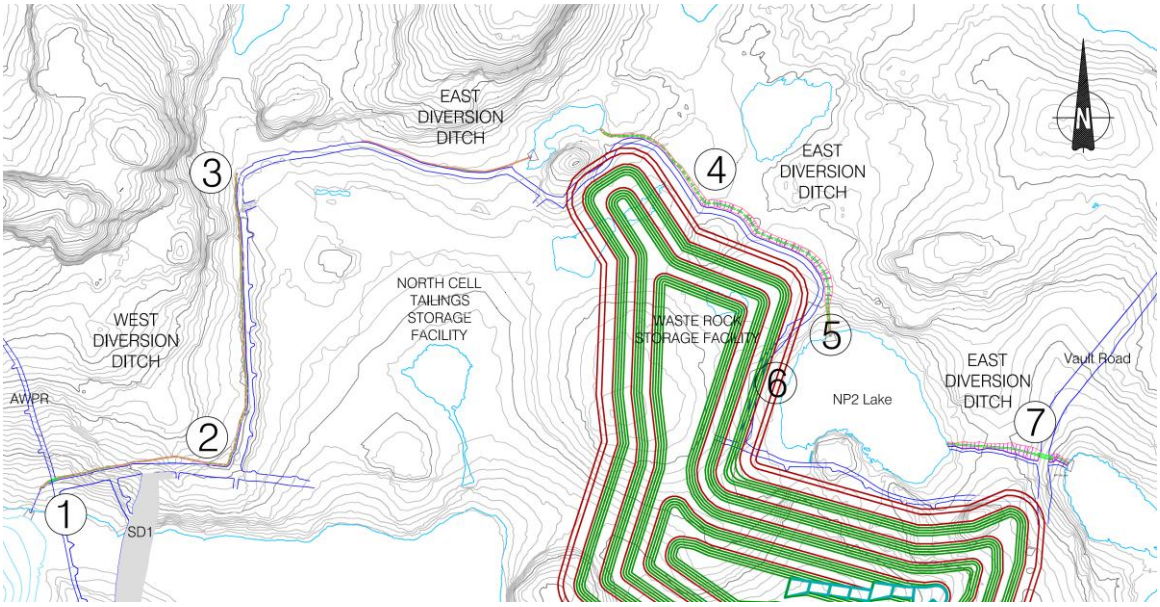


Figure 2-3: Location of the areas of interest for the 2015 diversion ditches freshet Action plan

2.3.1.1 AWAR culvert – discharge to Third Portage Lake

Ditch outflows are important to ensure proper flow of freshet drainage. The culvert under the AWAR (Figure 2-3 #1) is a critical section of the West Diversion Ditch. Snow removal must be performed to avoid ponding and damage to the ditch/trench structure as well as to maintain the integrity of the AWAR which, in turn, is critical to transportation at the Meadowbank mine site.

Figure 2-4 illustrates this culvert. Snow and/or ice must be removed using an excavator on each side of the culvert to allow water to flow through to prevent upstream ponding. The culvert may need to be steamed if blocked by ice. Before starting the cleaning operation, it is important to ensure that the electrical cable (5kV) location has been visually identified.

After flowing through the culvert the water discharges across the tundra into Third Portage Lake – see Figure 2-4 below. Snow and ice needs to be removed in early May to prevent any back up in the West Diversion ditch. This could increase water levels upstream in the ditch causing problems discussed in Section 2.3.1.2. If necessary silt curtains will be installed at the discharge area to Third Portage Lake to control elevated TSS during the freshet period.

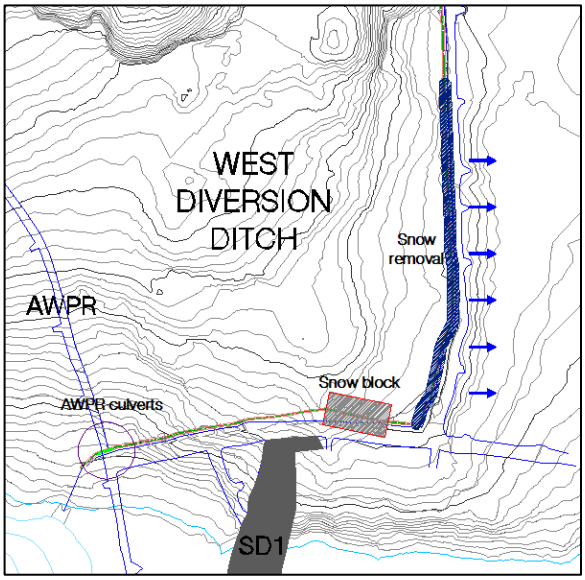


Figure 2-4: West diversion ditches area of interest

A turbidity barrier installed in 2014 has been left in place over the winter. Additional barriers can be installed after ice melt as a contingency. Daily inspections will be conducted starting in mid-May. Sample monitoring will commence when open water is present in accordance with the Water License (ST-6). Sampling frequency of ST-6 may be increased if TSS results are near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated. If a discharge of TSS occurs, the Environment Department will notify DFO.

2.3.1.2 West Diversion Ditch Elbow

One of the deepest sections of the West Diversion ditch is located in the corner next to the Saddle Dam 1 – see Figure 2-4 and Figure 2-3 #2 above. In 2013 a large accumulation of snow blocked the flow through this ditch at a location denoted by the red square. Water accumulated behind the blockage and raised upstream creating channels through the rockfill and into the North Cell TSF. In early May of each year, AEM will remove the snow accumulation to allow the water to flow freely preventing the water upstream from increasing in level and hydraulic head pressure. In addition, large flows can scour the ditch system causing sediment migration through the ditches which could impact Third Portage Lake. To prevent this, snow must be removed from the corner area with a long reach excavator in early May.

As a further precaution, AEM constructed an interception sump located at the west diversion ditch elbow location in 2014. The sump has a capacity of 3000 m³. The sump is designed to intercept water coming from the most critical parts of the West Ditch. Sample monitoring will determine if there is any seepage from the TSF or elevated TSS from the ditch. If water does not meet discharge criteria it will be pumped back to the North Cell TSF. These measures will prevent any contaminated water from reaching Third Portage Lake. This sump will also act as a settling pond

to prevent water with elevated TSS from reaching Third Portage Lake. Daily inspections will be conducted during the freshet. Sample monitoring will also be conducted if necessary. Figure 2-5 shows the North Cell interception/settling sump after the completion of the construction.

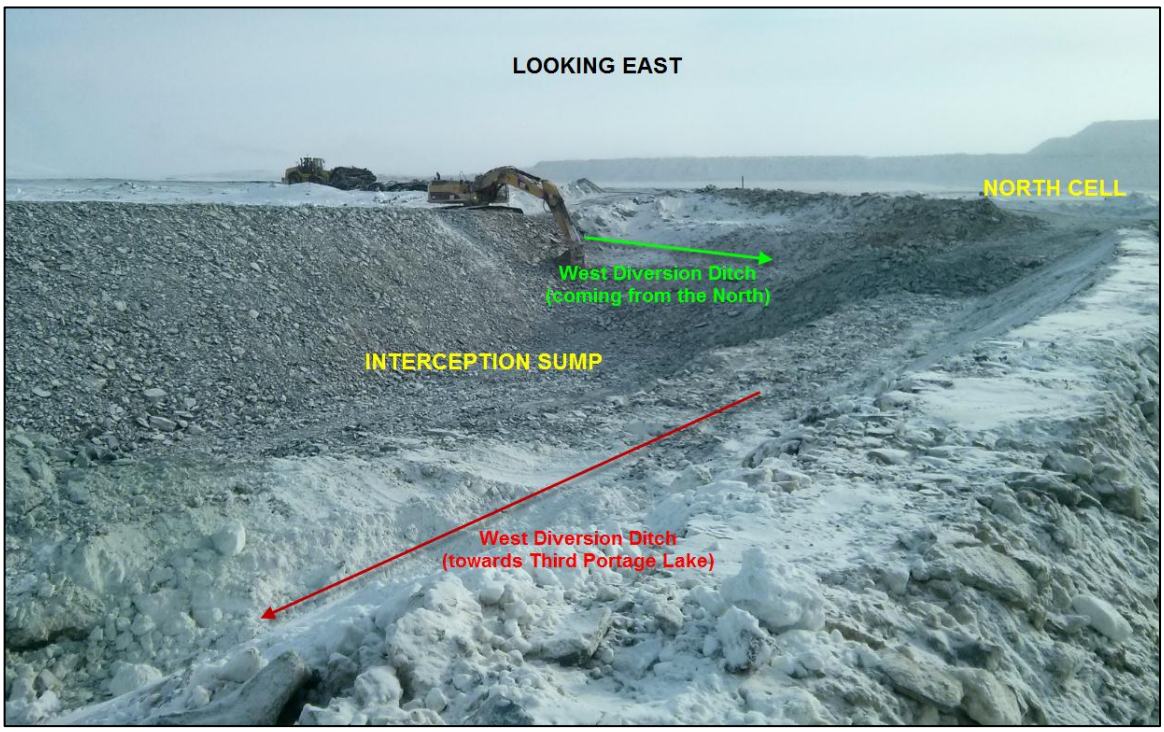


Figure 2-5: North Cell West Diversion ditch interception sump

2.3.1.3 Northwest Corner of North Cell TSF

The construction access road at the Northwest corner of the North Cell TSF (see Figure 2-6 and Figure 2-3 #3) is vulnerable to damage from the freshet water flow from the northern watershed (see watercourse flow in Figure 2-6 denoted by light blue dotted line). The start of the West Diversion ditch is also located in this area and is designed to collect most of the freshet flow – note arrows in Figure 2-6. In order to prevent the water from accumulating against the access construction road and possible overflow to the tailings pond, the snow and ice must be removed in early May from the areas indicated by the red circle in Figure 2-6. This is very important as the start of the West ditch is shallow, must manage a high initial flow rate and can plug easily (with snow). Also, note in the Figure 2-6 two areas where water ponded during the 2013 and 2014 freshet. As a contingency, a pump can be utilized to transfer this water to the North Cell TSF or the West Diversion ditch (non-contact water only). In addition, to prevent any contamination of Third Portage Lake, daily inspections will be completed and samples will be taken if AEM suspects that any seepage contamination is migrating out of the TSF (analysis for CN and metals). If water is contaminated with tailings, the water will pumped back to the TSF.

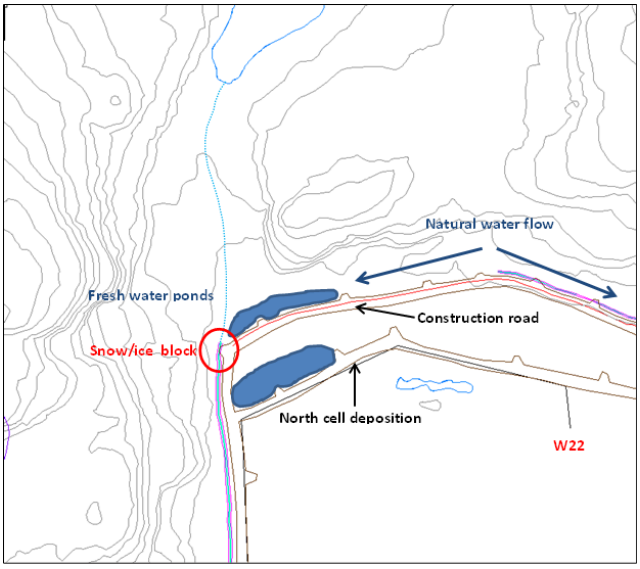


Figure 2-6: View of the northwest corner of the ditches

2.3.1.4 East Diversion Ditch Low Point

There is a low point located on the northernmost portion of the East Diversion ditch – see Figure 2-7 below and Figure 2-3 #4. Snow needs to be removed from this area, denoted by the blue arrow, to prevent watershed flow from following the historical watercourse (dotted line) and reaching the toe of the NPAG Waste Rock extension (RSF). Removing the accumulated snow in early May at a downstream location referenced by the blue arrow will allow the runoff to flow freely through the East Diversion ditch to NP-2 Lake. Daily inspections will be undertaken to ensure the watershed non-contact water flows freely in this section of the East Diversion Ditch.

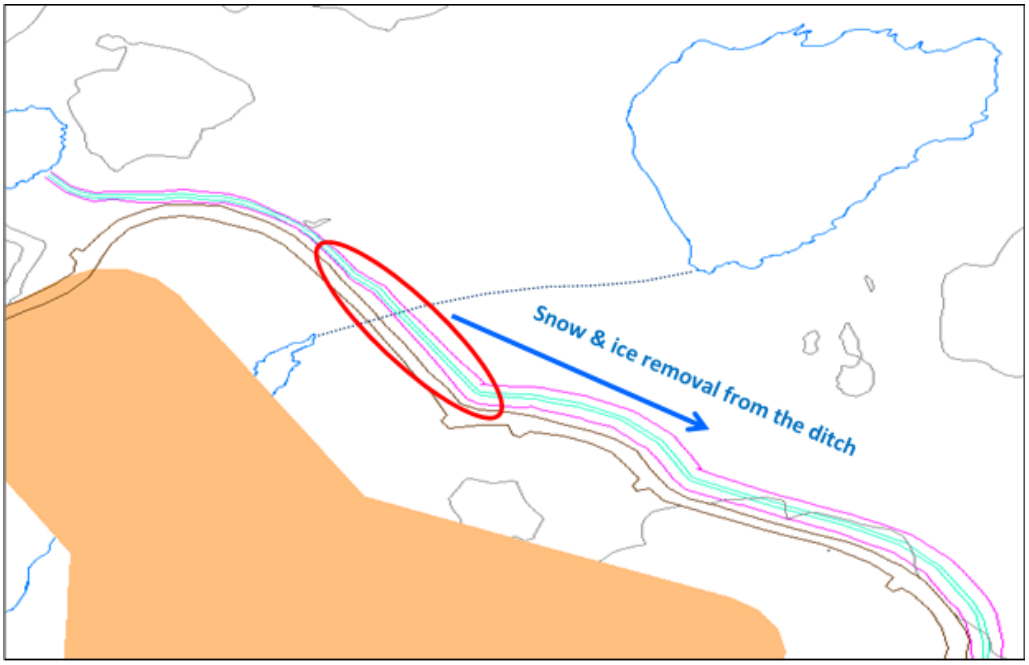


Figure 2-7: View of the north low area where a snow build up retained water in spring 2013

2.3.1.5 East Diversion ditch outlet to NP-2 Lake

This area of the East Diversion ditch, seen in Figure 2-8 and Figure 2-3 #5, is critical as it acts as the outflow of the North part of the East Diversion ditch into NP-2 Lake. This outlet must be cleared of obstructions – snow and ice in early May to promote drainage through the ditch and into NP-2 Lake. The presence of ice blocks will be mitigated using the steam machine to melt away the obstruction. Daily inspections will commence in early May and sample monitoring will be conducted monthly during open water in accordance with the Water License (location ST-5). Sampling frequency of ST-5 may be increased if TSS results are near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated. Turbidity barriers have been installed at the ditch outlet into NP-2 in 2013 to mitigate elevated TSS. If a discharge of TSS occurs, the Environmental Department will notify DFO.

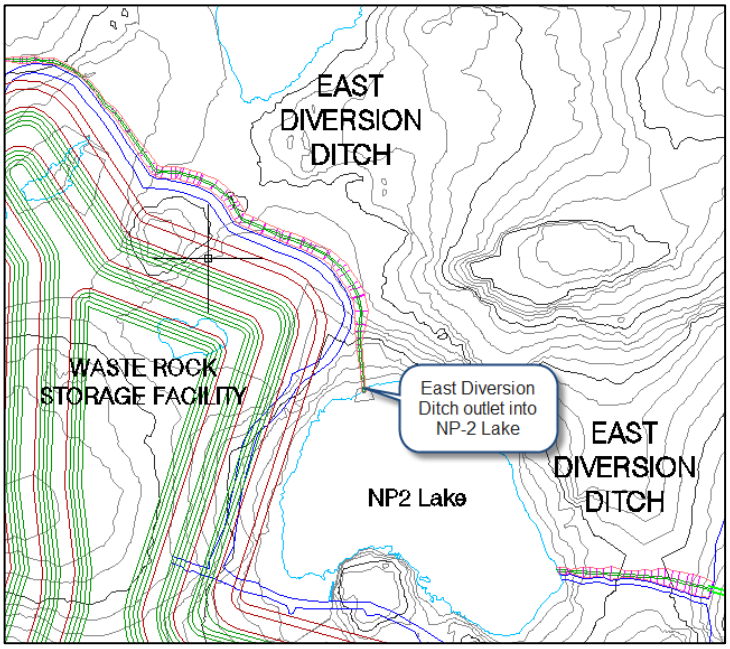


Figure 2-8: View of the East Diversion ditch outlet into NP-2 Lake

2.3.1.6 NP-2 Outlet and Vault Road Culvert

This area of the East Diversion ditch is critical as it acts as the outflow of NP-2 Lake through the Vault Road culvert (see Figure 2-3 #7). The culvert seen in Figure 2-9 connects the East Diversion ditch from Lake NP-2 to NP-1. Snow and ice must be removed from the area, including upstream at the exit of NP-2 Lake in early May to ensure that the outlet of NP-2 flows freely to NP-1 and ultimately to Dogleg Lake. Back up could cause upstream water raises in Lake NP-2 which could cause overflow into the RSF at ST-16. First, snow from the ditch between NP1 and the road (1) would be removed in early May. Next, any obstruction between the road and NP2 Lake (2) would be removed. If needed, the steam machine would be used to remove the ice and snow from inside the culvert (3) and ensure that any other ice obstructions were removed from the outlet of NP2 Lake (4) to allow free flow of melt water. Daily inspections will commence in early May and TSS sample monitoring will be conducted monthly. Sampling frequency may be increased if TSS results are near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated. A turbidity barrier (orange barrier #1) was installed in 2014 at the ditch outlet into NP-1 to mitigate the risk of elevated TSS (Figure 2-10). If a discharge of TSS occurs, the Environmental Department will notify DFO.

In June 2015, while conducting regular inspections as per the Freshet Action Plan, AEM staff observed elevated TSS in the water running under Vault Road (culvert) toward Lake NP-1. The flow was largely localized due to a large accumulation of snow in this area, significant snowmelt occurring due to spring freshet and recent heavy rain. After some additional melting of ice and snow it was clear that water with elevated TSS was flowing past the turbidity and silt barrier that

was in place from last year, onto the lake ice. A second turbidity barrier (yellow barrier #2) was installed just outside of the first barrier. Two additional barriers were also installed as a precautionary measure at the outlet of NP-1 (barrier #3) and at the inlet of Dogleg Lake (barrier #4) (Figure 2-11). The incident was of short duration and the turbidity barriers prevented migration of TSS to Dogleg Lake which is fish bearing. AEM also proceeded to raise the Vault road near NP-1 culverts (Figure 2-12). A different source of aggregate – NPAG from Vault was used (harder material) which will prevent an accumulation of fine material and will allow for water to runoff instead of accumulating or percolating through the road. For the next winter season there will be no additional snow from ploughing placed in this area.

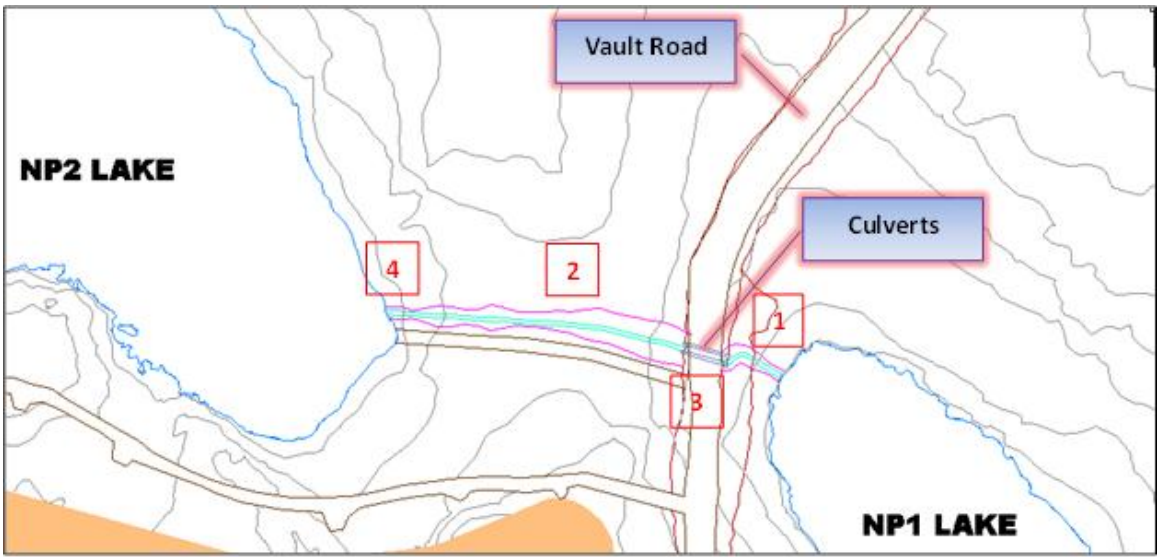


Figure 2-9: View of the diversion ditches at the Vault road area

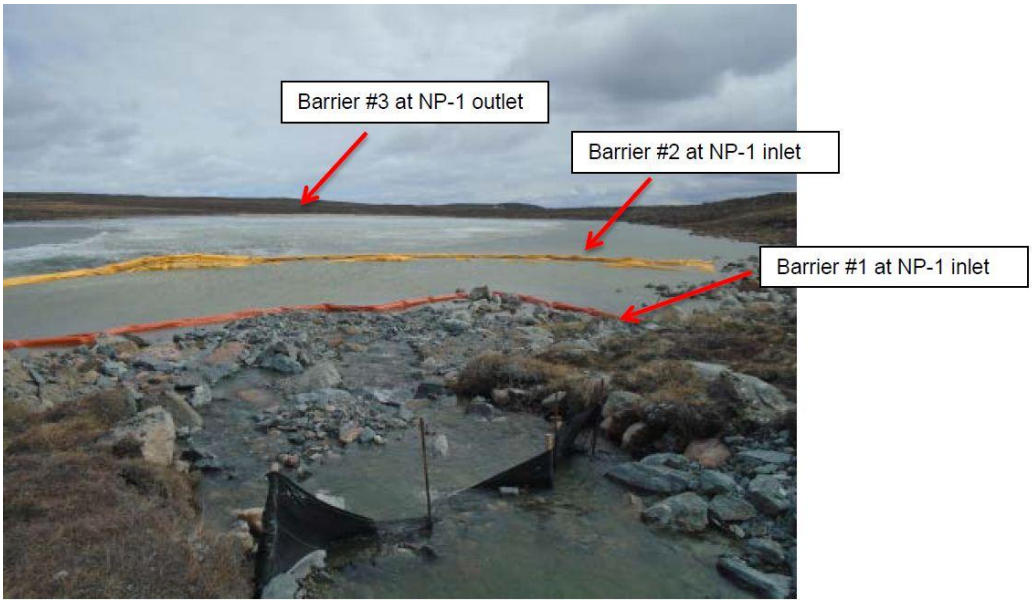


Figure 2-10:Turbidity barriers at inlet of NP1

Figure 2-11: Turbidity barriers at the inlet of Dogleg Lake

.

Figure 2-12: Vault Road repair

2.3.1.7 North Portion of NPAG Waste Rock Expansion

The northwestern area of the RSF, which consists entirely of NPAG material, extends towards the East Diversion ditch as shown in Figure 2-3 #6. Runoff from this area, while not anticipated to be contaminated could, if significant, discharge to NP-2 lake after crossing the tundra. A natural depression should capture most of the NPAG runoff. Daily inspections will be conducted by the Environmental Department. Sample monitoring will be undertaken when water is observed in order to determine water quality. Contaminated water must be kept from reaching NP-2 Lake. Ditching can be undertaken as a mitigation measure if required.

2.3.2 Saddle Dams

2.3.2.1 Saddle Dam 1

This dam, peripheral to the North Cell TSF, is critical to the normal operation of the North Cell TSF. Daily inspections starting mid-May will be required for Saddle Dam 1 (SD1) to ensure that water does not pool against the toe of the dike. A pumping station located along the toe of the dike was installed previously to mitigate the pooling of water at the toe. This pumping station must be operational once water is observed at the toe to pump the water to the TSF. The pumping system must be checked in early May to ensure proper operation. Monthly sampling will be conducted at this station (ST-S-2) during open water conditions in accordance with the Water License.

2.3.2.2 Saddle Dam 2

This dam, just South of SD1, is also critical to the normal operation of the North Cell TSF. Historically, this structure has not had any issues with water pooling at the toe, therefore monthly inspections starting mid-May will be required for Saddle Dam 2 (SD2) to ensure that water does not pool against the toe of the dike. If water is observed at the toe, a mitigation plan will be determined and implemented by the Geotechnical department.

2.4 VAULT ROAD CULVERT

The Vault road crosses over a connection between two water bodies, Turn Lake and Drill Trail Lake, at approximately km 2. A system of culverts was installed to allow flow to occur between the two waterbodies. Beginning in mid-May it will be important to complete daily inspections. In the case that excessive TSS is observed, samples will be taken and analyzed. In the case, where the TSS levels go beyond 30 mg/L, a report will be made to the DFO. Turbidity barriers will be installed as a mitigation measure if needed.

2.5 STORMWATER MANAGEMENT POND

The Stormwater Management Pond is a small shallow and fishless water body that can be seen in Figure 2-13 adjacent to Portage Pit. Treated sewage is discharged into this pond before being transferred to the active TSF. The quantity of water transferred each year is recorded. Weekly inspections will be undertaken to determine the commencement of pumping.

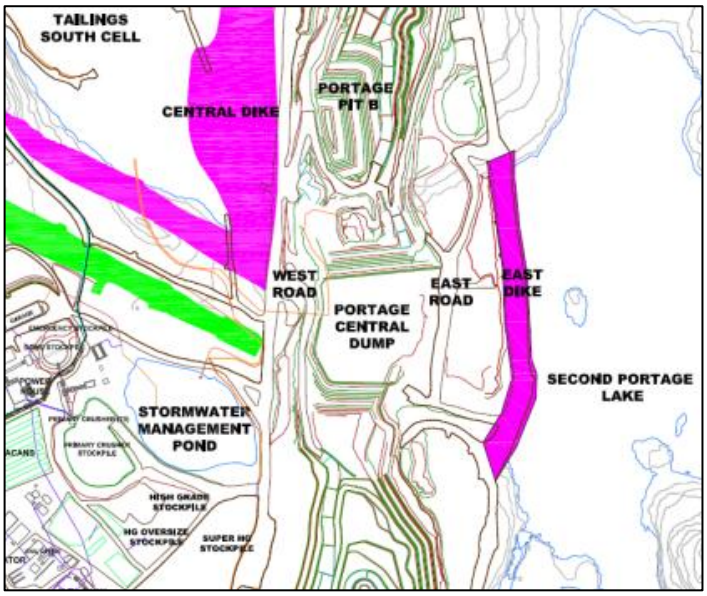


Figure 2-13: Portage Pit area with the Stormwater Management Pond

2.6 FUEL TANK FARMS

2.6.1 Meadowbank Tank Farm

Snow and ice accumulation within the fuel tank farm must be adequately managed to prevent overflow to the environment and/or damage to the fuel handing systems. The Site Service Department will advise the Environmental Department of their intent to pump the containment area once ice/snow begins to melt. Water samples will be taken in accordance with the Water License to ensure compliance prior to its release. A notice must be provided to the Inspector 10 days prior to this pumping activity. Once sample results have been obtained, the Environmental Department will advise the Site Service Department if pumping can begin. If sample results permit, the pumping may begin; to direct water to the tundra/ground in a way to prevent erosion. In the event that the water sample results do not meet discharge criteria the water can be pumped to the Stormwater Management Pond.

2.6.2 Baker Lake Tank Farms

Snow and ice accumulation within the fuel tank farms at Baker Lake must be adequately managed to prevent overflow to the environment and/or damage to the fuel handling systems. The Site Service Department will advise the Environmental Department of their intent to pump the containment area once ice/snow begins to melt. Water samples will be taken in accordance with the Water License to ensure compliance prior to its release. A notice must be provided to the Inspector 10 days prior to this pumping activity. Once sample results have been obtained, the Environmental Department will advise the Site Service Department if pumping can begin. If sample results permit, the pumping may begin; to direct water to the tundra but the flow rate shall be such to avoid erosion or damage to the tundra. **In the event that the water sample results do not meet discharge criteria the water cannot be pumped to the tundra.**

2.7 AWAR CULVERTS ON THE BAKER LAKE PORTION

Weekly inspections will be undertaken at all culverts along the AWAR to ensure that water during freshet is flowing freely and no erosion is occurring. If elevated TSS levels are observed sampling will occur and the results assessed. In addition snow and ice removal may be required to allow the water to flow as per design specifications.

2.8 MEADOWBANK ASSAY LAB

The Assay Lab needs to be advised of the extra sampling that will occur during the freshet period, well in advance. Consideration should be given to reducing the initial sampling after one month period if sample results are consistent or results indicate no elevated contaminant levels. The onsite laboratory, although not accredited, can provide indicative results quickly so that mitigation measures can be implemented in a timely manner.

3 INCIDENT RESPONSE

3.1 ST-16 SEEPAGE

In July 2013, it was noted that seepage from the Waste Rock Storage Facility (RSF) had migrated through a rockfill road at a seepage sump located on the north-east side of the RSF (see ST-16 on Figure 3-1). The seepage, which contained elevated copper, nickel, ammonia and cyanide entered NP-2 Lake. It was determined through investigation that the likely source of the contaminants was reclaim water from the North Cell TSF. This water migrated underneath the RSF through a former watercourse into the seepage sump area (ST-16). AEM took immediate measures to stop the seepage and implement corrective measures to prevent a recurrence. This included, keeping the sump area pumped to a low level, installation of an impermeable barrier (till plug) in the rockfill road, implementation of a comprehensive monitoring program and ensuring tailings deposition was enhanced in the North Cell to create beaches that would stop any water egress (this activity is continuous as it is part of AEM's Tailings Deposition Plan). A permanent pumping system was installed in 2014 in order to direct seepage back to the North Cell TSF. In addition, as mentioned previously (Section 2.3.1.6), snow will be removed from the ditches and culvert at the outlet of NP- 2 to NP-1 Lake to ensure freshet flows do not back up and overflow into the ST-16 seep location and that the north watershed non-contact runoff flows freely through to NP-1 Lake and further downstream (Dogleg Lake) Pumped volumes will be documented and daily inspections of the area will be undertaken. Please note that 2014 pump volumes are reportred in the AEM 2014 Annual Report within the Water Management Report and Plan (Section 3.1.9) and in Table 1 below.

Table 1: Water pumped from ST-16 Seepage back to TSF

	Volume (m^3)	
	2013	**2014**
January	0	0
February	0	0
March	0	0
April	0	0
May	0	14,591
June	0	9,294
July	2,091	3,810

August	2,900	3,386
September	1,364	1,088
October	227	0
November	0	0
December	0	0
Total	**6,582**	**32,169**

During the renewal process for the Meadowbank Type A Water License (2014 – 2015) the KIA requested additional monitoring related to this incident. The revised monitoring plan in NP-2 Lake as well as downstream lakes (NP-1, Dogleg and Second Portage Lakes) is attached in Schedule 1. A discussion and analysis of the 2014 monitoring results can be found in the AEM 2014 Annual Report (Section 8.1.4.2, pg 41 and Appendix G2). The water quality in NP-2 Lake has improved significantly and no impacts have been observed in the aforementioned downstream lakes.

As soon as the Lake and seep area are ice free the sample monitoring program will commence.

In the event that seepage water flows through the rockfill road reaching NP-2 Lake, the Environmental Department will notify authorities.

Also, in 2014, in accordance with the overall mitigation plan for this incident, tailings beaches were built along RF-1 and RF-2 before tailings deposition switched to the South Cell TSF on November 19 2014. Filters barriers were installed along RF-1 and RF-2 to prevent water egress from the North Cell (suspected source area). Coverplacement was installed in late 2014 and early 2015 along RF-2. Thermistors installed in 2013 indicate that freezeback is occurring along the seepage path. All the information collected in 2014 from the inspections, pumping, thermistors, and sampling results were compiled and submitted as progress reports to regulators. This report “Follow up AEM Report – Seepage Water From Waste Rock Storage Facility – Sample Location ST-16” can be found in Appendix G2 of the 2014 Annual report.

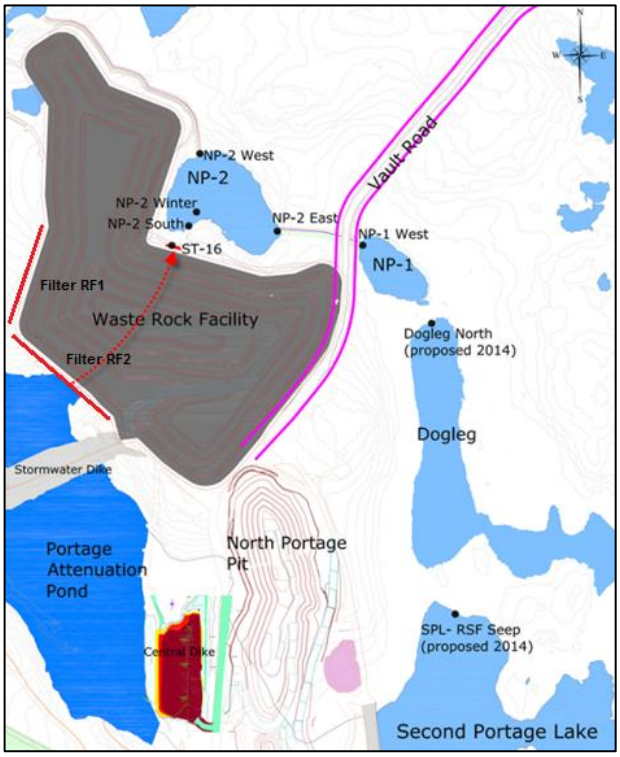


Figure 3-3-1: View of the RSF seepage observed at the ST-16 station with a red arrow representing the flow of the seepage. Red Lines represent installed filters and areas where tailings beaches were built up to minimize flow through.

3.2 MILL SEEPAGE

In November 2013, AEM observed seepage discharging at a location West of the site access road in front of the Assay Lab (see Figure 3-2). Initial sample results revealed elevated cyanide and copper which is indicative of mill processes. After an investigation, which included sampling, the source was determined to be seepage from several containment areas within the mill; the worst being the CIP tank overflow collection sump. Repairs to seal all the mill sumps and containment areas was completed in 2014 thus stopping the source of the seep. AEM hired Tetra Tech in December 2013 to propose a drilling delineation program and further steps necessary to control the seepage and prevent offsite migration to Third Portage Lake – see Figure 3-3 for the seep location. AEM completed the drilling program and based on the results constructed an interception/collection trench prior to the 2014 freshet (completed early May 2014).

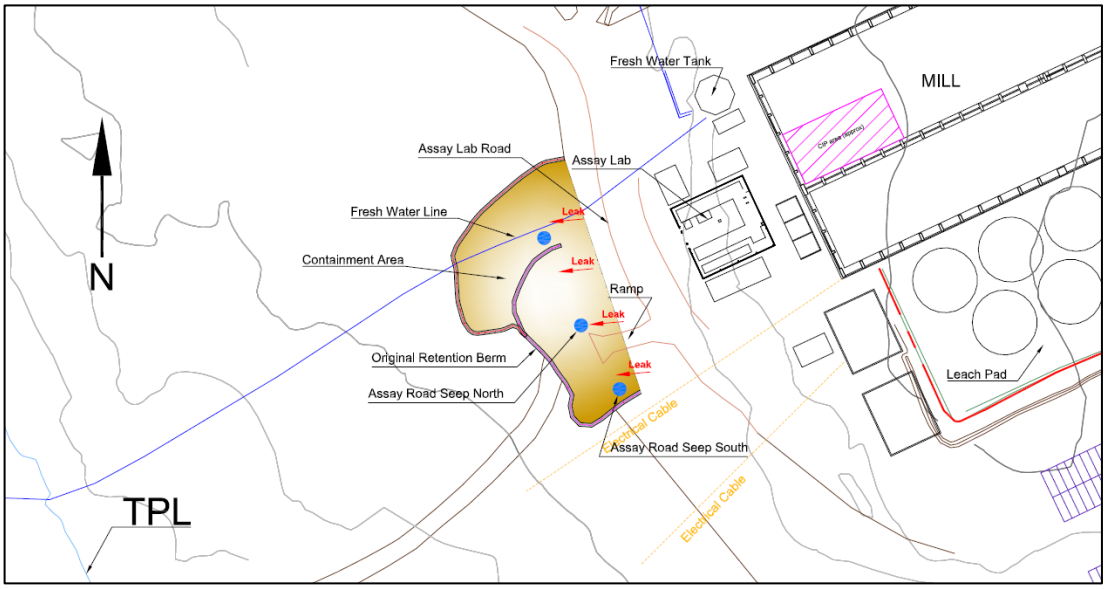


Figure 3-3-2: View of the mill seepage area and initial retention berm construction

The design of the trench can be seen in Figure 3-3. A pumping system was installed and all water collected is pumped back to the mill. Pumping begins as soon as water is evident and volumes are recorded monthly – See Table 2 below.

Table 2: Water pumped from Mill Seepage back to the mill

	Volume (m^3)	
	2013	**2014**
January	0	0
February	0	0
March	0	0
April	0	0
May	0	2,450
June	0	1,935
July	0	1,158
August	0	3,979

September	0	2,420
October	0	1,043
November	Ice	842
December	0	871
Total	**0**	**14,698**

In addition, a recovery/monitoring well, MW-203, located beside the Assay Lab upstream of the trench is continuously pumped back to the mill to intercept the seepage. 2014 pump volumes are reported in the AEM 2014 Annual Report within the Water Management Report and Plan and included in Table 2 above.

CN WAD (on site uncertified lab) levels in MW-203 have diminished significantly over the winter of 2015 as have the flow rates. This well will remain in operation.

As soon as the trench, monitoring wells and Third Portage Lake are unfrozen a comprehensive monitoring program will be implemented. This program is attached in Schedule 2. A complete discussion of the monitoring results for 2014 is included in AEM's 2014 Annual Report (Section 7, pgs 32-34). In summary, the results of monitoring indicate that the interception trench and initial containment berm were substantially successful in preventing any contaminants from reaching Third Portage Lake. The levels of contaminants decreased significantly during the monitoring period in the interception trench. The seepage appears to have been effectively contained and the source area has been repaired.

Daily inspections will be conducted of the pumping, collection systems and perimeter area and the pumped volumes will be recorded in 2015.

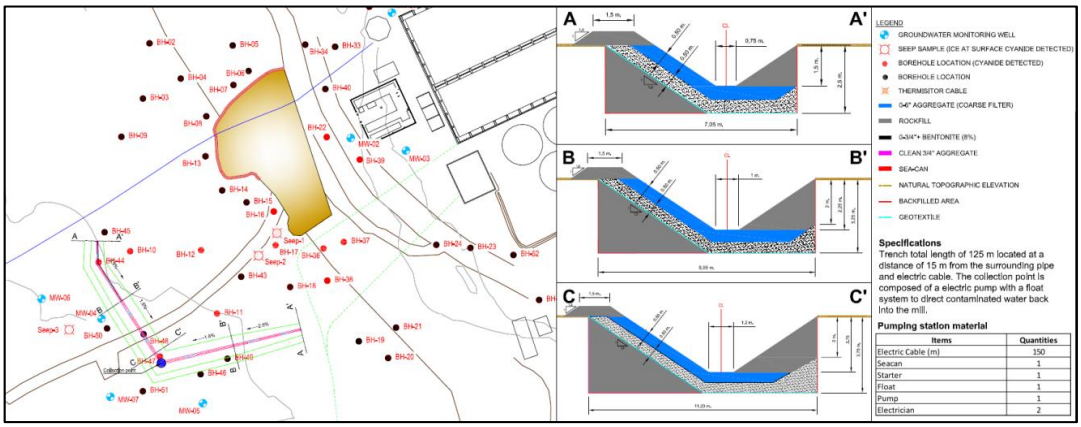


Figure 3-3: View of the mill seepage area and interception trench design

APPENDIX 1

2015 Freshet Action Plan Procedure

Section	Area of Concern	Role/Action	Responsbilities	Dates
2.1	**Mining Pits and Pit Walls**			
2.1	Mining Pit and Pit walls - General	1) Clean all ice, mud and snow on all permanent ramps, jump ramps, etc.	Mine Operations	Before May
		2) Check and service all pumps.	Dike/Dewatering and Maintenance	Before May
		3) Check that all piping systems starting from the different pits leading to the South Cell TSF are free of ice by validating pumping values (if pumping systems is active) and/or performing an air test in the pipe with a compressor.	Dike/Dewatering	Before May
2.1.1	**Goose Pit**			
2.1.1	Goose Pit	1) No further action in this area during the freshet period as mining is complete in Goose Pit. Water and/or ice will remain as part of the pit reflooding activity.	Engineering	N/A
2.1.2	**Portage Pit**			

2.1.2	Portage Pit	1) Runoff water accumulated in ponds GP-3, GP-4, GP-8 and Pond 8 will be pumped into Goose pit; 2) Runoff water accumulated in pit B will be pumped to the South Cell Tailings Storage Facility (TSF); 3) Runoff water accumulated in pit E will be pumped to the South Cell Tailings Storage Facility (TSF).	Geotech tech and Engineering	Before June
2.1.3	**Vault Pit**			
2.1.3 Vault Pit		1) The dewatering of Vault Lake was completed in 2014. During the freshet period water management consists of making sure all sumps are pumped to the Vault Attenuation Pond (former Pond D).	Mine Operations	May to Sept
		2) Set-up pumping from pond A & D to Vault Attenuation Pond (former Pond B & C) to prevent water from flowing into the Vault pit area.	Mine Operations	
		3) Notify Environmental Department before discharging any water to Wally Lake. **NOTE: Any discharge of contact water must be through the Diffuser.**	Water engineers and Engineering	Freshet/Summer 2015
		4) Inspect all piping and discharge diffuser	Dike/Dewatering	May
		5) Inspect and commission the WTP	Dike/Dewatering	May
2.2	**WASTE ROCK STORAGE FACILITY**			

2.2.1 Portage RSF Inspection	1) Weekly inspection around the RSF perimeter to identify any seepage.	Env. Department	May - as soon as freshet starts until freeze up
	2) If seepage observed notify Eng Department AND sample for Cn and Water License Parameters.	Env. Department	May - as soon as freshet starts until freeze up
2.2.2 Vault RSF Inspection	1) Weekly inspection around the RSF perimeter to identify any seepage.	Env. Department	May - as soon as freshet starts until freeze up
	2) If seepage observed notify Eng Department AND sample for Water License Parameters – ST-24.	Env. Department	May - as soon as freshet starts until freeze up
2.3 NORTH CELL TAILINGS STORAGE FACILITY			
2.3.1 North Cell Tailings Storage Facility (Diversion Ditch areas)			
2.3.1.1 AWAR Culvert - West Diversion ditch exit to TPL	1) Snow and/or ice must be removed with an excavator on each side of the culvert to allow water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
	2) If needed, steam to free any ice blockage.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20

	3) Before starting snow clearing operation, make sure the electrical cable location has been visually identified in the field.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
	4) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
	5) ST-6 sampling as per Water License and monthly inspection.	Env. Department	Monthly as soon as freshet starts (open water) and continue until freeze up.
	6) Increase frequency of ST-6 sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated, can use onsite assay lab for this (provide notice). Extra sample to Multilab if needed.	Env. Department	Depends on TSS result
	7) Have turbidity and silt barriers in place at TPL (2) and maintain.	Env. Department	May - before freshet starts and until water freezes up

		8) Report any discharge of TSS to DFO/NWB (grab > 30 mg/L).	Env. Department	May - as soon as freshet starts and until water freezes up
2.3.1.2	West Diversion Ditch elbow near SD1	1) Snow and/or ice must be removed with an excavator to allow water flow and prevent ponding upstream.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
		2) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
		3) Sample for TSS monthly (Multi Lab) and as needed for Turbidity - can use on site lab for TSS if necessary. Increase frequency of sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average).	Env. Department	May - until Freshet complete and after rain events
		4) If water exceeds Water License criteria (TSS - 30 mg/L (grab) and 15 mg/L (monthly average), contact Engineering to pump water to TSF and temporarily stop (dam) flow through ditch to prevent impact to TPL.	Env Dept/ Eng Dept if limits exceeded, Dikes/Dewatering if pumping needed	May - as soon as freshet start and until water freeze up
2.3.1.3	Northwest corner of North Cell TSF (West Diversion ditch)	1) Snow and/or ice must be removed with an excavator to allow water flow to enter West Diversion Ditch.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May

	2) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
	3) Sample if suspect Tailings water - analyse for Cn, Copper, Iron - can use onsite lab for CN WAD as indicator.	Env. Department	May - until Freshet complete and after rain events
	4) If tailings water present - water to be pumped back to TSF, contact engineering and dikes/dewatering.	Env. Dept Eng. Dept if limits exceeded, Dikes/Dewatering if pumping needed	May - as soon as freshet start and until water freeze up
	5) Tailings beach to be maintained in North TSF.	Water engineers to ensure tailings deposition	All year
2.3.1.4 East Diversion Ditch low point (E 638418, N7216815). **(area where former pipe was through road)**	1) Snow removal to allow free water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
	2) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events

2.3.1.5	East Diversion ditch outlet to NP-2 Lake	1) Snow and/or ice must be removed with an excavator on each side of the culvert to allow water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
		2) If needed, steam to free any ice blockage.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
		3) Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
		4) ST-5 sampling as per Water License and monthly inspection (keep record).	Env. Department	Monthly as soon as freshet starts and until water freezes up
		5) Increase frequency of ST-5 sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average), or visually elevated, can use on site assay lab for this (provide notice). Extra samples to Multi lab if necessary.	Env. Department	Depends on TSS result
		6) Install turbidity barriers in NP-2, if needed, and maintain.	Env. Department	May - before freshet starts and until freeze up or water clears

		7)	Report any discharge of TSS to DFO/NWB (grab > 30 mg/L).	Env. Department	May - as soon as freshet starts and until water freezes up
2.3.1.6	East Diversion Ditch - NP2 Oulet and Vault Road culvert.	1)	Snow and/or ice must be removed with an excavator on each side of the culvert and upstream at the exit of NP-2 Lake to allow water flow.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
		2)	If needed, steam culvert to free any ice/snow blockage.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Before May 20
		3)	Daily inspection - keep record.	Env. Department	May - until Freshet complete and after rain events
		4)	Install turbidity barriers in NP-1, if needed, and maintain - see # 5 below.	Env. Department	May - before freshet starts and until freeze - up
		5)	Sample for TSS monthly (Multi Lab) and as needed for Turbidity. Increase frequency of sampling if TSS near 30 mg/L (grab) and 15 mg/L (monthly average) - use on site assay lab as this location is not regulated. Multi Lab to verify levels >30 mg/l - install turbidity barrier for elevated levels	Env. Department	May - until Freshet complete and after rain events

2.3.1.7	North portion of NPAG Waste Rock Expansion	1) Daily inspection - keep record	Env. Department	May until runoff complete
		2) Sample for ST-S-XX and ST-16 metals when water observed; sample upstream (background)in diversion ditch for same parameters and compare results (rush analysis). If results indicate potential for impact, ie results are > background, meet with engineering and determine necessity of ditching	Env. Dept + Eng Dept assistance if ditches needed	May until runoff complete
		3) Prevent **contaminated** contact water from reaching NP-2.	Env. Department	May until runoff complete
2.3.2	**Saddle Dams**			
2.3.2.1	Saddle Dam 1	1) Inspect pumping system	Dikes/Dewatering	Early May
		2) Daily inspection - keep record	Eng Dept and Dikes/Dewatering	May and until water freezes
		3) Start pumping to TSF when water observed. Keep volume pumped out.	Eng Dept and Dikes/Dewatering	After May and until water freezes
		4) ST-S-2 sampling as per Water License.	Env. Department	Monthly as soon as freshet starts and until water freezes

2.3.2.2	Saddle Dam 2	1) Monthly Inspection - keep record.	Geotech engineer and Engineering	May until water freezes
2.4	**VAULT ROAD CULVERT**			
2.4	Vault road culvert from Turn Lake to Drill Trail Lake (~km 2 on Vault road)	1) Daily inspection - keep record	Env. Department	May - until Freshet complete and after rain events
		2) Install turbidity barriers, if needed, and maintain	Env. Department	May - until freshet complete and after rain events
		3) Sample monitoring for TSS, if excess turbidity observed - use onsite assay lab and Multi Lab to verify levels >30 mg/l.	Env. Department	May - until freshet complete and after rain events
		4) Report any discharge of TSS to Drill Tail to DFO (grab > 30 mg/L).	Env. Department	May - until freshet complete and after rain events
2.5	**STORMWATER MANAGEMENT POND**			
2.5	Stormwater Management Pond	1) Pump Stormwater to applicable TSF in Spring/Fall - pumped volume must be kept.	Site Services and Dike/Dewatering	When required in Spring and/or Fall

2.6 FUEL TANK FARMS			
2.6.1 Meadowbank Tank Farm	1) Site Service to advise Env Dept in advance of intent to pump once ice melts in containment area	Sites Servies and Env. Department	Probably mid-June and September
	2) Sample water in accordance with Water License to ensure compliance with limits prior to release.	Env. Department	Probably mid-June and September
	3) Provide notice to Inspector 10 days prior to pumping.	Env. Department	Probably mid-June and September
	4) Advise Site Services if pumping can begin based on sample results.	Env. Department	Probably mid-June and September
	5) Pump to tundra/ground or Stormwater Mgt Pond (note pumping to Stormwater Mgt Pond does not requi:re compliance with limits - at Meadowbank only). **NOTE: The water cannot be pumped out to the tundra if it does not meet the Water License criteria.**	Site Services	Probably mid-June and September
2.6.2 Baker Lake Tank Farms	1) Site Service to advise Env Dept in advance of intent to pump once ice melts in containment area.	Sites Servies and Env. Department	Probably mid-June and

			September
	2) Sample water in accordance with Water License to ensure compliance with limits prior to release.	Env. Department	Probably mid-June and September
	3) Provide notice to Inspector 10 days prior to pumping.	Env. Department	Probably mid-June and September
	4) Advise Site Services if pumping can begin based on sample results.	Env. Department	Probably mid-June and September
	5) Once approval given by Env Dept, Site Services can pump to tundra but must avoid erosion during pumping, ie., low flow, the volume must also be determined by Site Services personnel **NOTE: The water cannot be pumped out to the tundra if it does not meet the Water License criteria.**	Site Services	Probably mid-June and September
2.7	**AWAR CULVERTS ON THE BAKER LAKE PORTION**		
2.7 AWAR Culverts on the Baker Lake Portion	1) Weekly inspection of culverts along AWAR to Baker Lake.	Env. Department	May 2015

		1) Sample for TSS and Turbidity if elevated TSS observed.	Env. Department	May - until freeze up
		2) Notify Site Services if severe erosion/scouring observed - for repair action.	Env. Department	May - until freeze up
		3) Install turbidity barriers if required.	Env. Department	May - until freeze up
2.8	**ASSAY LAB**			
2.8	Meadowbank Assay Lab	1) The Assay Lab needs to be advised of the extra sampling that will occur well in advance of the freshet.	Env. Department	May 2015
		2) Consideration should be given to reducing the initial sampling after an initial one month period. If we are managing the water as planned (i.e. on site) there is no need to require extra sampling.	Env. Department	May 2015
3.0	**INCIDENT RESPONSE**			
3.1	**ST-16 Seepage**			
3.1	ST-16 Seepage	1) Check Piping from pump to discharge area at North Cell TSF.	Engineering and Dikes/Dewatering	Early May

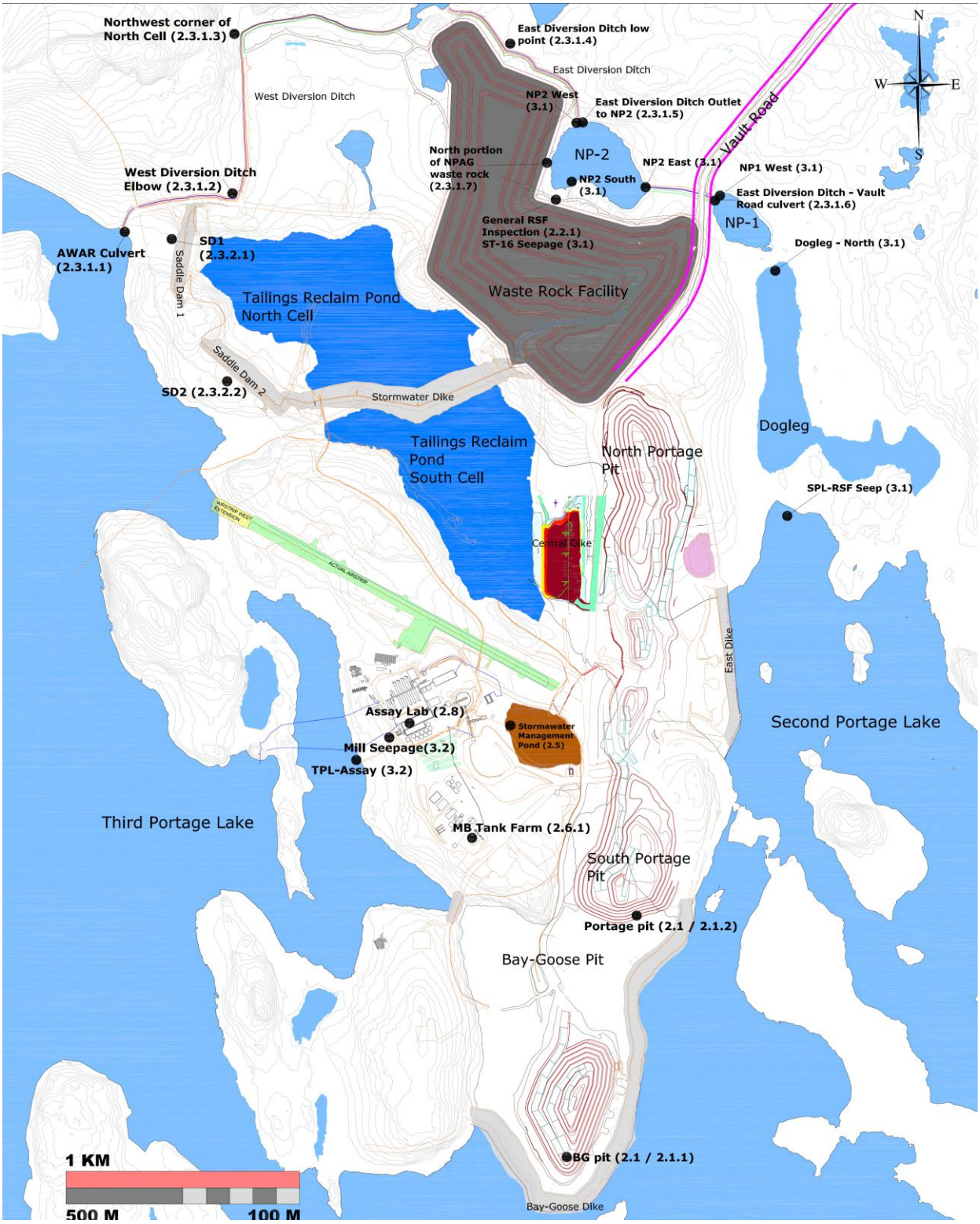
2) If the snow accumulation is judged to be too great, then snow must be removed.	Engineering to coordinate with Site Service, Mine and Dikes/Dewatering	Early May
3) Daily inspection - keep record.	Env. Dept, Eng Dept and Dikes/Dewatering	May - as soon as freshet starts until freeze up
4) Notify Eng. Dept and Dikes/Dewatering when water present and pumping can start. **Water level to be maintained, as a minimum, below the till plug elevation. Water should not pond against the Till plug for extended time periods - ie < 2 - 3 hours. For emergencies the mine water trucks can be requested. Start pumping.**	Env. Department	May/early June - as soon as free water present and ice has melted until freeze up
5) Water sampling program starts when water present in accordance with attached Schedule 1.	Env. Department	May/early June - as soon as water present until freeze up
6) Any seepage through rockfill road to NP-2 must be reported to Env Dept and authorities.	Env. Dept, Eng Dept and Dikes/Dewatering	May/early June - as soon as water is present until freeze up
7) Thermistor Monitoring.	Env. Department	Ongoing throughout the year

		8) Submit progress/update report to regulators.	Env. Department	Annual Report2015
3.2	**Mill Seepage**			
3.2	Mill Seepage	1) Pump water from the trench to the mill - volumes documented.	Env. Dept with assistance from Site Services	Start May/early June when water present until freeze-up
		2) Daily inspection of pumping, collection systems, bermed areas and perimeter area – keep record. **For emegencies the mine water trucks can be requested.**	Env. Department	Start May/early June when water present until freeze-up
		3) Monitoring Program – in accordance with attached Schedule 2, commences when water present and ice has melted.	Env. Department	May/early June as soon as water present until water freeze

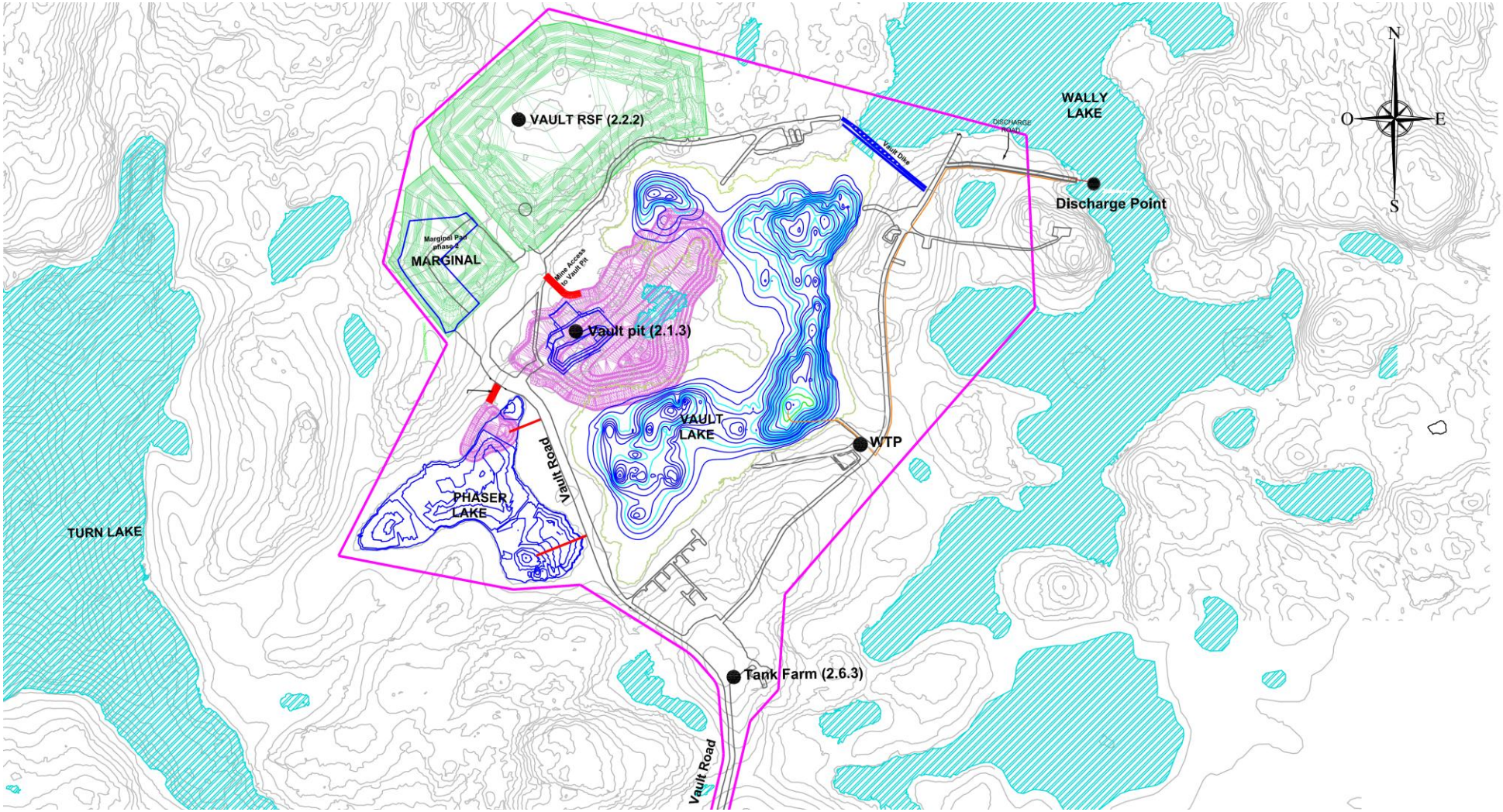
APPENDIX 2

2014 Monitoring Locations and Areas of Concern for the Freshet Action and Incident Response Plan

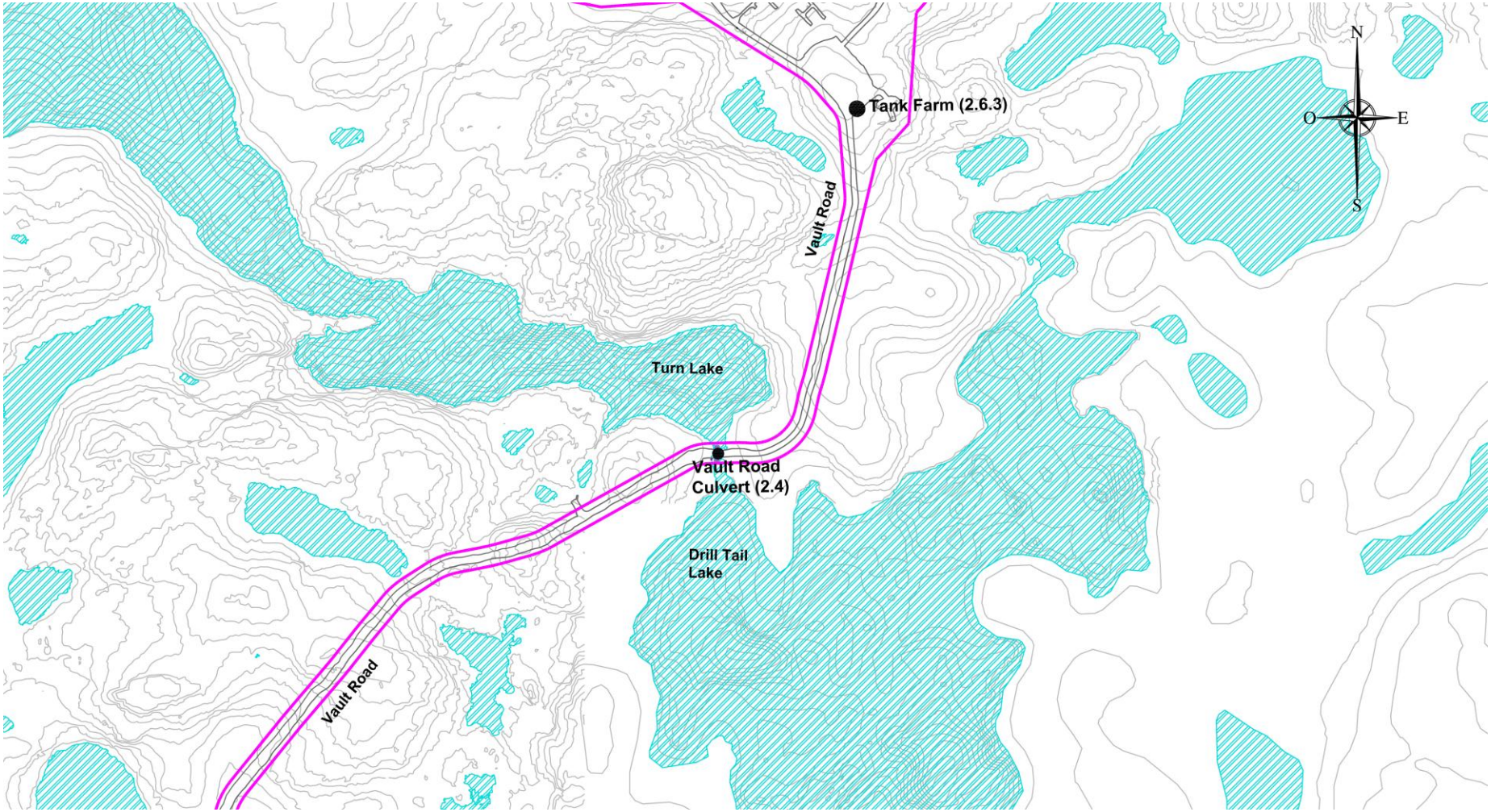
Meadowbank Areas of Concern and Monitoring Locations


Northwest corner of North Cell (2.3.1.3)
East Diversion Ditch low point (2.3.1.4)
East Diversion Ditch
West Diversion Ditch
NP2 West (3.1)
East Diversion Ditch Outlet to NP2 (2.3.1.5)
Vault Road
N
W
E
S
North portion of NPAG waste rock (2.3.1.7)
NP-2
NP2 East (3.1)
NP1 West (3.1)
West Diversion Ditch Elbow (2.3.1.2)
NP2 South (3.1)
East Diversion Ditch - Vault Road culvert (2.3.1.6)
General RSF Inspection (2.2.1)
ST-16 Seepage (3.1)
NP-1
AWAR Culvert (2.3.1.1)
SD1 (2.3.2.1)
Saddle Dam 1
Dogleg - North (3.1)
Tailings Reclaim Pond North Cell
Waste Rock Facility
Saddle Dam 2
SD2 (2.3.2.2)
Stormwater Dike
Tailings Reclaim Pond South Cell
North Portage Pit
Dogleg
SPL-RSF Seep (3.1)
Central Dike
East Dike
Assay Lab (2.8)
Second Portage Lake
Stormawater Management Pond (2.5)
Mill Seepage(3.2)
TPL-Assay (3.2)
Third Portage Lake
MB Tank Farm (2.6.1)
South Portage Pit
Portage pit (2.1 / 2.1.2)
Bay-Goose Pit
BG pit (2.1 / 2.1.1)
Bay-Goose Dike
1 KM
500 M
100 M

Vault areas of concern


VAULT RSF (2.2.2)
WALLY LAKE
Vault Dike
DISCHARGE PIPELINE
Discharge Point
N
O
E
S
Marginal Pad phase 2
MARGINAL
Mine Access to Vault Pit
Vault pit (2.1.3)
VAULT LAKE
WTP
Vault Road
PHASER LAKE
TURN LAKE
Tank Farm (2.6.3)
Vault Road

Vault Road areas of concern


Tank Farm (2.6.3)
Vault Road
Turn Lake
Vault Road
Culvert (2.4)
Drill Tail
Lake
Vault Road
N
O
E
S

SCHEDULE 1

ST-16 Seepage Monitoring Program

ST-16 Seepage Monitoring Program (May/early June - as soon as water present until freeze up)			
Parameters	**Laboratory**	**Station**	**Frequency**
pH, Conductivity, Turbidity, Colour, Hardness, Bromide, Thiosulfate, Fluoride, Thiocyanate, Alcalinity, Ammonia-nitrogen, Total Ammonia, Nitrite, Nitrate, TDS, Chloride, Sulfate, Ortho-Phosphate, TOC, TSS, Dissolved Oxygen (DO), Total Kjeldahl Nitrogen (TKN), Mg, K, Dissolved and total metal: Al, Ag, As, Sb, Ba, Be, B, Cd, Cu, Cr, Co, Fe, Pb, Li, Mn, Hg, Mo, Ni,Se, Sr, Tl, Sn, Ti, U, V, Zn, and Chlorophyll A (Lake site), CN tot / CN Wad, Total P	Multilab	ST-16 NP-2 South NP-2 West NP-2 East NP-1 Dogleg SPL	Monthly
CN Free	SGS	ST-16 NP-2 South NP-2 West NP-2 East NP-1 Dogleg SPL	Monthly
CN Wad	Assay Lab	ST-16 NP-2 South	2x/week initially and 1x/week after 1 month

SCHEDULE 2

Mill Seepage Monitoring Program

Mill Seepage Monitoring Program (May/early June - as soon as water present until freeze up)			
Parameters	**Laboratory**	**Station**	**Frequency**
CN Total Cu Fe	Multilab	Trench Original Sump MW 4-5-6-7-8	Monthly
CN Free	SGS	Trench Original Sump MW 4-5-6-7-8 TPL-Assay	Monthly
pH, Conductivity, Turbidity, Colour, Hardness, Bromide, Thiosulfate, Fluoride, Thiocyanate, Alcalinity, Ammonia-nitrogen, Total Ammonia, Nitrite, Nitrate, TDS, Chloride, Sulfate, Ortho-Phosphate, TOC, TSS, Dissolved Oxygen (DO), Total Kjeldahl Nitrogen (TKN), Mg, K, Dissolved and total metal: Al, Ag, As, Sb, Ba, Be, B, Cd, Cu, Cr, Co, Fe, Pb, Li, Mn, Hg, Mo, Ni,Se, Sr, Tl, Sn, Ti, U, V, Zn, and Chlorophyll A (Lake site), CN tot / CN Wad, Total P	Multilab	TPL-Assay	Monthly
CN WAD	Assay Lab	Trench Original sump MW 2-3-8-201-202-203	2x/week initially and 1x/week after 1 month

AGNICO EAGLE

MEADOWBANK GOLD MINE

AMMONIA MANAGEMENT PLAN

MARCH 2015

EXECUTIVE SUMMARY

AEM is committed to continue the sample monitoring program, which includes monitoring for Ammonia in all mine pit sumps, seeps, etc., in accordance with the site Water License, implement a comprehensive, regular inspection program related to explosives management within the mine pits, conduct regular inspections at the explosives manufacturing facility (Dyno Nobel) to ensure all explosive products are stored in locked, sealed containers prior to use and continue to perform continuous review of analysis results such that mitigation measures can be implemented when increasing trends of ammonia are determined. It is important to note that AEM has not exceeded any ammonia discharge criteria (Water License or MMER) to date.

This technical note provides guidance for monitoring ammonia levels at the mine site, as part of the conditions applying to waste disposal and management listed in the water license (NWB 2008) for this water quality parameter.

DOCUMENT CONTROL

Revision				Pages Revised	Remarks
#	Prep.	Rev.	Date		
00	SNC		February 2013	All	
01	AEM	1	March 2015	13	Table 1 update
				16	Add section 6

Prepared By: _____

Environmental Department

Approved by:

_____

Environmental Department

TABLE OF CONTENTS

1 INTRODUCTION 5

2 EXPLOSIVE MANAGEMENT AND BLASTING PRACTICES 7
2.1 Site description 7
2.1.1 Explosive Storage 7
2.1.2 Roads 7
2.1.3 Pits 7
2.2 AMMONIA PATHWAYS 7
2.3 EXPLOSIVES AND BLASTING 8
2.3.1 Explosive Products 8
2.3.2 Procedures and Practices 9
2.4 MONITORING 9

3 MILL EFFLUENT 11
3.1 SITE DESCRIPTION 11
3.2 AMMONIA PATHWAY 11
3.3 MONITORING 11

4 WATER MANAGEMENT 13

5 REPORTING 15

6 INSPECTION 16

7 REVIEW OF AMMONIA MANAGEMENT PLAN 17

8 REFERENCES 18

List of Appendix

APPENDIX 1 ENVIRONMENT FIELD STATIONS – MINE SITE VIEW

APPENDIX 2 SPILL CONTROL AND LOADING PROCEDURE PLAN

APPENDIX 3 DYNO NOBEL EMERGENCY RESPONSE PLAN – MAGAZINE, PLANT AND WORK SITE

APPENDIX 4 MSDS FOR BULK EMULATION AND PRESPLIT

APPENDIX 5 EMULSION PLAN / BLAST AREA INSPECTION SHEET

1 INTRODUCTION

The previous version of the Water Management Plan (WMP) for the Mine was presented in 2009 (Doc. 833), updating the first edition of the WMP, support document (Doc. 500) to the Type-A Water License Application for the Mine. The WMP was then updated in 2011 (Doc. 1270). This technical note was produced as an appendix to the 2012 WMP update and covers the ammonia management plan for the mine site. The Ammonia Management Plan is being updated at this time in response to concerns raised during the Water License renewal process (January, 2015 - NWB Technical Meetings – Baker Lake). These concerns were in regard to ammonia loading to mining infrastructure, i.e., the Tailings Storage Facility (TSF) from cyanidation, the use and management of exposives and sewage management. In addition, there was a request for loading calculations of ammonia to the receiving environment. It should be noted that there is no further discharge of mine contact water to Third Portage Lake from the Portage Attenuation Pond. The onsite CREMP program takes into account the overall ammonia levels in Third Portage Lake and to date AEM has not reached any level of concern (no trigger levels have been reached for ammonia).

As a result of these concerns AEM is committed to continue the sample monitoring program, which includes monitoring for Ammonia in all mine pit sumps, seeps, etc., in accordance with the site Water License, implement a comprehensive, regular inspection program related to explosives management within the mine pits, conduct regular inspections at the explosives manufacturing facility (Dyno Nobel) to ensure all explosive products are stored in locked, sealed containers prior to use and continue to perform continuous review of analysis results such that mitigation measures can be implemented when increasing trends of ammonia are determined. It is important to note that AEM has not exceeded any ammonia discharge criteria (Water License or MMER) to date.

This technical note provides guidance for monitoring ammonia levels at the mine site, as part of the conditions applying to waste disposal and management listed in the water license (NWB 2008) for this water quality parameter.

Ammonia is a naturally occurring nitrogen compound found in the environment. However, there are two sources at the mine site that can contribute to the mobilization of ammonia in the groundwater or surface runoff:

1. Blasting of ammonium-nitrate (AN) explosives is typically the primary source of ammonia in areas of mining operations. AN readily absorbs water and dissolves easily, thereby mobilizing ammonia in either groundwater or surface runoff.

2. In gold mine operations using a cyanidation process to extract the gold from the ore, the cyanide in solution is oxidized to cyanate (CNO^-) using a sulfur dioxide (SO_2) air process before discharge to the Tailings Storage Facility. The cyanate can then hydrolyze to ammonia in the Tailings Storage Facility reclaim pond.

Ammonia dissolved in water exists in equilibrium of interchanging un-ionized (NH_3) and ionized (NH_4^+) forms. The equilibrium is influenced by pH, temperature, and ionic strength (salinity) where the amount of un-ionized ammonia is favoured as the pH becomes more basic or as the water temperature or salinity increases. Un-ionized ammonia can readily pass across the gill

surface and enter into the bloodstream of fish, while ionized ammonia passes with greater difficulty. Once inside the fish, both forms of ammonia can cause toxic effects (CCME, 2010). Furthermore, it should be noted that ammonia oxidizes to nitrite (NO_2) and nitrate (NO_3), the former being particularly toxic to fish and humans. Both nitrite and nitrate are regulated by the CMME for the Protection of Aquatic Life.

This ammonia management plan (AMP) proposes monitoring of blasting practices for the assessment of explosive quantity used and blast performance, and monitoring of water quality to determine ammonia levels in waters within the mine site. The monitoring results can be used to review and adjust blasting practices or water management if ammonia levels need to be reduced.

In addition to ammonia, monitoring of nitrate and nitrite is also considered in the AMP, as both water quality parameters are signature compounds of AN explosives. NO_3 is listed with a discharge level threshold in the conditions applying to waste disposal and management in the water license (NWB 2008).

2 EXPLOSIVE MANAGEMENT AND BLASTING PRACTICES

2.1 SITE DESCRIPTION

2.1.1 Explosive Storage

Storage of explosive products will be located at the mine site emulsion plant area. The explosive products arrive by barge at the Baker Lake marshalling area. They are then transported by ground to the emulsion plant located at the Meadowbank mine site.

The emulsion plant area is located approximately four kilometers north of the mine plant and camp site, and is accessible from the All Weather Access Road (AWAR). This area consists of an emulsion plant for the preparation of bulk emulsion explosives, two buildings for the storage of AN, and four explosive magazines along the access road to the plant.

Explosive products at the storage facilities are packed in sea containers, which limit the possibility of spillage. The products are only removed from these containers prior to use at the mine site emulsion plant area. Surface areas are graded to collect water runoff within the storage facilities.

2.1.2 Roads

The AWAR is a restricted access road constructed and operated by AEM for ground transportation between the Meadowbank mine site and Baker Lake. This road is used to transport explosive products from the Baker Lake site facilities to the emulsion plant area at the mine site. In preparation for blasting operations, explosive products are transported from the emulsion plant area to the appropriate blasting locations via local site roads and the Vault Haul Road.

Spillage control protocols, procedures and handling of spilled material, and explosive management for both storage and transport have been established by Dyno Nobel Inc. (Dyno) and are provided in Appendix 2. Explosive products and spills on the AWAR are also referenced in the Meadowbank Spill Contingency Plan.

2.1.3 Pits

The development sequence of the mine site is provided in Section 3 of the 2014 Mine Waste Rock and Tailings Management Plan. Explosives are used for the excavation of waste rock and mining of the ore at the Portage, Goose and Vault pits.

2.2 AMMONIA PATHWAYS

Ammonia not fully detonated within the in-pit blasting operations mobilizes through several pathways on the mine site. Water from drainage runoff is the primary mechanism of mobilization for ammonia residuals remaining within the pits. This water is collected at pit sumps and then has been pumped to the Portage Attenuation Pond, which became the South Cell TSF Reclaim Pond on November 2014. Blasting residuals are also expected to be attached to waste rock and ore materials, which are transported from the open pits to their respective storage and processing facilities. Residuals from waste rock may be washed off by precipitation and be ultimately

conveyed to the South Cell TSF (former Attenuation Pond), or the Vault Attenuation Pond. Residuals from the ore may be carried in the tailings to the Tailings Storage Facility. All of these pathways (mine sumps, Vault Attenuation, South Cell TSF are monitored in accordance with the Water License).

2.3 EXPLOSIVES AND BLASTING

Based on experience at other open pit mines in the Canadian Arctic, the largest potential source of ammonia in mine water will be from explosive residue from blasting. Depending on the wetness of the site, water may leach explosives from blastholes prior to the blast. Other forms of ammonia released from AN are explosives flowing into cracks and fissures in the rock and not detonating, or leading to an incomplete detonation of the explosive column and misfired blastholes. An AN based emulsion is used as a blasting agent at the Meadowbank site. This material is designed to repel water thus minimizing the potential for ammonia to impact mine water.

Blasting operations on site include monitoring of explosive quantities and blast design, procedures and practices. Combined with water monitoring, the compilation of these data is used to assess blasting performance. The results of this assessment are used to adjust blasting practices as needed to:

a) Optimize the use of explosives; and

b) Increase the completion and efficiency of explosive detonations.

Any modifications to blast design are intended to decrease the amount of ammonia that may become available for mobilization in mine water.

This section summarizes the explosive products and blasting design parameters, procedures and practices employed at Meadowbank. Associated monitoring is also discussed.

2.3.1 Explosive Products

Explosive products used at the mine site include bulk explosives (bulk emulsion), packaged explosives, cast boosters, detonating cords, non-electric delay detonators and non-electric lead lines. The material safety data sheets (MSDS) for these products are provided in Appendix 4. Of these products, the greatest potential for water contamination comes from the bulk explosives. Presently, Meadowbank uses emulsion as the primary bulk explosive for its blasting operations.

Bulk emulsions typically contain some or all of the following components:

- Ammonium, sodium and/or calcium nitrate;
- Fuel and/or mineral oil;
- Methylamine nitrate;
- Emulsifiers; and
- Ethylene glycol.

Although bulk emulsions are water resistant, contaminants can be leached from the product if it is left in contact with standing or flowing water for extended periods of time. The performance of the explosive, and hence the potential for post-blast contaminations, deteriorates with the length of time that the emulsion remains in the blasthole after it has been loaded (i.e., sleep time). Blast

procedures currently in use are designed to minimize sleep time so that standing or flowing water is not in contact with the bulk emulsion for extended periods of time.

2.3.2 Procedures and Practices

Quality control procedures are in place to verify AN content in bulk explosives. Quality control procedures for the emulsion occur at the plant and density tests are done at the blast site (on the trucks). Loading procedures specify that blastholes be loaded with emulsion from the bottom of the blastholes to provide a continuous explosive column. Details on the explosive quality control and loading procedures have been established by Dyno and are provided in Appendix 2.

The primary factors that may reduce the amount of ammonia available for mobilization in mine water are:

- Explosives handling
- Completeness of detonation

Bulk emulsion spillage during blasthole loading could (as bulk emulsion is resistant to water) be a source of ammonia that could be carried by water collected in the pits. Spillage control protocols, procedures and handling of spilled material, and explosive management for storage and transport, as well as the emergency response plan, have been established by Dyno and are provided in Appendix 2 and 3.

Incomplete detonation results in higher ammonia residue on the blasted rock. Evidence of incomplete detonation is often observed as an orange fume after a blast and sometimes an orange pigment on the blasted rock. Explosives that have failed to detonate may be observed in the muckpile. Muckpiles are routinely inspected by Meadowbank staff for signs of incomplete detonation.

2.4 MONITORING

Monitoring of explosive handling and blasting is as follows:

a) Explosive quantities: Records of explosive quantities used for in-pit blasting are kept for each blasting event and will be conserved throughout the mine life. Furthermore, a record of blast location (i.e., pit and elevation), blast date, and bulk explosive type and name used (emulsion, with the corresponding ratio of AN over emulsion) is kept for all events.

b) Design parameters: Blast design parameters, as well as changes in the blast design parameters from the standard are recorded and dated.

c) Loading instructions: Loading instruction forms are completed for each blast event and provide a record of the as-loaded parameters for all blastholes in the blast pattern including:
    - Hole depth
    - Collar height
    - Priming (single or double)

- Other observations made by the blast crew (e.g., wetness of holes, use of liners, collapsing holes or difficulty loading)

d) Video footage: Videos are taken of each blast. This practice provides a visual, qualitative record of the results of each blast and provides insight into potential problems such as incomplete detonation (e.g. orange fumes) and misfires, as well as areas of poor muckpile heave and forward movement.

e) Blast audits: Blast audits are conducted on a monthly basis to ensure that best practices are being followed in the field (audits may be adjusted to a lesser frequency if low ammonia levels are consistently observed, or conversely may be adjusted to a higher frequency if high ammonia levels are consistently observed).

An additional monitoring technique commonly used is the measurement of the Velocity of Detonation (VOD), which has been shown to be directly related to the volumetric fraction of the explosive that has been consumed. This technique will be implemented if poor or incomplete detonation is consistently suspected.

3 MILL EFFLUENT

3.1 SITE DESCRIPTION

The mill effluent consists of tailings produced at the mill that is pumped as slurry and deposited in the Tailings Storage Facility (TSF) where the tailings particles are allowed to settle and consolidate. The reclaim water is pumped back to the mill for re-use. Prior to discharge of the mill effluent to the TSF, the effluent is sent to the cyanide destruction process. The cyanide destruction process at Meadowbank uses the sulfur dioxide (SO_2) and air process to oxidize weak acid dissociable cyanide (CN-WAD) to a less toxic form: cyanate (CNO^-) based on the following reactions:

$$SO_2 + O_2 + H_2O + \text{CN-WAD} \rightarrow CNO^- + H_2SO_4$$

The process can also use sodium metabisulfite ($Na_2S_2O_5$) instead of sulfur dioxide in case there are operating issues with the dosing of sulfur dioxide gas in the process. This ensures that chemicals required for the cyanide destruction process (either SO_2 or $Na_2S_2O_5$) are always available.

3.2 AMMONIA PATHWAY

Cyanate produced from the oxidation of CN-WAD can readily hydrolyze to ammonia (NH_3) and carbon dioxide (CO_2) based on the following reaction:

$$CNO^- + H^+ + H_2O \rightarrow NH_3 + CO_2$$

Thus, the mill effluent provides an ammonia loading to the TSF reclaim water.

During the operation of the TSF, the reclaim water will be pumped to the mill for re-use in a closed loop system. Consequently, there will be no discharge of reclaim water to the environment during this period. Furthermore, it is expected that the ammonia concentration will gradually increase in the TSF reclaim pond over time, even though (1) there may be some slight attenuation of ammonia due to microbial/algae activity in the summer and (2) ammonia may oxidize to nitrite and nitrate, particularly near the top of the pond where oxygen is most present.

The Water Quality Forecasting – Update based on the 2014 Water Management Plan Report (SNC, 625618-0000-40ER-0001) provides a forecast of the concentration for ammonia in the TSF reclaim pond during the life of the mine. Furthermore, the report provides a forecast of the ammonia concentration in the Portage and Goose Island Pit once flooding activities has started.

3.3 MONITORING

Concentrations of ammonia, nitrate and nitrite are parameters that are monitored on a monthly basis as part of this sampling campaign of the TSF reclaim water at station ST-21.

In the Water Quality Forecasting – Update based on the 2014 Water Management Plan Report (SNC, 625618-0000-40ER-0001), a maximum ammonia concentration in the TSF reclaim water is evaluated in order to meet the CCME guidelines for the Protection of Aquatic Life in the Portage and Goose Island Pits once flooding activities are completed. If this concentration is exceeded before the end of the flooding operation, measures could be undertaken to lower the ammonia

concentration, as well as nitrate and nitrite if required, in the TSF reclaim pond prior to the transfer of TSF reclaim water to the pits.

Ammonia treatment technologies that could be further investigated, if the need arises, include:

i) Biological nitrification / denitrification during the summer months.

ii) In-situ volatilization of ammonia during the summer months.

iii) Ammonia removal by snow making.

4 WATER MANAGEMENT

Water quantity and quality monitoring assist in the monitoring of ammonia loadings from explosive residuals, as well as ammonia concentration found in the Tailings Storage Facility reclaim pond. The Meadowbank water quality and flow monitoring plan (AEM 2015) and water license (NWB 2008) includes monitoring stations that are used for the monitoring of ammonia loadings. The stations that specifically monitor for ammonia are listed in Table 1 and are shown in the Figures in Appendix 1.

Table 1 Water Monitoring Station Included under the Meadowbank Water License

Station	Description	Phase	Parameters	Frequency
ST-9	Portage Attenuation Pond prior to discharge through Third Portage Lake Outfall Diffuser	Early operation	Ammonia, nitrite, nitrate	Prior to discharge and Weekly during discharge
			Water Volume	Daily during periods of discharge
ST-10	Vault Attenuation Pond prior to discharge through Wally Lake Outfall Diffuser	Late operation	Ammonia, nitrite, nitrate	Prior to discharge and Weekly during discharge
			Water Volume	Daily during periods of discharge
ST-16	Portage Rock Storage Facility	Late operation	Ammonia	Monthly during open water
		Closure	Ammonia, nitrite, nitrate	Bi-annually during open water
ST-17	North Portage Pit Sump	Operation	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge
	Portage Pit Lake	Late operation	Ammonia, nitrite, nitrate	Monthly during open water
		Closure	Ammonia, nitrite, nitrate	Bi-annually during open water
ST-19	South Portage Pit Sump	Early operations	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge
	Third Portage Pit Lake	Late operations	Ammonia, nitrite, nitrate	Monthly during open water
ST-20	Goose Island Pit Sump	Early operations	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge

	Goose Island Pit Lake	Late operations	Ammonia, nitrite, nitrate	Monthly during open water
		Closure	Ammonia, nitrite, nitrate	Bi-annually during open water
ST-21	Tailings Reclaim Pond	Early (North Cell) and late (South Cell) operation	Ammonia, nitrite, nitrate	Monthly during open water
ST-23	Vault Pit Sump	Late operations	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
			Water Volume	Daily during periods of discharge
ST-24	Vault Rock Storage Facility	Late operation	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water
		Closure	Ammonia, nitrite, nitrate	Monthly during open water
ST-25	Vault Attenuation Pond	Late operation	Ammonia	Monthly during open water
			Nitrite, nitrate	Bi-annually during open water

In addition to the monitoring listed in Table 1, the following actions are undertaken as part of the AMP:

- If runoff or seepage is detected at the rock storage facility, water samples collected at the Portage or Vault Rock Storage Facility during late operation will also be analyzed for nitrate and nitrite to complete the suite of signature compounds found in explosive residuals.
- Tailings slurry volumes and density from the mill pumping facility to the TSF are recorded on a monthly basis.
- The records of water volumes pumped from the Portage Pit sumps include the destination: South Cell TSF (former Attenuation Pond).
- The records of water volumes pumped from the Portage or Vault Attenuation Pond will include the destination: Third Portage Lake, Wally Lake or other future destination.

Sampling frequency at the pit sump will also be increased if high variability is identified in observed constituent concentrations as a result of the blasting schedule.

5 REPORTING

Reporting of ammonia concentrations at the sampling stations listed in Table 1 is included as part of the requirement of the water license (NWB 2008). The reporting frequency is provided in AEM (2009b), and includes:

- Brief monthly reports of the compiled water quality monitoring results, sent to the Nunavut Water Board (NWB), the AANDC Water License Inspector and to the Kivalliq Inuit Association (KIA); and

- An annual report submitted to the NWB, KIA, Aboriginal Affairs and Northern Development Canada, Nunavut Impact Review Board, Government of Nunavut, and other interested parties. This report summarizes monitoring results for each sampling station, annual seep water chemistry results, annual groundwater monitoring results, receiving water monitoring results, spills and any accidental releases, measured flow volumes, effluent volumes and loadings, and results of QA/QC analytical data.

Mine operation personnel reviews on a monthly basis the data gathered from the sampling stations in Table 1 and from the monitoring action proposed under the AMP. If the data indicates that further studies and/or significant changes to the water management infrastructure are required to assess or control ammonia concentrations, AEM will notify the Nunavut Water Board as early as practical. Results of these further studies and/or changes to the AMP monitoring actions will be transmitted to the Nunavut Water Board for review.

6 INSPECTION

On a weekly basis, the environment department will conduct inspection in the blasting area to ensure that the Dyno Nobel loading procedures are being implemented (this will minimize blasting residues). In addition inspections will be undertaken at explosive product storage facilities (Dyno Nobel) to ensure that explosives products are stored in sealed containers and there is no spillage. If any non-conformities are observed follow up action will be undertaken andcorrective measure will be put in place. See Appendix 5 for copy of the AMP inspection form.

7 REVIEW OF AMMONIA MANAGEMENT PLAN

Review of the results of the site water quality and AMP monitoring during the year may provide new information, and/or indications that changes to the AMP are necessary. When revisions are warranted, an updated AMP will be submitted to the Nunavut Water Board for review.

8 REFERENCES

AEM (2015), Meadowbank water quality and flow monitoring plan. January 2015.

CCME (2010), Canadian Water Quality Guidelines for the Protection of Aquatic Life, Ammonia.

Golder (2009). Updated Water Management Plan. Agnico-Eagle Mines. July 2009

Golder (2011), Updated Water Management Plan, Agnico-Eagle Mines, July 2011

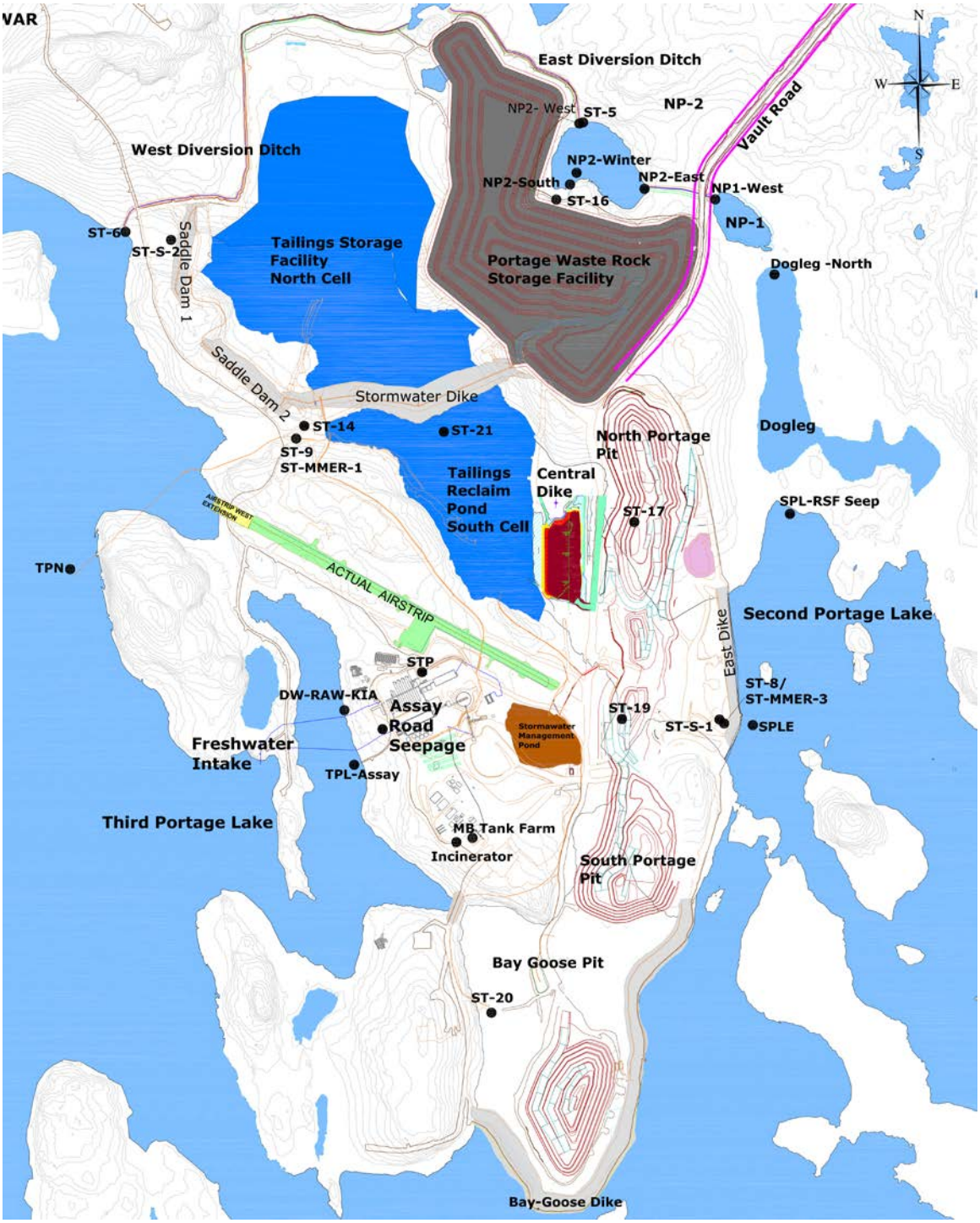
NWB (Nunavut Water Board License) (2008). Water License No: 2AM-MEA0815. Agnico- Eagle Mines Ltd. June 2008.

SLI (2012). Water Management Plan 2012. Agnico-Eagle Mines. Document No. 610756- 0000-40ER-0001, Rev. 02. March 2013.

SLI (2012). Water Quality Forecasting for the Portage Area 2012-2025. Agnico-Eagle Mines. Document No. 610756-0000-40ER-0002, Rev. 01. March 2013

APPENDIX 1

ENVIRONMENT FIELD STATIONS – MINE SITE VIEW


VAR
East Diversion Ditch
NP2- West
ST-5
NP-2
Vault Road
West Diversion Ditch
NP2-Winter
NP2-South
NP2-East
NP1-West
ST-16
NP-1
ST-6
ST-S-2
Saddle Dam 1
Tailings Storage Facility North Cell
Portage Waste Rock Storage Facility
Dogleg -North
Saddle Dam 2
Stormwater Dike
ST-14
ST-21
ST-9
ST-MMER-1
North Portage Pit
Dogleg
Tailings Reclaim Pond South Cell
Central Dike
ST-17
SPL-RSF Seep
TPN
ACTUAL AIRSTRIP
Second Portage Lake
East Dike
STP
ST-8/
ST-MMER-3
DW-RAW-KIA
Assay Road Seepage
ST-19
ST-S-1
SPLE
Stormwater Management Pond
Freshwater Intake
TPL-Assay
Third Portage Lake
MB Tank Farm
Incinerator
South Portage Pit
Bay Goose Pit
ST-20
Bay-Goose Dike
N
W
E
S

APPENDIX 2

SPILL CONTROL AND LOADING PROCEDURE PLAN

Dyno Spill Control and Loading Procedure Plan

1) All trucks are washed inside shop to contain any residue that may have contacted trucks. The water from the washing of the trucks and or the shop floors themselves is then picked up by the AEM e vacuum and disposed of in the onsite Stormwater Management Pond.

2) A.N. Prill is brought to the Emulsion Plant site in 20 ft Seacans and is stored in the Seacans on the A.N. Pad for the site till it is needed. It is then taken out of the Seacan /s and brought into the Plant for use. Sometimes enough product for the next batch is stored outside to speed up Batching time when it is necessary. A.N. Prill is not left outside if weather looks like it is going to be damp or raining to prevent the leaching of Prill through the Tote bags and on to the ground surface.

3) Any A.N. spills that occur are promptly cleaned up and disposed of in 1 of 2 ways:
    i. Any contaminated prill is put into containment barrels or buckets inside Plant, depending on amount, and put into the next Ansol batch to be made.
    ii. Any contaminated Prill is put in Barrels or Buckets (depending on amount) and then transferred from barrels to buckets for the Emulsion Truck Operators to take to the Blast Pattern and placed into the boreholes after they have been loaded (disposal via blast).

   Any spills that are too difficult (some of our drummed Products) to take care of in this manner are placed in Metal Drums or HAZMAT bins etc. with absorbing materials, sealed and sent to AEM HAZMAT AREA (for shipment south).

4) Emulsion waste (with contaminants) is also either contained in drums or bins until it can be transferred into buckets and taken to Blast patterns and placed into boreholes for disposal (disposal via blasting).
   Any non contaminated Emulsion is put back through the system and on to Trucks.
   When Trucks need to be de-contaminated or process lines of trucks or plant need to be cleaned out, the excess water is strained through a Sack (this allows the water to go through, but contains the Emulsion) to minimize nitrites in our plant sump containment.

5) When an Emulsion Truck has completed loading on a blast pattern the remaining emulsion is flushed out of the loading hose by running water through the hose (water holding tank on trucks) until water discharges out the end of the hose into the borehole.
   This does not completely remove all of the Emulsion out of the Hose; there is still a residue amount left in the hose. Thus, when the Truck operator starts up on the next blast pattern, the hose is put into the borehole and the Operator primes the hose and all the residue Emulsion is contained in borehole and disposed of when hole/s are blasted.

APPENDIX 3

DYNO NOBEL EMERGENCY RESPONSE PLAN – MAGAZINE, PLANT AND WORK SITE

DYNO
Dyno Nobel
Groundbreaking
Performance

EMERGENCY RESPONSE PLAN

QAAQTUQ

Agnico Eagle Meadowbank (Baker Lake)
Nunavut

For Dyno Nobel Canada Inc.

Magazine, Plant and Work Sites

This Emergency Response Plan (ERP) addresses incidents and potential incidents involving the manufacturing, handling and storage of explosives and related products in Dyno Nobel Canada Inc.' magazines, plants and worksites. This ERP has been developed for Dyno Nobel Canada Inc. and all of it's wholly-owned subsidiaries (DNX Drilling). Actions detailed within this plan are compulsory, under the approval and authorization of DNCI's Regional Operations Managers.

"This document, as presented on Dyno Nobel's database, is a controlled document and represents the version currently in effect. All printed copies are uncontrolled documents and may not be current".

Note: Information provided within this document may be privileged and is not intended for general distribution.

Original Date of Publication: 15 October 2003, as amended site specific, December 19, 2011

Publication/ Amendment Date	Changes To Prior Edition	Pg.
15 Oct 03	**New document**	All
26 Apr 04	**Amendment # 1**	
	Renumbering of Appendices 6 – 13	App. 7 – 14
	Miscellaneous Typos & Amendment Dates	All
17 March 08	**Amendment #2**	
	Updated Contact information	
	Addition of definitions	
	Included Calling and responding emergency procedures	
	Addition Duties of Key personnel	
	Addition of response to Natural disasters	
	Addition of visitor and contractors access control -	
	Replaced the Appendices and renumbering	
	Included a Emergency Report form	
	Addition of Nitric acid, Aluminum and Diethylene glycol and CFE	
	Addition of alternate methods of communication	
	Addition of Reportable Substance list	
	Miscellaneous Typos & Amendment Dates	All
August 18, 2010	**Amendment #3**	
	Updated Scope and ERP Outline	
	Added Sign-off sheet for Annual Fire Department Review	
	Added Appendix for Employee Training sign-off	
	Updated Reporting Incidents Flowchart	
	Updated procedure for Raw Material Truck Spills	
	Updated Bomb Threat Checklist	
September 29, 2011	Amendment #4	
	Updated contacts and phone numbers	
November 15, 2011	Amendment #5	
	Amended Appendix 8	
	Addition of Appendix 10	

Table of Contents

Section	Topic	Pg.
1.0	Scope	4
2.0	Related Documents	4
3.0	ERP Outline	4
4.0	Preparation and Planning	6
5.0	Training	7
6.0	Emergency Procedures and Lines of Authority	8
6.1	Duties Of Key Personnel	8
Table 6-1	Flow Chart	9
6.2	Fire & Explosives	13
Table 6-2	Fire Fighting Information	15
Table 6-3	Control Measures	16
Table 6-4	Evacuation Distances	17
6.3	Environmental Releases	18
Table 6-5	Environmental Release Procedures	20
6.4	Security	21
6.5	Bomb Threat	21
Table 6-6	Bomb Threat – Conversation Guidelines	21
6.6	Lines of Authority	22
7.0	Notification and Reporting	23
Table 7-1	Reportable Substances Quantity List	25
8.0	Decontamination	27
9.0	Work Site Closure / Shut Down	27
10.0	Response to Natural Disaster Preventive Measures	28
11.0	Work Site Start Up	29

Work Site Phone Numbers and Magazine / Plant Details

Appendix 1 DNCI Emergency report form
Appendix 2 DNCI Corporate Contacts
Appendix 3 ERA Contact List
Appendix 4 Management and Site Contact list
Appendix 5 Site Specific Information
Appendix 6 Bomb Threat Checklist

Appendix 7 New/Transferred Employee or Annual Refresher Form
Appendix 8 Annual Fire Department Review Form / Debrief Form
Appendix 9 TDG Regualtion Class Quantity Emission Limit

1.0 SCOPE

This document provides a Work Site Emergency Response Plan covering fire/explosion, spills, security breach, bomb threat, evacuation and prescribed actions that employees must take to ensure employee and public safety in the event of an emergency. The general reference to DNCI's "Work Sites" throughout this document includes magazines, plants and miscellaneous work locations.

The Emergency Response Plan appearing on Dyno Nobel Canada Inc.' database is a controlled document. Uncontrolled copies of this ERP are provided to customers and associates who own the land on which DNCI's worksite is located, plus applicable municipal and regulatory authorities. As well, uncontrolled copies are issued to all Company employees and are placed in all central offices and Company delivery vehicles.

2.0 RELATED DOCUMENTS

The following documents also relate to emergency situations that can arise and should be held at each Work Site:

- Federal, Provincial and Municipal regulations, standards and guidelines
- Corporate Policies plus MSA Standards & Procedures
- Standard Operating Procedures (SOP's)
- Dyno Nobel General and Specialized Work Rules
- Material Safety Data Sheets
- Prime Contractor's / Customer's ERP
- Transportation ERAP #2-1037
- Crisis Communication Plan

3.0 ERP OUTLINE

3.1 The following materials are covered by this ERP:
Fuel Oil
ATF Hydraulic Fluid
Ammonium Nitrate Prills and Solution
Sodium Nitrite
Sodium Thiocyanate
ANFO
Emulsion

Packaged Explosives
Detonators
Acetic acid
Diethylene glycol
Aluminum
Enviro CFE

3.2 The following situations are addressed in this ERP:

- Fire / Explosion
- Storage Tank Failure
- Spills from Product Delivery Trucks
- Spills from Raw Material Delivery Trucks
- Process Spills
- Shut down due to weather, floods, lightning, fires, explosions and other threats to the security and operation of DNCI's facilities, equipment and material.
- Bomb Threats
- Quantities of spills and reportable to Dyno Nobel and authorities

3.3 This ERP covers:

Preparation	Reporting
Training	Waste Disposal Permits
Lines of Authority	Containment
Notification	Inspection
Decontamination	Maintenance

3.4 The following definitions apply to this plan:

DNCI Corporate contact : A DNCI corporate employee who is assigned to receive Emergency Calls at all times from the answering service.

ER Advisor: Emergency Response Advisor (ERA), who will normally be the applicable General Manager, Area Manager, or Technical Advisor who will liaise with First Responders.

OSC: (DNCI) On Scene Coordinator, the Senior DNCI employee at an incident site who manages and controls DNCI resources in support of First Responders and incident recovery.

ERT: Emergency Response Team, DNCI personnel dispatched to an incident site to assist First Responders and conduct incident recovery under the direction of the OSC.

4.0 PREPARATION AND PLANNING

4.1 In order to provide competent emergency response at Dyno Nobel Canada Inc.' magazines, plants and worksites, first responders (local fire departments and mine rescue personnel) must be thoroughly briefed on an annual basis of the potential hazards involved in a Dyno Nobel Canada Inc. worksite fire. To this end, Work Site Supervisors must take fire department plus mine safety and security representatives on an annual magazine / plant tour to view:

Explosives Storage Areas	Evacuation (Meeting) Area
Bulk Emulsion Equipment	Communications Equipment
ANFO Blending Area	Facility Layout
Fire Fighting Equipment Sites	(Waste) Burn Facilities

A record of each explosives worksite tour and the names of the first responder representatives attending are to be documented and kept on file.

Annual Fire Department Review Form (Appendix 9)

4.2 All DNCI employees shall review this ERP on an annual basis and participate in ERP drills / exercises when scheduled.

4.3 All worksite accidents involving fire, explosion, reportable spills/emissions, breaches of security and bomb threats are to be reported to applicable authorities and senior management. As per incident reporting procedure

4. 4 Spill procedures for each of the materials listed in section 3.1 are outlined in Table 6-3. All procedures specify: Method of Cleanup, Method of Disposal and Protective Clothing. Based on the procedures presented in Table 6-3, worksite supervisors must ensure that adequate clean-up equipment and materials are readily available and in good condition.

4.5 Worksite information for each of DNCI's facilities is contained in the attached appendices. The ERP is revised whenever significant changes are made.

4.6 Current Material Safety Data Sheets (MSDS) are to be kept at each Work Site for all hazardous materials that are stored and handled at the Work Site. Copies of current product MSDS' are also made available to customers and landowners. Obsolete MSDS' will be replaced as new ones are issued.

4.7 Each Work Site will hold and maintain in good repair, appropriate fire fighting and spill control equipment for potential emergencies. Fire extinguishers, hoses and other fire fighting equipment are to be visually inspected on a monthly basis to ensure Magazine, Plant, Work Site and delivery vehicle readiness.

5.0 TRAINING

5.1 All employees will complete training on the contents of this Plan during their "new hire" orientation and review the plan annually.

5.2 A trained person is considered to have reviewed all related documents (Section 2.0), to have been instructed on the use of related equipment and procedures, and to have discussed with their Supervisor or trainer, questions and issues of concern.

5.3 Training records, including certificates for training completed, are to be kept onsite in the Employee's Training Record.

5.4 The Magazine, Plant or Work Site Supervisor/Manager will certify their employees as having received training by signing the training form. In signing the training form, the Supervisor / Manager will have satisfied themselves that trained employees are able to:

- Recognize fire and explosive hazards for the materials and processes to which they are exposed /involved with;
- Competently use Fire Fighting / Fire Protection Equipment (Note: employees should receive refresher training in the use of fire extinguishers at least every three years)
- Competently use applicable personal protective equipment (PPE) when handling hazardous substances;
- Recognize and be familiar with substances which become hazardous wastes when spilled; and

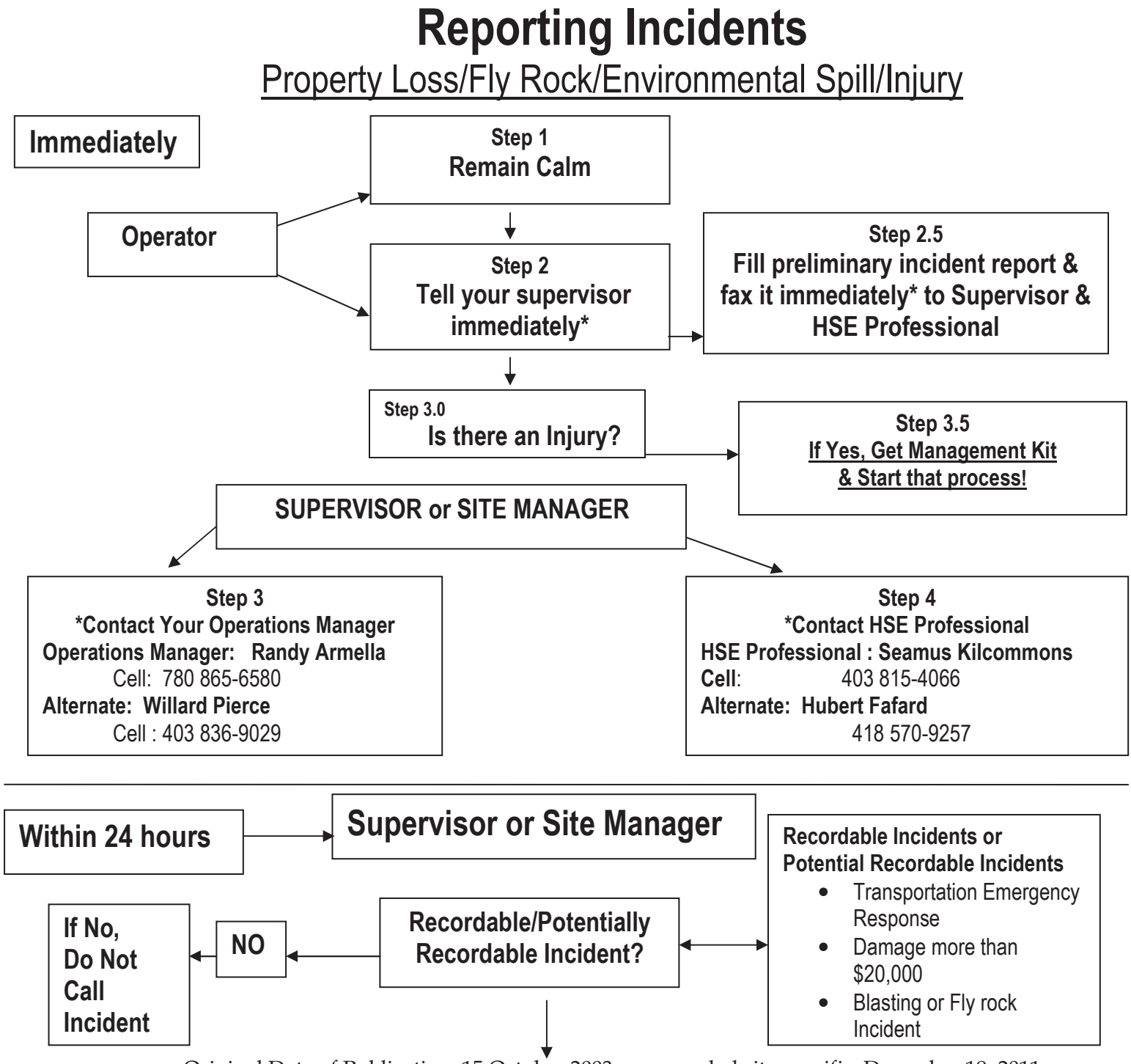
- Follow SOP's and use established work practices to minimize the potential for fires, explosions, environmental releases and other accidents.
- Worksite Managers / Supervisors will ensure that all contractors receive a worksite orientation before commencing work or being left unaccompanied in the worksite. Following the orientation process, the contractors will be required to sign off on the Contractor Checklist acknowledging training in the applicable areas including the site emergency response plan.
- All Plant & Magazine sites will have in place, a continuous (24 hour) access control system to control the entrance, presence and exit of visitor and contractors and their equipment and materials
- Employees must be trained on Reportable Quantities to the Government in the unlikely event of a spill.
- All employees are aware of evacuation routes, muster point location, and all-clear notice procedure.
- New/Transferred employee or Annual Refresher sign-off form located in Appendix 8

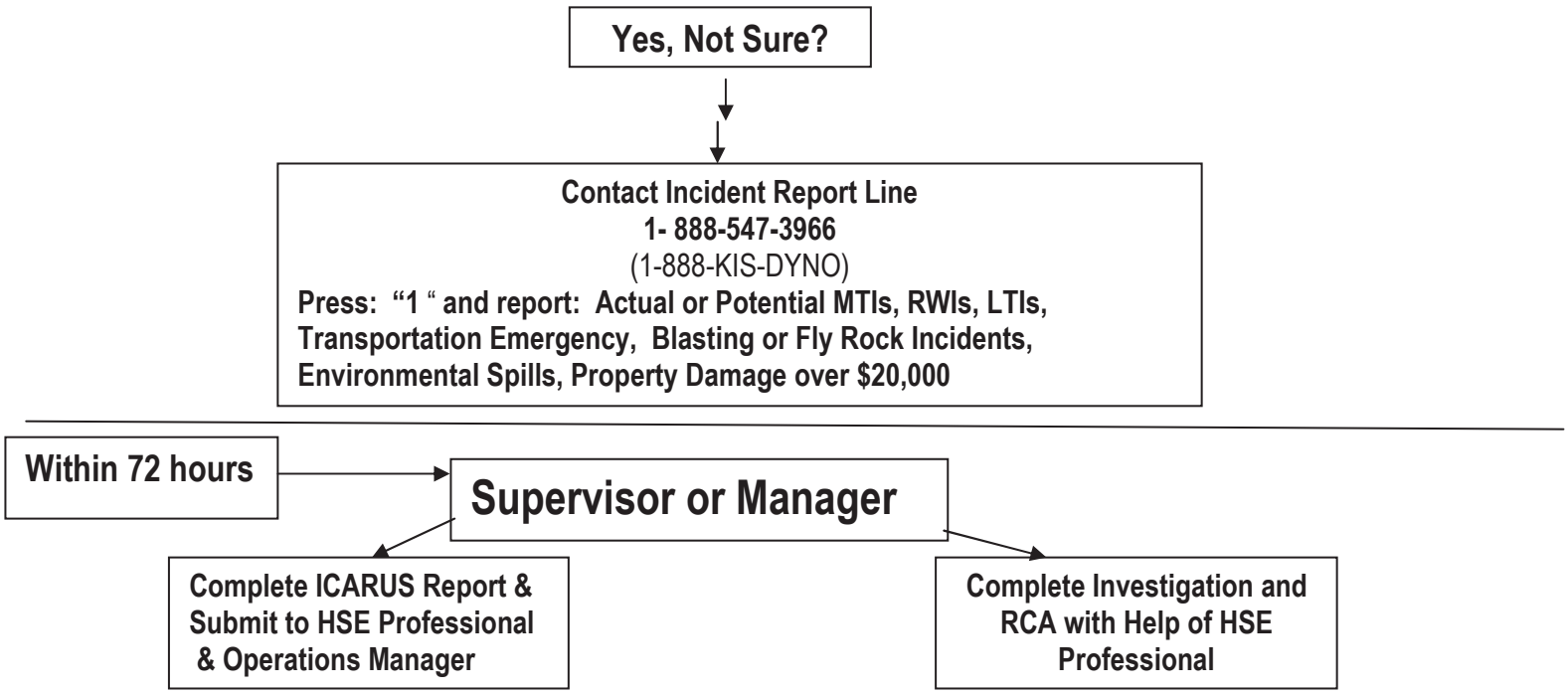
6.0 EMERGENCY PROCEDURES AND LINES OF AUTHORITY

6.1 GENERAL

Reporting Incidents Flow Chart (continued on next page)

Table 6-1
Emergency Response Flow Chart





SITE SUPERVISOR/DELAGATE
EXPERIENCING EMERGENCY / POTENTIAL EMERGENCY

- **CALL FOR EMERGENCY ASSISTANCE**
  In the event of an emergency, accidental release or imminent accidental release involving explosives, eliminate potential sources of detonation where possible (eg. turn off the ignition of a vehicle), call **911** (or the local police number) for immediate assistance, **call the site Supervisor/ Area Manager** and initiate the site's Emergency Response Plan. If normal phone systems are down other methods of communication can include two way radios, satellite phones, pager, e mail and vehicle satellite tracking systems.

- **WARN PUBLIC WITHIN EVACUATION DISTANCES IF RISK OF DETONATION**
  Should there be explosive detonations, or the risk of detonations due to the presence of fire or other detonating factors, advise the First Responders (or anyone within the immediate vicinity if First Responders are not at the scene) of the risk and applicable safety distances per Table 6-4, page 17 (liaise with Emergency Response Advisor (ERA) if time permits). Help organize perimeter guards to prevent people from entering the evacuation zone.
  Note: See ERP, page 17 Table 6-4 for Evacuation Procedures.

- **ASSIST LOCAL AUTHORITIES**
  Assist First Responders and Local Authorities in eliminating the emergency situation, and liaise with DNCI's On-Call Employee / ERA until relieved by the Company's Emergency Response Team (ERT).

TO RESPOND TO AN EMERGENCY CALL

DNCI Corporate contact instructions:

Upon receiving a call for emergency response assistance, keep a log of all subsequent communications and actions, and do the following:

1. Immediately obtain the name and callback number of the caller, in case the telephone line is lost.

2. Obtain information as fully and accurately as possible following the emergency report form (see appendix 1).

3. Call an ER Advisor for the applicable Region (see appendix 2) and report the emergency situation. In turn, the ER Advisor will phone the emergency scene caller, establish ongoing contact, assess the emergency, determine what Company resources and/or contracted emergency response services are required and organize an Emergency Response Team – ERT to proceed to the emergency scene if required.

4. Assist the Emergency Response Advisor (ERA).

5. Liaise with Company Executive / Senior Managers.

Emergency Response Advisor (ERA) instructions:

1.Call the Branch/Plant Supervisor nearest the emergency scene plus provincial & federal authorities (see applicable appendix to Annex D) to advise them of the situation and the need for an emergency response.

2. Designate, assemble and dispatch an Emergency Response Team (ERT), made up of Groups 1 & 2 personnel (see ERAP pg. 16 and Annex D) under the leadership of an On Scene Coordinator (OSC), if required.

3. Authorize the dispatching of additional resources, communications, transportation and contracted services as necessary.

4. Contact and instruct the designated Emergency Response Team (ERT) to proceed to the emergency scene with the required vehicles and equipment.

5. Liaise with the Person in Charge of the Emergency) and/or Local Authorities to obtain a situation update.

6.Advise Local Authorities as appropriate, regarding the properties, hazards and handling procedures for the explosives involved in the emergency. In particular, advise the Local Authorities of appropriate evacuation distances per Table 6-4 pg. 17.

7. Continue to consult with the Local Authorities as appropriate, plus the Company's On-Scene Coordinator (OSC), to stabilize and eliminate the emergency.

8. Refer to **Regional Manager** *Tom Medak or Cory Redwood .(see appendix2))* for any media requests in accordance to the Crisis Communication Plan (CCP). Media contacts shall be through Regional Manager designated for the area.

9. Contact the explosives supplier and / or transporter (if other than DNCI) to advise them of the emergency and to request their assistance if/as required.

ON-SCENE CO-ORDINATOR (OSC)

- The On-Scene Coordinator (OSC) is the Company's representative and local authority in charge of all company actions and resources at the emergency scene. Once the OSC arrives at the emergency scene, the ERA will transfer communication with First Responders/Local Authorities to the OSC. In turn, the OSC will liaise with the ER Advisor as required. Throughout the Company's emergency response, the OSC will ensure that First Responders and Company personnel (employees and contractors) observe all safety and regulatory standards and procedures.
- The OSC may revise / adjust the composition of the Emergency Response Team (ERT) and supporting resources as required. The OSC may, in consultation with the ER Advisor, contract commercial services to assist in addressing and resolving the emergency situation.

- The OSC will oversee the Company's local involvement with emergency services, government (municipal & provincial) and public interests until the emergency is fully resolved. Post-emergency activities (clean-up, restoration, etc.) under the direction of the Environment Manager may be delegated to an appropriate Branch, Plant or Area Manager. **EMERGENCY RESPONSE TEAM (ERT)**

- Selected emergency response personnel will take their direction to assemble and proceed to the emergency scene from the ERA or their representative. Team members will immediately report to the On-Scene-Coordinator.

- The primary role of the ERT is to provide a competent and trained / certified workforce plus specialized equipment and material to assist First Responders / Local Authorities in the stabilizing and elimination of an 'explosives emergency', and to retrieve / recover, repackage and remove to safe and secure storage, non-detonated explosives.

- While at the emergency scene, ERT members will take their direction from the Company's OSC and remain available until released by the OSC.

NOTE:

ONLY INDIVIDUALS WHO HAVE RECEIVED TRAINING AS REQUIRED UNDER THE TRANSPORTATION OF DANGEROUS GOODS (CLEAR LANGUAGE) REGULATIONS, OR WHO ARE WORKING UNDER THE DIRECT AND CONTINUOUS SUPERVISION OF AN EMPLOYEE WHO HAS BEEN TRAINED FOR CLASS 1 DANGEROUS GOODS UNDER TDG, MAY PARTICIPATE IN SITE CLEAN-UP ACTIVITIES SUCH AS PICKING UP, REPACKAGING AND TRANSPORTING EXPLOSIVE MATERIAL.

6.1.1 In any emergency the Work Site Supervisor/Manager or their delegate must take certain actions, including the following:

- Call local fire/emergency authorities (at mine sites, also call Mine Fire, Safety and Security if different and give relevant information).
- Account for all employees and visitors. Arrange for Rescue of anyone who may be trapped, without endangering oneself or others.
- Notify Dyno Nobel Canada Inc. ERA's so that necessary arrangements can be made for technical / administrative support, including accident reporting and investigation plus continued/alternate production. The following information should be provided and refer to appendix 1:

What Occurred	Time of Occurrence
Action Taken	People Contacted
Status of Situation	Anticipated Follow-up

6.2 FIRE & EXPLOSIVES

6.2.1. There are three categories of fire that may involve explosives:

I. Fires Directly Involving Class 1 Explosives and Blasting Agents

- **DO NOT FIGHT THE FIRE.** Instruct all fire fighters on the scene not to fight fire with explosives.

- Shut off power at main breakers if possible. At mine sites, call Mine Security or Fire/Rescue. At all other DNCI locations call local Fire/Rescue personnel.
- Evacuate all personnel from the Work Site to the safe meeting place as outlined in the Work Site Appendix.
- Set up a communications base at the meeting place and guard
- against anyone entering the area.

II. **<u>Fires Involving Components For Manufacture of Blasting Agents</u>**

Bulk blasting agents may be in the form of emulsion or ANFO. ANFO is a mixture of prilled ammonium nitrate and fuel oil.

Under conditions of large mass, intense heat, confined dust / vapor buildup, and the right mixture combination of the basic ingredients, emulsion and ANFO will explode. The probability of explosion with ammonium nitrate (AN) alone is very small, but increases when under intense heat and confinement. Table 6-1 includes recommended fire fighting procedures for each of these substances.

III. **<u>Fires Involving Dyno Nobel Canada Inc. Trucks</u>**

In cases where the Dyno Nobel Canada Inc. delivery trucks are in a building that is on fire, if there is no explosives and safe to do so, may be moved provided access to the truck and exit from the building is not barred by flames or smoke, with available fire extinguishers with caution only if the fire is small and not in the storage compartment.

Fires on re-pump or other bulk explosive delivery vehicles shall not be fought if the fire involves the explosives compartment. Fire fighting measures should be taken immediately to prevent any fire such as a tire, electrical or cab fire from reaching the explosives compartment.

Fires on other transport vehicles may be fought with caution. Fires that cannot be controlled sufficiently to avoid involvement of the vehicle's fuel compartment shall be left and personnel evacuated to a safe distance.

6.2.2. When a fire is small and does not involve any explosive agents, it may be fought with plant extinguishing equipment. If the fire is widespread and intense, all

personnel, including visitors and contractors should be evacuated to the meeting area outside the main gate.

Table 6 - 2
FIRE FIGHTING INFORMATION

MATERIAL	RECOMMENDED FIRE-FIGHTING METHODS	SPECIAL CONSIDERATION
Ammonium Nitrate Prill – Odorless white to light tan crystaline solid	Use flooding amounts of water in early stages of fire. Keep upwind. AN is an oxidizing agent which supports combustion and is an explosive hazard if heated under confinement that allows high-pressure buildup. Ensure good ventilation and remove combustible materials if it can be safely done. Evacuate to designated area if fire cannot be controlled.	Toxic oxides of nitrogen are given off during combustion. Fire fighters require self-contained positive pressure breathing apparatus. Avoid contaminating with organic materials. Many powdered metals such as Al, Sb, Si, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, Sn, Zn and brass react violently and explosively with fused AN below 200˚C Sensitivity to detonation increases when heated.
Ammonium Nitrate Solution- Colorless/Odourless Liquid – white paste like solid when cooled	Use flooding amounts of water in early stages of fire. Cool containing vellels with with flooding quantities of water until after fire is out	Material will not burn, but thermal decomposition may result in flammable/toxic gases being formed. These products are nitrogen oxides and ammonia. (NO,NO_2 NH_3). Product may form explosive mixtures when contaminated and comes in contact with organic materials. Explosive when exposed to heat or flame under confinement. Avoid temperatures over 210°C (410°F) A self contained breathing apparatus should be used to avoid inhalation of toxic fumes
Acetic Acid – Colourless liquid with a pungent odour	Use dry chemicals, CO_2, Alcohol foam or water spray	Isolate and restrict area access, stay upwind. Water run-off and vapour cloud may be corrosive.
Sodium Thiocyanate – White solid - odourless	Use extinguishing media most appropriate for the surrounding fire	Wear self contained breathing apparatus – MSHA/NIOSH approved or equivalent, and full protective gear. During a fire, irritating or highly toxic gases may be generated by thermal decomposition or combustion.
Sodium Nitrite – Oxydizing agent - white to light yellow crystals- faint odour	Flammability class – not regulated. Flood with water only – Isolate materials not involved in the fire and cool containers with flooding quantities of water until well after the fire is out.	Self contained apparatus should be worn in a fire involving Sodium Nitite.Thermal decomposition will cause reddish brown nitrogen oxides to be released.
Fuel Oil (No. 2 diesel) Dyed or pale yellow liquid with petroleum odor; and/or ATF Fluid	Use water spray to cool fire-exposed surfaces and to protect personnel. Shut off fuel from fire. Use foam, dry chemical or water spray to extinguish fire. Avoid spraying water directly into storage container due to danger of boil-over.	Avoid strong oxidizing agents.

Explosive emulsions, ANFO, packaged explosives and firing devices.	**Fire involving explosive materials must never be fought. Evacuate the incident scene. Do not confine (ventilate to prevent / reduce pressure build-up if safe to do so).**	Explosion hazard.
Enviro CFE	Dry chemical, foam, water spray (fog). Use water spray to cool exposed surfaces and containers	OIL FLOATS ON WATER. Do not use direct or heavy water stream to fight fire. Use organic vapour respirator or self-contained breathing apparatus to fight fire.

Table 6 - 3
CONTROL MEASURES FOR FIRE

MATERIAL	RECOMMENDED FIRE-FIGHTING METHODS	SPECIAL CONSIDERATION
Acetic acid	Small fire: type ABC dry chemical or CO_2 fire extinguisher. Large fire: water fog or foam.	May react violently with oxidizers and nitric acid. May react with aluminum powder and give off highly flammable hydrogen gas.
Aluminum	Small fire: type D fire extinguisher, dry sand. **Never use water**.	May react with oxidizers (nitrate and perchlorate) and acids. Avoid contact with water. Highly flammable hydrogen gas may be released.
Diethylene glycol	Small fire: type ABC dry chemical or CO_2 fire extinguisher. Large fire: water fog.	Keep away from oxidizers (nitrates and perchlorate). Explosion hazard if heated under confinement.

EVACUATION PROCEDURES

Advise the first emergency responders at the scene (police or fire) of the need to evacuate using the guidance in the Emergency Response Plan. Employees at the scene should assist local emergency services to the best of their ability to accomplish this. For incidents within a worksite such as a mine, quarry or construction operation, in most cases access is radio controlled. The quickest way of alerting people, therefore, is by site radio. Clearly state your location, situation and call for assistance in evacuating the area.

DO NOT FIGHT EXPLOSIVES FIRES. EVACUATE THE AREA AND LET THE FIRE BURN ITSELF OUT.

THE MINIMUM EVACUATION DISTANCE IS AS OUTLINED IN TABLE 6-4 (Pg. 17) FOR ALL DIRECTIONS (which is based on a higher traffic / risk / population density within the area, without benefit of protective features such as berms and hills. (**Transport Canada requires 1,600 meters for situations that involve high-risk surroundings**) upon determining actual quantity of explosives refer to Table 6-4 as per ERD quantity of distances.

Table 6 - 4
EVACUATION DISTANCES
Based On Amount of Explosives Present

Explosive Quantity		**Metric Distance**		**English Distance**
250 kg		70 Meters		230 Feet
500 kg		100 Meters		320 Feet
1,000 kg		150 Meters		500 Feet
2,000 kg		240 Meters		800 Feet
5,000 kg		400 Meters		1,300 Feet
7,000 kg		450 Meters		1,450 Feet
10,000 kg		480 Meters		1,550 Feet
20,000 kg		700 Meters		2,300 Feet
40,000 kg		800 Meters		2,640 Feet
60,000 kg		870 Meters		2,860 Feet
80,000 kg		960 Meters		3,150 Feet
100,000 kg		1040 Meters		3,420 Feet
120,000 kg		1100 Meters		3,610 Feet
>120,000 kg		1600 Meters		5,250 Feet

6.3 ENVIRONMENTAL RELEASES

6.3.1 Procedure For Fuel Oil Storage Tank Failure

- Assess the magnitude of the leak.
- If the leak is slow and the source can be determined, take the appropriate action to prevent further leakage.
- Transfer fuel from storage tank into drums if necessary.
- Collect spilled material, including contaminated soil, with absorbent pads or inert solid absorbent and store in drums labeled for disposal.
- If the leak is large and further leakage cannot be prevented, allow the dyke to fill. Transfer to drums, label for reuse or disposal, and store.
- Inspect empty tank to identify failure/cause of leak and repair tank.

6.3.2 Procedure For Raw Material Truck Spills

- Identify the material involved, assess the magnitude of the spill or leak and assist the driver to take appropriate action to stop the leak, taking care to prevent run off and/or entry into any water course or drainage system near the spill site.
- For AN prill, shovel spilled material into drums, label for reuse or disposal, and store. Use a non-sparking shovel to transfer spilled material into lined drums.
- For spilled fuel, contain by dyking with earth. Collect spilled fuel with absorbent pads or solid inert absorbent, transfer into drums, label and store for disposal.
- Remove contaminated soil for disposal in conformance with Environment Canada standards.

6.3.3 Procedure For Process Spills

- Identify the material involved and assess the magnitude of the spill or leak, taking care to prevent run off and/or entry into any watercourse or drainage system near the spill site.
- For AN prill, shovel spilled material into drums, label for reuse or disposal, and store.
- For spilled fuel, contain by dyking with earth. Collect with absorbent pads or solid inert absorbent, transfer into drums, label, and store for disposal.
- In the case of leaking bags of ANFO, sweep or shovel the spilled material into a clean drum or other suitable container, label for reuse or disposal, and store.
- Remove contaminated soil for disposal in conformance with Environment Canada standards.

- Have any process equipment (pumps, process lines, parts, gauges, etc.) involved in a leak or spill inspected and repaired or replaced. Re-inspect and test if necessary after repair is affected.

6.3.4 **Procedure For Emulsion Tank Failure**

- Assess the magnitude of the leak.
- If the leak is slow and the source can be determined, take the appropriate action to prevent further leakage.
- Transfer remaining emulsion from leaking storage tank into another storage tank, a tanker trailer if available, or into drums as necessary.
- Collect spilled material using double diaphragm pump(s) and store in labeled drums for reuse or disposal at the mine.
- If the leak is large and further leakage cannot be prevented, allow the room to fill. Transfer to drums, label for reuse or disposal, and store.
- Inspect empty tank to identify failure/cause of leak and repair or replace the tank

6.3.5 **Procedure For Fire**

- In the event of a raw material or product fire, take care to protect all persons from exposure to smoke and gaseous emissions from the fire.
- Potential toxic gaseous emissions from fires involving explosive materials include:

  Oxides of Nitrogen
  Carbon Monoxide
  Cyanide Gas

- All fires must be reported to local authorities and Mine Site Security as soon as possible.
- Self contained breathing apparatus is required for fighting a fire in the plant.
- Follow procedures outlined above for any spills and leaks resulting from fire when it is safe to do so

Table 6 – 5
ENVIRONMENTAL RELEASE PROCEDURES

MATERIAL	SPILL AND LEAK PROCEDURES	WASTE DISPOSAL
Ammonium Nitrate Prill (odorless white to light tan crystalline solid)	Remove source of heat and ignition. Sweep or shovel spill into a clean, non-combustible container. Wash remaining trace residues with water. Wear rubber gloves and safety glasses to minimize contact with skin and eyes.	Re-use if possible or give it to a farmer as a fertilizer. If not possible, dispose of as-is in approved. Remove as much as possible the spilled material as a solid.
Ammonium Nitrate Solution-Colorless/Odourless Liquid – white paste like solid when cooled	Small spill - Dike and contain spilled material. Ensure spilled material does not enter sewers, wells or water courses. Allow to solidify. Use appropriate tools to place in container for disposal. Larger spill - Dike and contain spilled material. Ensure spilled material does not enter sewers, wells or water courses. Notify downstream water users. Allow to solidify. Use appropriate tools to place in container for disposal.	Call for assistance for disposal. Ensure disposal complies with regulatory requirements and regulations.
Fuel Oil (dyed or pale yellow liquid with petroleum odor)	Eliminate any source of ignition. Prevent spills from entering watercourses or drainage systems. Contain with sand or earth. Recover with pump or inert absorbent material into clean container. Wear safety glasses and rubber gloves to prevent contact with the eyes and skin.	Dispose of recovered material in approved landfill or other waste disposal facility.
ANFO (Ammonium Nitrate Fuel Oil)	This material is an explosive. Remove all sources of heat and ignition. Transfer into clean plastic container with a plastic shovel. Label drums. Wear rubber gloves.	Recycle product, if possible. If not practical, explode it inside a borehole or burn it in an authorized burning ground.
Emulsion	This product is a blasting agent. Remove all sources of heat and ignition. Prevent spills from entering watercourses or drainage systems. If large amount of emulsion is involved, contain spill with earth or sand found locally. Recover spilled material with a diaphragm pump. Use of a diaphragm pump also requires an air compressor. Limitation of the pump suction is approximately 2.5 meters, pump discharge is approximately 8 meters. Use a screening device on pump suction hose. Out of area spills will require taking two pumps and extra hose. Transfer the product into a tanker trailer or clean 200 liter drums. If small amount of emulsion is involved, transfer material into a clean plastic container with a plastic shovel. Label tanker trailer or drums. Wear rubber gloves and rubber boots.	Recycle product, if possible. If not practical, explode it inside a borehole or if large amount is involved, demulsify it with liquid detergent.

Enviro CFE	Eliminate any source of ignition. Prevent spills from entering watercourses or drainage systems. Contain with sand or earth. Recover with pump or inert absorbent material into clean container. Wear safety glasses and rubber gloves to prevent contact with the eyes and skin.	Dispose of recovered material in approved landfill or other waste disposal facility.
Sodium Thiocyanate – White solid - odourless	Ensure adequate ventilation whe handling Sodium Thiocyanate. Keep containers closed when not in use. Wear appropriate PPE – eye protection, gloves and appropriate clothing to prevent skin exposure.	Vacuum or sweep up material and place into a suitable disposal container. Avoid run off into storm sewers and ditches which lead to waterways. Not regulated as a hazardous material. Chemical waste generators must consult appropriate hazardous waste regulations to ensure complete and accurate classification.
Sodium Nitrite – Oxydizing agent - white to light yellow crystals- faint odour	In the event of a spill or leak, contact the vendor (403-263-8660) for advice. Wear respirator, protective clothing and gloves. Vacuuming is the recommended method to clean up spills. Do **not** sweep or use compressed air for clean up. Recover spilled material on non-combustible material, such as vermiculite. Use non-sparking tools and place in covered containers for disposal. Any recovered material mau be used for it's intended purpose , depending on contamination.	Dispose of the waste material at an approved hazardous waste treatment/disposal facility.
Acetic Acid – Colourless liquid with a pungent odour	Wear appropriate PPE – evacuate downind areas as required to prevent exposure and to allow fumes and vapours to dissipate. Prevent entry into sewers or streams. Dike if needed. Eliminate all sources of ignition. Neutralize the residue with sodium carbonate or crushed limestone. Absorb win an inert dry material and place in an appropriate container for disposal. Flush area with water to remove trace residue.	Waste disposal must be done in accordance with provincial and federal regulations. Empty containers must be recycled or disposed of through an approved waste management facility.

6.4 SECURITY

6.4.1. In the event of a breach of security at a Dyno Nobel Canada Inc. Work Site, a call is to be made to the RCMP / local Police Department at the discretion of the Supervisor/Manager, or their delegate. In the case of a breach of security, Dyno Nobel Canada Inc.' HSE, Regulatory Affairs and Executive / Senior Management shall also be informed immediately and provided with the same information as outlined in Section 6.1

6.4.2. Any person(s) apprehended during the course of a serious security breach shall be detained until the Police arrive (note: employees are not to put themselves at undue risk by attempting to apprehend or restrain a potentially violent person).

6.5 BOMB THREAT

6.5.1. The safety of employees and the public is of primary concern. A person receiving a bomb threat over the telephone should attempt to remain calm and keep the caller talking by asking the questions listed in Table 6-6 (ERP pg. 20). Recording (writing) as much information about the caller and their comments is also very important for future reference. If possible, alert a co-worker to the situation while talking to the caller.

6.5.2. The police / mine security should be advised of the bomb threat as soon as possible. Unless there is good reason to the contrary, all personnel should evacuate the Work Site and await the arrival of the police / first responders at the designated meeting area. Suspicious objects should be reported but not tampered with and other people should be prevented from entering the Work Site until the local authority has authorized a return to the Work Site. Employees should be prepared to assist local authorities in their search / inspection of the Work Site as necessary.

Table 6 - 6
CONVERSATION GUIDELINES IN THE EVENT OF RECEIVING A BOMB THREAT

See Appendix 7

6.6 LINES OF AUTHORITY

6.6.1 Based upon the information available at the time of the incident, the Work Site Supervisor/Manager, in consultation with others (such as DNCI Senior Management, Mine/local authorities and/or Dyno Nobel advisors), will evaluate the incident and proceed with appropriate steps to implement this ERP. A decision on when to return to the scene of a serious incident will be made in like fashion, subject to approval by public authorities overseeing the incident.

6.6.2 The Work Site Supervisor/Manager will have overall responsibility for the implementation of this ERP and the supervision of all Company activities. Public authorities and the site owner have ultimate authority regarding the resumption of normal production activities.

7.0 NOTIFICATION AND REPORTING

7.1 Any incident that activates this ERP shall be documented on the DYNO Incident (Cintellate) Report. The Corporate Emergency Response Advisor must also be notified and in turn will advise the:

HSE Manager Vice President Operations
Area Manager

It is the responsibility of the HSE Manager or his delegate to report the incident to DYNO's HSE Management Team. A major incident involving a fire with emissions and/or a hazardous material spill shall be reported to a provincial Environment Officer under the direction of the Environmental Manager. Major incidents shall also be reported to the Chief Inspector, Explosives Branch, Natural Resources Canada; a Provincial/Territorial Safety Officer; and as applicable, an Emergency Measures Official.

Any incident which involves a spill at a Mine Site shall be immediately reported to the Mine Site Environmental Representative, and followed up with a copy of the incident report when complete.

7.2 Spills and Releases – Reportable and Significant Classifications

1) Determine if the spill/release is reportable
All environmental incidents are to be input into Cintellate. Reportable spills/releases are not only input into Cintellate, but the investigation and corrective action sections of Cintellate must be completed. To assist in determining if a spill/release is reportable, a listing of common materials with assigned reportable quantities is referenced (see Appendix 5, Reportable Substance List). The reportable quantities utilize the most stringent "reportable quantity" in Canada. Even if the spill/released material is recovered, the media impacted by the spill/release may be reportable to authorities (e.g., a portion of a spill reaching a source of drinking water or wetland). In addition, a spill/release is reportable if the amount equals or exceeds the Dyno Nobel Default Threshold.

2) Determine if the spill/release is significant

- Significant spills/releases are disclosed in the company's annual report. Significant spills/releases trigger time-critical internal actions as required by the company's procedures (crisis communication, internal investigation, etc)

The following table is provided to assist in making these determinations:

Reporting of Environmental Spills

Is the spill reportable?

- Yes if above a Reportable Quantity
- Yes if oil sheen is visible or sludge/emulsion is deposited beneath water surface
- Yes if water quality standards are exceeded
- Yes if from a UST exceeding 25 gallons or result in a sheen

Is the spill significant?

- Yes if authorities implement a national contingency plan
- Yes if "sensitive" environmental features have been impacted
- Yes if neighbors are evacuated
- Yes if authorities and/or neighbors file complaints and/or demand response activities
- Yes if financial impact is >US$100K
- Yes if media coverage is adverse.

7.3 Internal investigation reports will include:

- Name, work address, and phone number of the investigating (reporting) individual
- Identification and quantity of the released substance
- Time, duration, and location of the release
- Nature and quantity of injuries, property damage, production loss, administrative penalty and/or legal liability
- Precautions taken during the incident
- Relevant environmental conditions
- Corrective actions taken at the time of the incident
- Recommended corrective actions to prevent future occurrence

7.4 Senior Management shall be immediately informed by telephone of any major incident that requires Government notification as per Dyno Nobel's reporting procedures.

7.5 Major incidents involving explosive material shall also be reported to the Chief Inspector, Explosives Branch, and Natural Resources Canada by the applicable Regulatory Affairs Coordinator.

Table 7 – 1
REPORTABLE SUBSTANCE QUANTITY LIST

Material Released	Reportable to Authorities		Dyno Nobel Default Threshold (Proposed)
	If Recovered	If Unrecoverable/ Abandoned / Disposed	
AN Solution	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	44 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
AN Prill	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	45 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
SN Prill	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
Acetic Acid	453 Kg (1,000 lbs)	454 Kg (1,000 lbs)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
Sodium Nitrite	45 Kg (100 lbs)	45 Kg (100 lbs)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 1mg/L-N)	Report if released to Drinking Water (DW std at 1mg/L-N)	
Fuel Oil	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	225 Kg (500 lbs); 261 L (69 gallons)
	State Regulations - Varies from Any Amount to specific Trigger Amounts	State Regulations - Varies from All Spills to specific Trigger Amounts	
	95 L (25 gallons) from UST	96 L (25 gallons) from UST	
Mineral Oil	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	225 Kg (500 lbs); 261 L (69 gallons)

	State Regulations - Varies from Any Amount to specific Trigger Amounts	State Regulations - Varies from All Spills to specific Trigger Amounts	
	95 L (25 gallons) from UST	96 L (25 gallons) from UST	
Emulsifier Agents	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	225 Kg (500 lbs); 261 L (69 gallons)
	State Regulations - Varies from Any Amount to specific Trigger Amounts	State Regulations - Varies from All Spills to specific Trigger Amounts	
Granular Aluminum	Not Reportable	Not Reportable	225 Kg (500 lbs)
ANFO	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	45 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
	Reportable if sheen on surface of pond, stream, etc.	Reportable if sheen on surface of pond, stream, etc.	
Emulsion	Not Reportable if it can be used as a product	45 Kg (100 lbs) as released oxidizer (not media specific)	225 Kg (500 lbs)
	44 Kg (100 lbs) for ammonia if released into water	45 Kg (100 lbs) for ammonia if released into water	
	Report if released to Drinking Water (DW std at 10mg/L-N)	Report if released to Drinking Water (DW std at 10mg/L-N)	
	Report if released to aquatic ecosystem (NH3 toxic to fish)	Report if released to aquatic ecosystem (NH3 toxic to fish)	
	Reportable if sheen on surface of pond, stream, etc. or sludge within such	Reportable if sheen on surface of pond, stream, etc. or sludge within such	
Ethylene Glycol	2250 Kg (5000 lbs)	2250 Kg (5000 lbs)	225 Kg (500 lbs)
Sodium Thiocyanate	45 Kg (100 lbs)	45 Kg (100 lbs)	225 Kg (500 lbs)
	Report if released to Drinking Water (DW std at 1mg/L-N)	Report if released to Drinking Water (DW std at 1mg/L-N)	

8.0 DECONTAMINATION

8.1 DNCI's Standard Operating Procedures and safety rules establish work practices that minimize employees' direct and indirect contact with hazardous substances.

8.2 Equipment, rubber boots, gloves and clothes that have been contaminated can be washed with soap and water. Wash water should be collected and disposed of in an approved manner with other contaminated material.

9.0 WORKSITE CLOSURE / SHUT DOWN

9.1 **Plant Shutdown (use appropriate lock-out/tag-out procedures)**

- In the event that a plant is shut down due to weather, flood, or other adverse situation, the Plant Manager / Supervisor or his delegate will ensure that all non-essential power is shut off. The Plant Manager / Supervisor will secure all valves and flow devices so as to prevent accidental opening.
- The Plant Manager / Supervisor shall determine if any raw material or raw material storage will be contaminated or at risk of fire/explosion, and take steps to move the material or isolate it from the contamination / hazard source.
- If the power and/or gas will create a dangerous situation the Plant Manager / Supervisor will cut the outside supply of power, thereby isolating all plant equipment.
- The Plant Manager /Supervisor will advise local Mine authorities of the plant shutdown and preventative actions taken.
- All sensitive documents must be secured.

9.2 **Magazine Closure (use appropriate lock-out/tag-out procedures)**

- In the event that a magazine is closed due to weather, flood, or other adverse situation, the Supervisor/Manager or his delegate will ensure that all non-essential power is shut off. Also, the Supervisor/Manager will ensure that all magazines and compound gates are locked before leaving the site.
- The Supervisor/Manager shall determine if any products or raw materials will be contaminated and take steps to move the material or isolate it from the contamination source.
- If power and/or gas will create a dangerous situation the Supervisor/Manager will cut the outside supply of power, thereby isolating all magazine equipment.

10. RESPONSE TO NATURAL DISASTER

Hurricanes, tornadoes, floods, slides, forest fires, and earthquakes, have the ability to damage or destroy everything in their path. Yet much of the damage or destruction associated with such phenomena is the result of some secondary event, e.g. fallen power lines, ruptured tanks valves, pipes etc. If reasonable warning of an approaching disaster is received, efforts can be made to minimize damage by taking specific preventative measures. These measures are outlined in the following procedures.

1.Consult the Site Supervisor for guidance and proceed according to his direction. **SEE SITE SPECIFIC POTENTIAL HAZARDS APPENDIX 10**
2. If so directed, notify key personnel regarding the action being taken.
3. Collect important files, records and papers for safekeeping.
4. Open main electrical breaker to cut off all power to the site. (The main breaker is marked for easy identification).
5. Secure all buildings and equipment and lock the site gate.
6. Evacuate the site taking mobile equipment to safety.
7. Post Guards on site access routes to monitor the activities of unauthorized personnel.
8. A report of the incident must be submitted to the Area Manager within 24 hours.

10.1 PREVENTIVE MEASURES

10.2 Waste Disposal Permits

If nitrate waste is generated, a disposal permit must be obtained and kept up to date if the product will be disposed of off-site, or in mine tailings. Permits to dispose of other collected waste in the event of spills or leaks (such as described in Section 6.3) must also be obtained in consultation with mine / provincial environmental representatives

10.3 Liquid Containment

All fuel / oil storage tanks must be dyked according to the provisions of Federal and/or Provincial regulations (eg. National Fire Code, Environmental Protection Act), or have a double-walled tank.

A plan must be in place and materials on hand to create a dyke in the event of a large fuel or solution leak or spill or other emergency spill situation.

10.4 Inspection

All site emergency storage areas and equipment must be inspected monthly by qualified personnel, monthly for physical condition and serviceability,

and the results recorded according to quality and safety standard operating procedures.

All recommendations/orders made by NRC Explosives Branch inspectors, Fire Marshals and insurance inspectors must be responded to and acted upon accordingly. Copies of their reports are to be forwarded to DNCI's HSE representative for the region.

10.5 **Maintenance**
All preventive and breakdown maintenance must be carried out and recorded in accordance with standard operating procedures.

11.0 WORK SITE START UP (Restoration of Business)

11.1 Before startup, the condition prompting the shutdown / closure must be over / corrected (i.e. flood, fire, explosion or blizzard).

11.2 All decontamination procedures must be followed and the site cleared and cleaned of any environmental waste hazards.

11.3 All repairs to plant equipment involving safety shutdowns and essential operating machinery must be completed.

11.4 All electrical circuits, plumbing and piping must be tested.

11.5 The Work Site Supervisor / Manager will ensure that all lockout and tag-out procedures have been followed and signed off.

11.6 The Work Site Supervisor / Manager will start up the facility by turning on individual switches to the components that have been shutdown.

11.7 Operational checks will be done to ensure that all equipment is functioning at safe working pressures and voltage.

11.8 The Work Site Supervisor / Manager will give the verbal "all clear" before workers will be allowed to return to work.

11.9 The Work Site Supervisor / Manager or one of their delegates will cancel / remove all roadblocks, terminate evacuation activities, and notify employees to return to normal activities.

APPENDIX 1

Basic Investigation Report

(Factual Report not prepared Under Legal Professional Privilege)

Incident Title	

Incident No.	
Incident Date	
Site	
Department / Location	
Report Author	
Report Date	
Investigation Manager	
Investigation Team Members	
Report Distribution	

Who was involved? **name, job, title**
When did it happen? **date & exact time**
Where did it happen? **The exact location**
What was the person doing at the time? **What product or equipment was involved**
What went wrong? **Not your opinion, only factual information. Eg: an operator fell off a ladder, the hose broke; spill / quantity**
What happened? **Describe the sequence and timing of events**
Immediate Control Actions **What first aid treatment was given and or actions taken (valve turned off, electricity isolated) immediately after the incident to make the situation safe**
Interim Control Action **The interim corrective actions to prevent re-occurrence**
5-Why Analysis - Consolidate the information above into a flow chart Double click on chart to enter visio and update as required

Contributing factors **What factors combined to make the situation unsafe – in descending order of importance**
Root Cause **What were the root causes identified in the 5Why analysis – in descending order of importance**

Corrective Action	**Who**	Due Date

Comments

APPENDIX 2

DNCI Corporate contact

Name	Position	Cell number
Benoit Choquette	Environmental Manager - Canada	(514) 246-6285
Seamus Kilcommons	H&S Manager Western Canada	(403) 815-4066
Tim Marles	H&S Advisor Artic	(403) 723-7540
Willard Pierce	Regional Manager West/ Central Canada	(403) 836-9029
Hubert Fafard	H&S Manager Eastern Canada	(418) 570-9257
Greg Brown	Sales Manager Western	(403) 512-5127
Ralph Olson	Operations Manager of Western Canada	(250) 713-8720
Randy Armella	Bulk Operations Manager	(780) 865-6580
Rick Chopp	H&S Manager – Central Canada	(705) 498-2855
Pierre St Georges	Regulatory Affairs Coordinator	(613) 677-1051
Cory Redwood	General Manager Western Canada	(867) 444-8533

APPENDIX 3

DNCI Emergency Response Advisors (ERA) per area

Name	Position	Cell number	Area (West, Central or East)
Tom Medak	Mgr, Bulk operations	(403) 818-4434	West / Arctic
Dennis Wall & Doug Robertson	Meadowbank Operations Supervisors	(867) 793-4610 opt 2 ext 6804 Cell (867) 222-3930	Arctic
Seamus Kilcommons	H&S Manager Western Canda	(403) 815-4066	West
Tim Marles	H&S Advisor Arctic	(403) 723-7540 office	Artic
Tyrone McClean	Operations manager, Manitoba and Saskatchewan	(204) 687-0046	Central
Corey Rachuk	Plant Supervisor – Flin Flon	(204) 687-0028	Central
Joss Forget	Operations Manager Northern Ontario	(705) 471- 8745	East
David Roy	Manager Plant operations	(418) 570-5604	East
Francois Lambert	Operations Manager	(514) 212-3490	East
Daniel Roy	Dyno Consult , Ste-Sophie	(514) 213-5889	East

APPENDIX 4
SITE: QAAQTUQ / Meadowbank Operations

MANAGEMENT AND WORK SITE CONTACT LIST

NAME	TITLE	BUSINESS PHONE	2 WAY RADIO	CELL PHONE
Dennis Wall	Site Supervisor	(867)793-4610 opt#2 ext 6804		(867) 222-3930
Doug Robertson	Site Supervisor	((867)793-4610 opt#2 ext 6804		(867) 222-3930
Tom Medak	Bulk Manager	(403) 236-9160		(403) 818-4434
Tim Marles	H&S Advisor Arctic	403 723-7540		TBA
Seamus Kilcommons	H&S Manager	(403) 236-9160		(403) 815-4066
Benoit Choquette	Environmental Manager	(450) 818-7176		(514) 249-6285
Pierre St George	Regulatory Affairs Coordinator	(613) 632-5844		(613) 677-1051

Agnico-Eagle Mines Ltd. – Meadowbank WORK SITE CONTACT LIST

NAME	TITLE	BUSINESS PHONE	2 WAY RADIO	CELL PHONE
Meadowbank Mine		(867)793-4610		
Julie Belanger	Agnico-Eagle	(867)793-4610 ext 6721		

EXTERNAL CONTACT NUMBERS

ORGANIZATION/CONTACT	LOCATION	PHONE NUMBER
NT Oil & Chemical Spills	Iqaluit, NU	(867) 979-8130
Environment Canada, NT	Yellowknife, NT	(867) 669-4700
NRC / Explosives Branch	Ottawa	(613) 995-5555
RCMP	Baker Lake, NU	(867) 793-1111 or (867)-793-0123
RCMP 'G' Division	Yellowknife, NT	(867)669-5100

APPENDIX 5

Area Office Address:
Agnico-Eagle Mines Ltd. - Meadowbank
PO BOX 540
Baker Lake, Nunavut
X0C 0A0

Type of Facility:
Bulk Explosives Site

Customer/Client Information:
Customer: Agnico-Eagle
Contact:
Title:

Evacuation and Emergency Meeting Place Upon Evacuation:
As identified on site orientation forms (Designated Muster Points)

Emergency Shutdown switch location:

"ONLY A CERTIFIED PERSONELLE ARE TO ACTIVATE THIS SWITCH"

Magazine and Plant Site Address:

Agnico-Eagle Meadowbank Mine

NRC License:

Site Plan and Evacuation Route:
Posted in site offices – site specific orientations required

Site Rescue Plans:
Site Supervisor or designate to conduct review of attendance sheet. If employees, visitors or contractors are unaccounted for, Site Supervisor will advise mine LPO of unaccounted persons and last known location. Site Supervisor shall attend last known location with mine rescue team and jointly determine potential hazards of re-entering area to locate unaccounted for persons. Site Supervisor and Rescue team entering the evacuated area must don all required PPE due to unknown potential dangers that may have come about. Proper fire retardant suits, SCBA and/or other PPE as determine by the site to protect rescuers from becoming overcome by physical, chemical or other hazards. If determined safe to enter site and/ or buildings, a counter clockwise sweep of the area is to be conducted.

Medical Emergencies: In the unlikely event of a medical emergency, the site shall ensure that it is compliant to OH&S Code. As per legislation requirements, the site shall have adequate first aiders and equipment to attend to individuals as required.

All incidents, first aid/ medical treatment/property damage/near miss or other, shall be in compliance with HSE MS Standard 9.2, which meets or exceeds legislative requirments.

Site First Aiders:	LOCATION	PHONE NUMBER
TBA		
Security (Mine Emergency Services –fire, EMS)		

Emergency Equipment On Hand:
Fire Extinguishers, Spill Kits, First Aid Kits, non-sparking shovels as outlined in site plan.

Delivery Vehicles:			Carrying
		(EVC/ETP)	Capacity
Unit #	Vehicle	TC Permit #	(80% of Max.)

APPENDIX 6
BOMB THREAT CHECKLIST

Exact time of call:
Exact words of caller:
QUESTIONS TO ASK
1- When is bomb going to explode?
2- Where is the bomb?
3- What does it look like?
4- What kind of bomb is it?
5-What will cause it to explode?
6- Did you place the bomb?
7- Why?
8- Where are you calling from?
9- What is your address?
10- What is your name?
CALLER'S VOICE (circle) 1- Calm Slow Crying Slurred 2- Stutter Deep Loud Broken 3- Giggling Accent Angry Rapid 4- Stressed Nasal Lisp Excited 5- Disguised Sincere Squeaky Normal
If voice is familiar, whom did it sound like?
Were there any background noises?
Remarks:

Person receiving call:	Telephone number call received at:
Date:	Report call immediately to:

APPENDIX 7

Dyno Nobel Inc.

JOB-SPECIFIC ORIENTATION CHECKLIST

(Modify as needed to meet site-specific needs)

Employee Name: Job Title:

Location: Hire Date:

CHECK COMPLETED ITEMS. FOR ALL ITEMS THAT ARE NOT APPLICABLE, ENTER "NA" ON THE LINE RETURN COMPLETED AND SIGNED CHECKLIST TO APPROPRIATE HR REPRESENTATIVE

1. JOB SPECIFIC ORIENTATION TO DNA WORK SITE(S)

a. ____ DN Safety & Quality Policy
b. ____ General Safety Rules
c. ____ Site Specific Safety Rules and Instructions
d. ____ Products and Services
e. ____ Tour of Site
f. ____ Rest Rooms, Lockers, Eating Areas
g. ____ Dress and Uniform Standards
h. ____ Personal Protective Equipment
i. ____ First Aid Procedures
j. ____ How to Report Near-Misses and Accidents
k. ____ Workers' Compensation and Return to Work
l. ____ Smoking Policy and Designated Areas
m. ____ Drug and Alcohol Policy
n. ____ Site Emergency and Evacuation Plans
o. ____ Fire Extinguishers
p. ____ DN Crisis Communication Plan
q. ____ Parking and Traffic Plan
r. ____ Security Issues
s. ____ Electrical Hazards
t. ____ Review Job Description
u. ____ Take 5 Program
v. ____ Site Specific SOPs

2. OCCUPATIONAL HEALTH AND SAFETY ACT - REGULATION (OHSA)

a. ____ Mobile Equipment (Forklifts/Bobcats)
b. ____ Review Site MSDS
c. ____ Confined Spaces
d. ____ Lockout/Tagout
e. ____ DNA Hearing Conservation
f. ____ Bloodborne Pathogens
g. ____ Worker's Rights

3. ENVIRONMENT CANADA

a. ____ Spill/Release Reporting
b. ____ Proper disposal of Waste
c. ____ Waste Minimization/Pollution Prevention
d. ____ Used Oil Management
e. ____ Drum/Container Management

4. TRANSPORTATION CANADA (TDG)

a. ____ Road Test
b. ____ TDG Transportation
c. ____ TDG Hours of Service Policy
d. ____ Pre and Post Inspections

5. NATURAL RESOURCES CANADA, EXPLOSIVES SAFETY AND SECURITY BRANCH

a. ____ Site Security Plans / Key Policy
c. ____ Inventory Accuracy
b. ____ Magazine Rules
d. ____ Guidelines for bulk explosive facilities

6. QUESTIONS AND SUMMARY

_
__
_ Ask employee if there are any questions or areas of employment not clearly understood. Advise employee what's next.
Comments
: _____

_____ _____ _____ _____ Employee
Signature Date Trainer/Supervisor Signature Date

Job Specific Orientation Page 1 of 1 Canadian Standard Revised 12/17/09

APPENDIX 8

ANNUAL FIRE DEPARTMENT REVIEW FORM

Information to be released to Emergency Services

From: Local Emergency Services

Subject: Emergency Response Plan for _____.

The following is a copy of the Emergency Response Plan that has been prepared by Dyno Nobel Inc. Has been received from _____ operations. The ERP has been discussed and being kept on file for future reference. If questions arise, we have been given the contact information for the _____ operations staff.

Signed:_____

Position:_____

Date:_____

EMERGENCY RESPONSE REPORT/DEBRIEF TEMPLATE (found in NEXUS Std 9.1)

Site:..... **Date**: ..... **Drill or Actual Event** (circle)

Emergency Call placed with: Mine Emergency ☐ 911 ☐

Supervisor/Manager Advised: ☐

Incident Details:

Sequence of Events

Time	Activity	By

Gaps Identified:

	Details of Gaps Identified	*Action Required
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

A report should be raised in SHAERS/ICARUS listing all gaps identified and action required.

Fax completed form to Health & Safety Advisor for your site

APPENDIX 9
Transportation of Dangerous Goods Regulation
Class Quantity Emission Limit

1	Any quantity that could pose a danger to public safety or 50 kg
2	Any quantity that could pose a danger to public safety or any sustained release of 10 minutes or more
3	200 L
4	25 kg
5.1	50 kg or 50 L
5.2	1 kg or 1 L
6.1	5 kg or 5 L
6.2	Any quantity that could pose a danger to public safety or 1 kg or 1 L
7	Any quantity that could pose a danger to public safety. An emission level greater than the level established in section 20 of the *Packaging and Transport of Nuclear Substances Regulations*
8	5 kg or 5 L
9	25 kg or 25 L

Table identified in Section 8.1(1) of Part 8 of the Transportation of Dangerous Goods Regulation Class Quantity Emission Limit

APPENDIX 10

Emergency Risk Assessment

Site Emergency Response Plan should be based upon a risk assessment of all types of probable emergencies and regulatory impact (as found in NEXUS Std 9.1)

Location Date Analysis Completed Completed by:

Emergency Type	Scenario(s)	Safeguards	Historical Frequency	Future Risk Potential	Loss Severity Rate	Probable Emergency 8+ to be in plan	Regulatory Notifications	Actions / Remarks
Bomb Threat								
Chemical Spill/Release								
Security								
Explosion								
Fire								
Loss/Theft of Explosives								
Equipment								
Process Loss/Interruption								
Catastrophic Injury/Illness								
Trespassing/Vandalism								
Extreme Temperatures								
Earthquake								
Hurricane								
Tornado								
Severe Flooding								
OFF SITE								
Blast Site Incident								
Fire (Forest/Brush)								
Neighboring Facility Incident								
Transportation Vehicle Accident								
Transportation Fire/Explosion Incident								
Transportation Chemical Spill								
Transportation Vehicle Breakdown								

Emergency Assessment Score Information **- Use to evaluate Emergency Type level of risk**

Historical Frequency	Score	Future Risk Potential	Score	Loss Severity Rate	Score	Probability Total A & B (8+) to be in plan
Several Time per Year	5	Several Time per Year	5	Catastrophic	5	
One Time per Year	4	One Time per Year	4	Major/Critical	4	12 or higher
Once Every 3-5 Years	3	Once Every 3-5 Years	3	Serious	3	8-11
Less than Once Every 10 Yrs	2	Less than Once Every 10 Yrs	2	Negligible- No Loss	2	Less and 8
Very Unlikely to Happen Ever	1	Very Unlikely to Happen Ever	1	No Loss Occurrence	1	

APPENDIX 4

MSDS FOR BULK EMULATION AND PRESPLIT

1. MSDS – Dyno Gold Lite Bulk Emulsion

2. MSDS – Detagel Presplit

Material Safety Data Sheet

Dyno Nobel Inc.
2650 Decker Lake Boulevard, Suite 300
Salt Lake City, Utah 84119
Phone: 801-364-4800 Fax: 801-321-6703
E-Mail: dnna.hse@am.dynonobel.com
FOR 24 HOUR EMERGENCY, CALL CHEMTREC (USA) 800-424-9300
CANUTEC (CANADA) 613-996-6666

MSDS # 1052
Date [redacted]

Supercedes
MSDS # 1052 03/21/05
Added Dyno® RG3

SECTION I - PRODUCT IDENTIFICATION

Trade Name(s): DYNO GOLD® C, DYNOGOLD® C EXTRA
DYNO GOLD® C LITE, DYNO GOLD® C LITE SUPER
DYNO GOLD® CS LITE
DYNO GOLD®, DYNO GOLD® LITE
DYNO GOLD® B, DYNO GOLD® B LITE
HD
1116, 1126P, 1136P, 1146P
IREMEX 362, IREMEX 562, IREMEX 762, IREMEX 764
RJ5
RG1-A
RUG-1 (Canada Only)
DX 5007; DX 5010
DX 5013; DX 5013G; DX 5013 PB
TITAN®XL1000
TITAN® 1000, TITAN® 1000 G, TITAN® PB 1000
DYNO® RG3

Product Class: Bulk Emulsion

Product Appearance & Odor: Translucent to opaque, viscous liquid. May be silvery in color. May have fuel odor.

DOT Hazard Shipping Description: As Transported:
Oxidizing Liquid, n.o.s. (Ammonium Nitrate) 5.1 UN3139 II
After Blending with Density Control Agent On-site:
Explosive, Blasting, Type E 1.5D UN0332 II

NFPA Hazard Classification: Not Applicable (See Section IV - Special Fire Fighting Procedures)

SECTION II - HAZARDOUS INGREDIENTS

Ingredients:	CAS#	% (Range)	ACGIH TLV-TWA
Ammonium Nitrate	6484-52-2	30-80	No Value Established
Sodium Nitrate[1*]	7631-99-4	0-15	No Value Established
Calcium Nitrate	10124-37-5	0-35	No Value Established
Fuel Oil	68476-34-6	0-10	100 ppm
Mineral Oil	64742-35-4	0-7	5 mg/m^3
Aluminum *	7429-90-5	0-5	10 mg/m^3

DYNO
Dyno Nobel

[1] Our source of Sodium Nitrate (Chilean) may contain perchlorate ion, which occurs naturally. Although Dyno Nobel does not analyze for the presence of perchlorate anion, based on published studies, the products listed above may contain between 0 and 300 ppm perchlorate.

* The hazardous ingredients marked with an asterisk are not found in the majority of listed products.

Ingredients, other than those mentioned above, as used in this product are not hazardous as defined under current Department of Labor regulations, or are present in deminimus concentrations (less than 0.1% for carcinogens, less than 1.0% for other hazardous materials).

SECTION III - PHYSICAL DATA

Boiling Point: Not Applicable
Vapor Density: (Air = 1) Not Applicable
Percent Volatile by Volume: <30

Evaporation Rate (Butyl Acetate = 1): <1

Vapor Pressure: Not Applicable
Density: 0.8 - 1.5 g/cc
Solubility in Water: Nitrate salts are completely soluble, but emulsion dissolution is very slow.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point: Not Applicable
Flammable Limits: Not Applicable
Extinguishing Media: (See Special Fire Fighting Procedures Section)
Special Fire Fighting Procedures: Do not attempt to fight fires involving explosive materials or emulsion explosive precursors. Evacuate all personnel to a predetermined safe location, no less than 2,500 feet in all directions.
Unusual Fire and Explosion Hazards: May explode or detonate under fire conditions. Burning material may produce toxic vapors.

SECTION V - HEALTH HAZARD DATA

Effects of Overexposure

Eyes: Can cause irritation, redness and tearing.
Skin: Prolonged contact may cause irritation.
Ingestion: Large amounts may be harmful if swallowed.
Inhalation: May cause dizziness, nausea or intestinal upset.
Systemic or Other Effects: *Perchlorate*: Perchlorate can potentially inhibit iodide uptake by the thyroid and result in a decrease in thyroid hormone. The National Academy of Sciences (NAS) has reviewed the toxicity of perchlorate and has concluded that even the most sensitive populations could ingest up to 0.7 microgram perchlorate per kilogram of body weight per day without adversely affecting health. The USEPA must establish a maximum contaminant level (MCL) for perchlorate in drinking water by 2007, and this study by NAS may result in a recommendation of about 20 ppb for the MCL.

Emergency and First Aid Procedures

Eyes: Irrigate with running water for at least fifteen minutes. If irritation persists, seek medical attention.
Skin: Remove contaminated clothing. Wash with soap and water.
Ingestion: Seek medical attention.
Inhalation: Remove to fresh air. If irritation persists, seek medical attention.
Special Considerations: None.

SECTION VI - REACTIVITY DATA

Stability: Stable under normal conditions. May explode when subjected to fire, supersonic shock or high-energy projectile impact, especially when confined or in large quantities.
Conditions to Avoid: Keep away from heat, flame, ignition sources and strong shock.
Materials to Avoid (Incompatibility): Corrosives (strong acids and strong bases or alkalis).
Hazardous Decomposition Products: Nitrogen Oxides (NO_x), Carbon Monoxide (CO)
Hazardous Polymerization: Will not occur.

SECTION VII - SPILL OR LEAK PROCEDURES

Steps to be taken In Case Material is Released or Spilled: Protect from all ignition sources. In case of fire evacuate area not less than 2,500 feet in all directions. Notify authorities in accordance with emergency response procedures. Only personnel trained in emergency response should respond. If no fire danger is present, and product is undamaged and/or uncontaminated, repackage product in original packaging or other clean DOT approved container. Ensure that a complete account of product has been made and is verified. Follow applicable Federal, State and local spill reporting requirements.
Waste Disposal Method: Disposal must comply with Federal, State and local regulations. If product becomes a waste, it is potentially regulated as a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR, part 261. Review disposal requirements with a person knowledgeable with applicable environmental law (RCRA) before disposing of any explosive material.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Ventilation: Not required for normal handling.
Respiratory Protection: None normally required.
Protective Clothing: Gloves and work clothing that reduce skin contact are suggested.
Eye Protection: Safety glasses are recommended.
Other Precautions Required: None.

SECTION IX - SPECIAL PRECAUTIONS

Precautions to be taken in handling and storage: Store in cool, dry, well-ventilated location. Store in compliance with Federal, State and local regulations. Keep away from heat, flame, ignition sources and strong shock.
Precautions to be taken during use: Avoid breathing the fumes or gases from detonation of explosives. Use accepted safe industry practices when using explosive materials. Unintended detonation of explosives or explosive devices can cause serious injury or death.
Other Precautions: It is recommended that users of explosives material be familiar with the Institute of Makers of Explosives Safety Library publications.

SECTION X - SPECIAL INFORMATION

The reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR 372 may become applicable if the physical state of this product is changed to an aqueous solution. If an aqueous solution of this product is manufactured, processed, or otherwise used, the nitrate compounds category and ammonia listings of the previously referenced regulation should be reviewed.

Material Safety Data Sheet

Disclaimer

Dyno Nobel Inc. and its subsidiaries disclaim any warranties with respect to this product, the safety or suitability thereof, the information contained herein, or the results to be obtained, whether express or implied, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE AND/OR OTHER WARRANTY. The information contained herein is provided for reference purposes only and is intended only for persons having relevant technical skills. Because conditions and manner of use are outside of our control, the user is responsible for determining the conditions of safe use of the product. Buyers and users assume all risk, responsibility and liability whatsoever from any and all injuries (including death), losses, or damages to persons or property arising from the use of this product or information. Under no circumstances shall either Dyno Nobel Inc. or any of its subsidiaries be liable for special, consequential or incidental damages or for anticipated loss of profits.

Detagel Presplit

Material Safety Data Sheet

5700 N. Portland, Suite 301 / Oklahoma City, OK 73112 / Phone: (405) 947-0765 / Fax: (405) 947-0768

SECTION 1 - PRODUCT INFORMATION

TRADE NAME:	Presplit
SYNONYM:	NA
CHEMICAL FAMILY:	Watergel Slurry High Explosive
FORMULA:	Mixture
CAS NUMBER:	None
UN/NA NUMBER:	UN0241
DOT HAZARD CLASS:	Explosive, Blasting, Type E, Class 1.1 D

SECTION 2 - HEALTH ALERT

DANGER - If misused or disposed of improperly, material could explode and cause death or serious injury.
DO NOT HANDLE WHEN IN DOUBT!!
See section VIII - Personal Protection
CHEM-TEL, INC. (800) 255-3924.

SECTION 3 - HEALTH HAZARD INFORMATION

EYE: May cause moderate irritation.
SKIN: May cause moderate irritation characterized my redness and/or rash.
INHALATION: Inhalation of decomposed products may irritate the respiratory tract. Prolonged exposure to these fumes may result in respiratory difficulties (shortness of breath, etc.) and possibly more severe toxic effects.
INGESTION: Swallowing large quantities may cause toxicity characterized by dizziness, bluish skin coloration, methemoglobinemia, unconsciousness, abdominal spasms, nausea, and pain.

SECTION 4 - EMERGENCY AND FIRST AID PROCEDURES

EYE CONTACT: Flush with large amounts of water. Seek medical aid.
SKIN CONTACT :Remove contaminated clothing. Wash skin thoroughly with soap and water.
INHALATION: Remove from exposure. If breathing stops or is difficult, administer artificial respiration or oxygen. Seek medical aid.
INGESTION: Give 8-16 oz. of milk or water. Induce vomiting. Seek medical aid.

SECTION 5 - RECOMMENDED OCCUPATIONAL EXPOSURE LIMIT/ HAZARDOUS INGREDIENTS

EXPOSURE LIMIT (PRODUCT): None required for product. *React to form Hexaminedinitrate

HAZARDOUS INGREDIENTS:	PERCENT	EXPOSURE LIMIT	PPM	MG/M3
Ammonium Nitrate	<65%	NONE		
Sodium Nitrate	<20%	NONE		
Sodium Perchlorate	<7%	NONE		
Nitric Acid*	<5%	ACGIH - TLV	2	5
Hexamine*	<15%	NONE		
Aluminum	<7%	ACGIH - TLV		
Pentaerythritol Tetranitrate	<2%	NONE		

NOTE: All ingredients are present in a gelled slurry matrix and individual hazard may not be present in this formulation.

SECTION 6 - REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY: Heat (confinement); Stacking (burning).
INCOMPATIBILITY: Can react violently or explode, with reducing agents and organic materials. Avoid amines, strong alkalies & acids. ***HAZARDOUS REACTION / DECOMPOSITION PRODUCTS:*** At high temperatures, especially >374 F, may emit severe toxic fumes of nitrogen oxides. ***CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION:*** Not applicable.

SECTION 7 - FIRE AND EXPLOSION HAZARD INFORMATION

FLASH POINT & METHOD: NA ***AUTO IGNITION TEMPERATURE:*** Explodes ***FLAMMABLE LIMITS (% BY VOLUME/AIR): LOWER:*** NA ***UPPER:*** NA ***EXTINGUISHING MEDIA:*** Water ***FIRE-FIGHTING PROCEDURES:*** When explosive is burning, ***EVACUATE AREA.*** Avoid breathing vapor. Don't disturb fire, as dusty cloud containing aluminum may form explosive mixture with air. ***FIRE & EXPLOSION HAZARDS:*** Dangerous when exposed to heat or flame. Can support combustion of other materials involved in a fire and is capable of undergoing detonation if heated to high temperatures, especially under confinement including being piled on itself in a burning fire. When heated to decomposition, highly toxic fumes may be emitted. Do not return to area of explosion until smoke and fumes have dissipated. Dry alkali or amine salts are explosive.

Detagel Presplit

Material Safety Data Sheet

SECTION 7 - FIRE AND EXPLOSION HAZARD INFORMATION (con't.)

Internally, product contains detonating cord, consisting of flexible cord with and explosive core of PETN (pentaerythritol tetranitrate) within a textile casing covered by a seamless polyethylene jacket. This portion, if removed from the cartridge, may explode when subjected to fire or shock. PETN crystals, if separated or spilled, are substantially more sensitive to initiation by impact and friction than other components of the product, and care should be taken to avoid shock, friction, and excessive heat.

SECTION 8 - PERSONAL PROTECTION INFORMATION

EYE PROTECTION: Safety goggles approved for the handling of explosives materials.
SKIN PROTECTION: Neoprene, natural rubber, polyethylene or polyvinyl chloride gloves. Use barrier creams, hand protection and protective clothing. ***RESPIRATORY PROTECTION:*** Not normally required. Mechanical filter or supplied air type respirator as required for concentrations exceeding the occupational exposure limit.
VENTILATION: Maintain adequate ventilation. Use local exhaust if needed.

SECTION 9 - PERSONAL HANDLING INSTRUCTIONS

HANDLING: Explosives should not be abandoned at any location for any reason. Do not handle during electrical storms.
STORAGE: Store in a cool, dry, well-ventilated area remote from operations. Storage area should be of non-combustible construction and in accordance with appropriate BATF regulations. Organic materials, flammable substances and finely divided metals should be stored separately. Flames, smoking and unauthorized personnel are prohibited where this product is used or stored. Protect against physical damage, static electricity and lightning.
WARNING: Use of this product by persons lacking adequate training, experience and supervision may result in death or serious injury. Obey all Federal, State, and local laws / regulations applicable to transportation, storage, handling, and use of explosives.
DISTANCE: Always stay from area of explosion or disposal sites. Stay behind suitable barriers.

SECTION 10 - SPILL & LEAK PROCEDURES

PROCEDURES IF MATERIAL IS RELEASED OR SPILLED (IN ADDITION, SEE SECTION 8): Isolate area. Eliminate ALL sources of ignition. Avoid skin contact. Scrape up. Remove soiled clothing.
WASTE DISPOSAL - USE APPROPRIATE METHOD(S): Disposal of unexploded or deteriorated explosives material can be hazardous. Expert assistance is positively recommended in destroying explosives. Accidents can be prevented by thorough planning and handling in accordance with approved methods. Consult your supervisor, or the nearest SEC Regional Office for assistance. If improperly disposed of, material could explode and cause death or serious injury.

In all cases, follow facility emergency response procedures. Contact Facility Environmental Manager for assistance. Report any discharge of oil or hazardous substance that may enter surface waters to the National Response Center (800) 424 - 8802.

Observe all applicable local, state, and federal environmental spill and water quality regulations.

SECTION 11 - PHYSICAL DATA

BOILING POINT: NA ***BULK DENSITY:*** 1.25 g/cc ***MELTING POINT:*** NA ***%VOLATILE BY VOLUME:*** NA
VAPOR PRESSURE: NA ***EVAPORATION RATE (ETHER=1):*** NA ***SOLUBILITY IN WATER:*** Negligible with short term exposure
APPEARANCE/ ODOR: Odorless ,gray/white gel packaged in polyethylene cartridges ***DECOMPOSITION POINT:*** 200 C

SECTION 12 - COMMENTS

This product is classified as a Class 1.1D High Explosive and must be stored in a high explosive magazine. Storage should be in a well constructed, well ventilated, dry structure located to conform with local, state, and federal regulations. The area surrounding an explosive magazine must be kept clear of combustible materials for a distance of 50 feet. Magazine floors and containers must be properly cleaned. Normal operating conditions are assumed unless otherwise stated. If any given information is not clear or does not apply to your situation, STOP, store the material suitably, and seek correct help from your supervisors, Institute of Makers of Explosives or Slurry Explosive Corporation.

Disposal sites must be clear of people at the time of disposal.

NOTICE: The data and recommendations presented herein are based upon data which are considered to be accurate. However, SEC makes no guarantee or warranty, either expressed or implied, of the accuracy or completeness of these data and recommendations. For more detailed information on the hazards of this product, contact the Regulatory Compliance Department at the address below:

Slurry Explosive Corporation
P. O. Box 348
Columbus, Kansas 66725
(620) 597-2552

Revised 6-2001

APPENDIX 5

EMULSION PLAN / BLAST AREA INSPECTION SHEET

Environmental Inspection Report for the Emulsion Plant Area and the Loading of Blast Holes

---

Date: **Inspected By:**

Location: Emulsion Plant **Weekly Inspection**

In Compliance with	Subject	Conform	Non-conform	N/A	Comments
NWB Part B Item 15	Sign posted to inform of a waste disposal facility				
NWB Part D Item 29 MBK SCP NIRB Condition 26	Are there any visual spills?				
NWB Part F Item 19	All Hazardous Waste disposal is located 30m from the ordinary high water mark.				
NWB Part H Item 3	Resources in place to prevent any chemicals, petroleum products, or unauthorized Wastes from entering a water body.				
NWB Part H Item 4 Ammonia Management Plan	Is secondary containment for chemical storage provided.				
NWB Part I Item 9	Monitoring signs are posted in English, French, and Inuktitut.				
MBK SCP	Spill Kits Present				
NIRB Condition 26	Ensure that spills, if any, are cleaned up immediately and that the site is kept clean of debris, including wind-blown debris.				
NIRB Condition 25	Management and control waste in a manner that reduces or eliminates the attraction to carnivores and/or raptors.				

NIRB Condition 27 Ammonia Management Plan	Ensure the hazardous material are contained using environmentally protective methods based on practical best management practices				
	Are storage containers clearly labelled to identify Hazardous substance?				
Ammonia Management Plan	Are storage containers in good condition? Is there any visible damage or leaks? Can the doors be sealed shut?				
Ammonia Management Plan	Where necessary – Are containers with product stored in an upright position?				
Ammonia Management Plan	Do you see any potential environmental hazards posed by these HAZARDOUS containers/materials?				
BMP	Are there any additional environmental hazards/potential impacts that require attention?				
MINE ACT	Are there any Health and Safety issues that should be addressed to prevent injury to workers?				

Pit Location: **Blast Pattern#**

In Compliance with	Subject	Conform	Non-conform	N/A	Comments
NWB Part D Item 29 MBK SCP NIRB Condition 26	Are there any visual spills, including emulsion?				
Ammonia Management Plan	Is there presence of Emulsion outside of the holes that are being loaded?				
NWB Part F Item 19	All Hazardous Waste disposal is located 30m from the ordinary high water mark.				

NWB Part H Item 3	Resources in place to prevent any chemicals, petroleum products, or unauthorized Wastes from entering a water body.				
NWB Part H Item 4 Ammonia Management Plan	Is secondary containment for chemical storage provided?				
NIRB Condition 27 Ammonia Management Plan	Ensure the hazardous material are contained using environmentally protective methods based on practical best management practices				

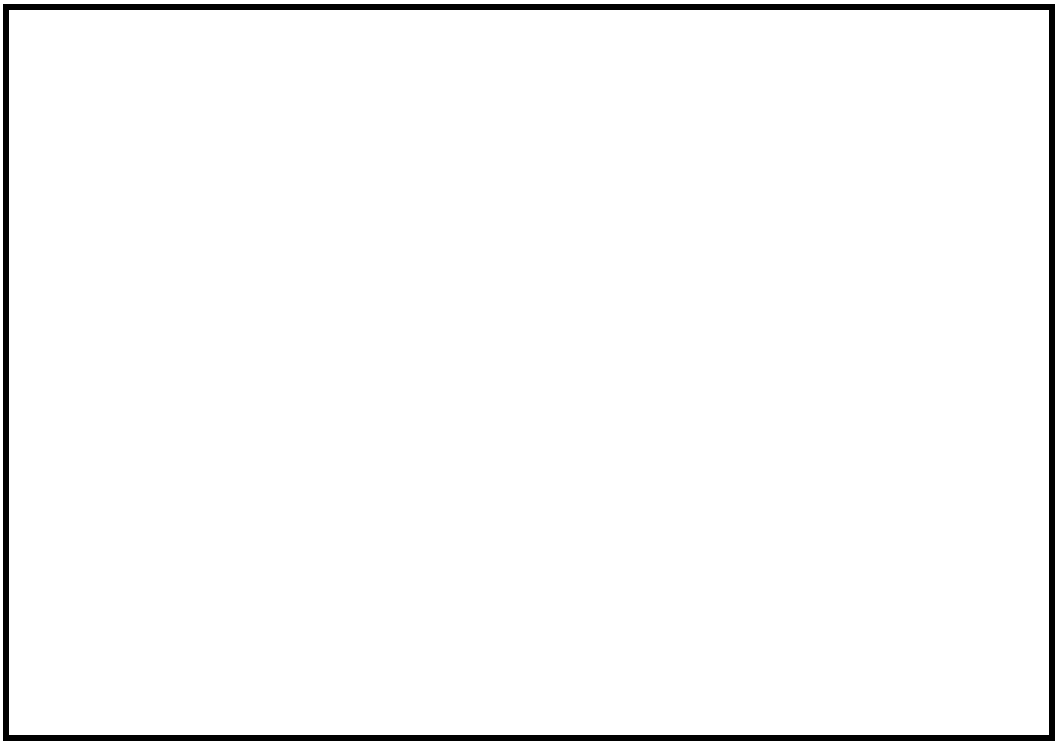
Comments/Recommendations:

Environmental Personnel Name:
Signature: _____

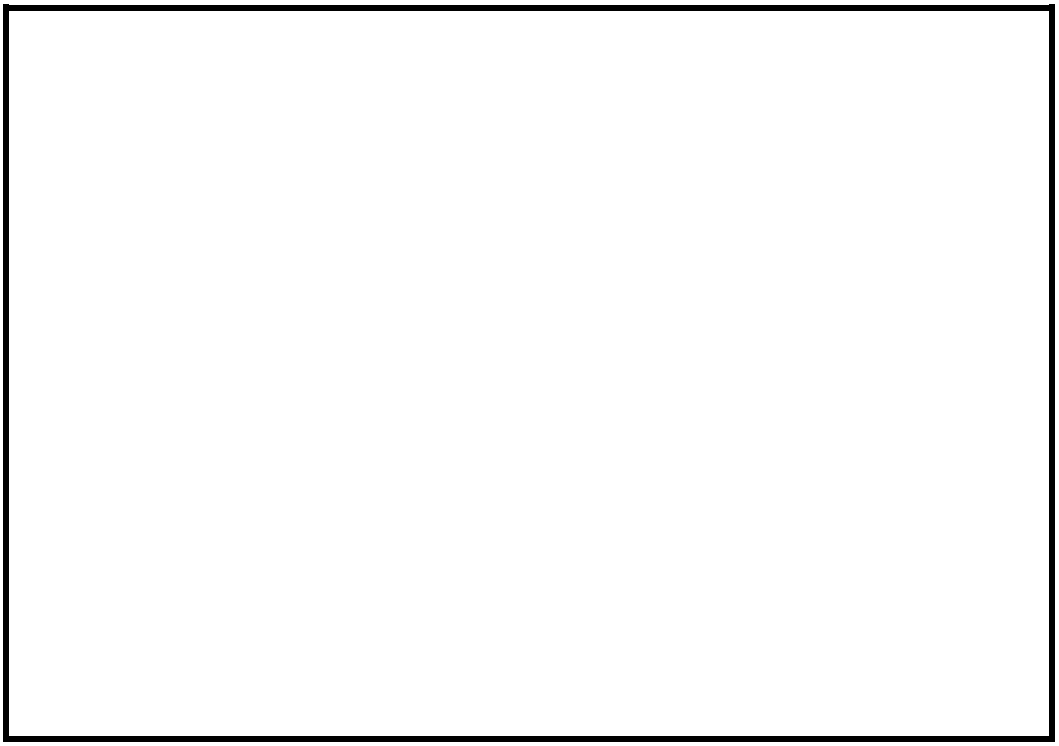
Actions Corrected:
_____
_____
_____
_____
_____

Site Service Supervisor Name: _____

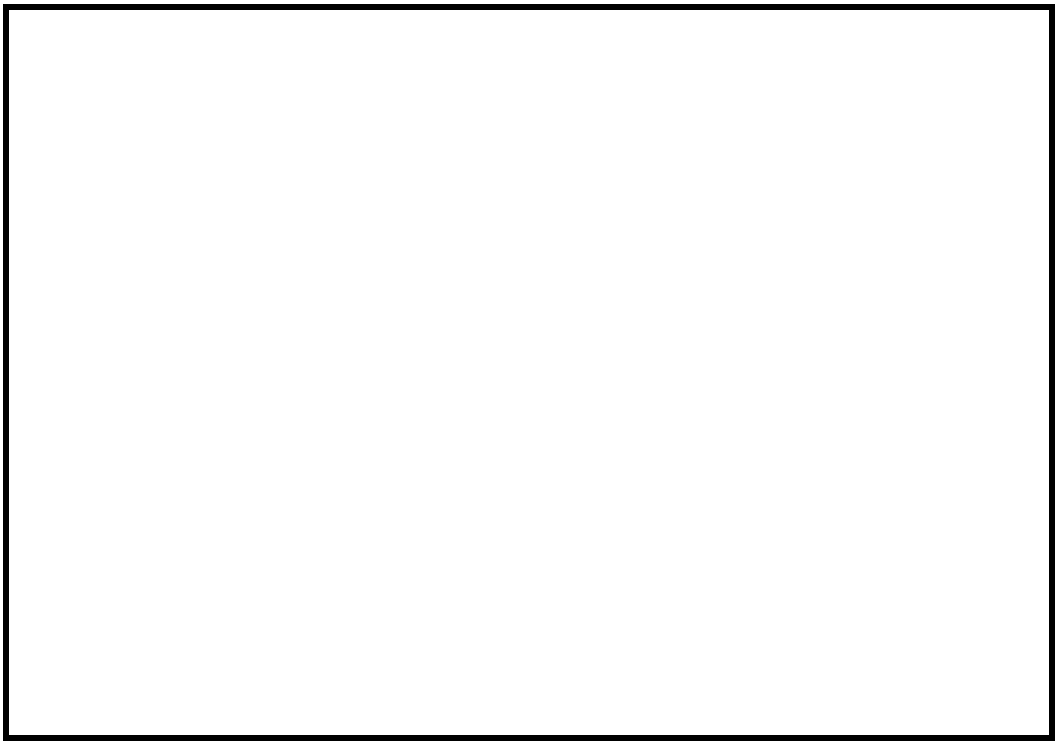
Signature: _____



Picture 1:



Picture 2:



Picture 3:

AGNICO EAGLE

MEADOWBANK GOLD PROJECT

Groundwater Monitoring Plan

In Accordance with Water License 2AM-MEA1525

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 6
September 2015

EXECUTIVE SUMMARY

This document presents the Meadowbank Mine Groundwater Monitoring Plan, a requirement of the Meadowbank Type A Water License No. 2AM-MEA1525.

The Meadowbank Mine currently has three operating groundwater monitoring wells, drilled in 2008 (MW-08-02 and -03) and 2014 (MW-14-01). A number of wells drilled in 2003, 2006, 2008, and 2011 are now inoperable for various reasons. The Goose Pit sump was added to the sampling program in 2014, as it was identified as occurring in a talik zone. However, the Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015. Methods to obtain groundwater samples from production drill holes continue to be investigated.

Groundwater chemistry data is used to predict the quality of water accumulating in open pits, and to determine any effects of mining on groundwater quality, particularly with respect to tailings deposition.

Groundwater sampling will be carried out on an annual basis. Analytical parameters will comply as per Schedule 1, Table 1, Group 2 of the Meadowbank Water License. Quality Assurance/Quality Control procedures will be implemented during each sampling event.

A groundwater monitoring report will be submitted by Agnico Eagle Mines Limited to the Nunavut Water Board (NWB) by March 31 annually. This report will include all data from the previous year's results as well as a historical record, dates and methods of sampling, and an assessment of the data obtained with particular regards to salinity parameters and indicators of tailings reclaim water movement (total cyanide and dissolved copper).

IMPLEMENTATION SCHEDULE

This Plan will be implemented immediately (September 2015) subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

AEM – Geology Superintendent

AEM – Engineering Superintendent

AEM – Geotechnical Engineer

AEM – Environment Superintendent

AEM – Environmental Coordinator

AEM – Environmental Technician

DOCUMENT CONTROL

Version	Date (YMD)	Section	Revision
1	08/08/08		Comprehensive plan for Meadowbank Project
2	09/03/31	all	Comprehensive update of plan to include 2008 well installations
3	11/12/14		Update Executive Summary; insert Figure 1; update Table 1; addition of information on wells created in 2011; include well installation section;
4	14/01		Update Executive Summary; update Section 1.2 to reflect current wells; add Section 3.3 and 3.4 (seep and production drill hole sampling methods); update Section 5 (additional reporting on tailings-related parameters)
5	15/04	1.3 and 3.3 2.3	Sampling of pit wall seeps discontinued. Sampling of Goose Pit sump added. Updated with installation information for new well.
6	15/09	4.1 and 4.2	Updated list of analyse parameters. QAQC Section to include Trip and Field Blank Remove Goose Pit sump as monitoring station

Version 6

Prepared By: Meadowbank Environment Department

Approved by:

Kevin Buck
Environmental Superintendent - Nunavut

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **II**

IMPLEMENTATION SCHEDULE ..... **III**

DISTRIBUTION LIST ..... **III**

DOCUMENT CONTROL ..... **IV**

LIST OF FIGURES ..... **VI**

LIST OF APPENDICES ..... **VI**

1 INTRODUCTION **1**

1.1 Purpose of Groundwater Monitoring 1
1.2 Monitoring Wells 1
1.3 Pit Wall Seeps 2
1.4 Production Drill Holes 2
1.5 Pit Sumps 2

2 MONITORING WELL INSTALLATION **4**

2.1 2008 Well Installation 4
2.1.1 MW08-02 & MW08-03 4
2.1.2 Instrumentation 4
2.2 2011 Well Installation 5
2.2.1 MW11-02 5
2.2.2 Instrumentation 5
2.3 2014 Well Installation 5
2.3.1 MW-14-01 5

3 SAMPLING METHODS **6**

3.1 Groundwater Well MW08-03 6
3.1.1 Well Preparation for Sampling 6
3.1.2 Well Purging 6
3.1.3 Groundwater Sampling 6
3.1.4 Well Close-Down Procedure 7
3.2 Groundwater Wells MW08-02, MW11-02, and MW-14-01 7
3.2.1 Well Preparation for Sampling 7
3.2.2 Well Purging 7

3.2.3 Groundwater Sampling 7
3.2.4 Well Close-Down Procedure 8
3.3 Production Drill Holes – ST-GW-#p 8
3.4 Goose Pit Sump (ST-GW-04) 9

4 SAMPLE ANALYSIS 10

4.1 Analysis 10
4.2 Quality Assurance / Quality Control 10
4.2.1 Handling 10
4.2.2 Duplicates, field and trip blank 10

5 REPORTING 12

LIST OF FIGURES

Figure 1 - Map of former and existing monitoring wells on the Meadowbank Site 3

LIST OF APPENDICES

Appendix A - Standard Operating Procedure for Sampling of Groundwater Monitoring Wells
Appendix B - Standard Operation Procedure for Sampling of Production Drill Holes (interim)

1 INTRODUCTION

This document presents the Meadowbank Mine Groundwater Monitoring Plan, Version 6. This version maintains the principles and sampling methodology for monitoring wells presented in Version 5 (AEM, 2015), which includes the alternative groundwater sampling option for production drill holes as suggested in the 2012 Groundwater Monitoring Report (Golder, 2012). The sampling of pit wall seeps has been discontinued, as only surface water seepage has been identified to date. Sampling of the Goose Pit sump has been added in 2014, as it was identified as groundwater. However, the Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015. Monitoring well and alternative sampling locations, design characteristics, and the sampling methodology used to recover water samples for chemical analysis are included in this Plan.

1.1 PURPOSE OF GROUNDWATER MONITORING

Groundwater data is used to predict the chemistry of water accumulating in open pits (especially salinity as TDS, conductivity and chloride), and to determine any effects of mining on groundwater quality, particularly with respect to tailings deposition. To this end, groundwater monitoring wells have been installed to sample talik water (unfrozen ground beneath large lakes) in areas where through taliks exist. No groundwater monitoring wells will be installed at the Vault deposit, as the Vault pit will be developed in an area where the talik does not extend down through the permafrost.

Groundwater sampling has traditionally been conducted using installed monitoring wells, but difficulties in obtaining representative samples by this method prompted the investigation of alternative methods in 2013 and 2014. Based on recommendations by Golder Associates (see 2012 Groundwater Monitoring Report), these included the sampling of pit wall seeps (now discontinued) and production drill holes. Traditional wells are also utilized in the monitoring program.

1.2 MONITORING WELLS

Four monitoring wells were installed at the Meadowbank site in 2003. Three of these wells (MW-03-02, MW03-03 and MW03-04) were damaged by frost action between 2004 and 2006. The fourth (MW03-01) was operable until 2010 when it was also damaged by frost action. The three defective wells were replaced in 2006 (MW06-05, MW06-06 and MW-06-07). The three wells were again damaged by frost action. MW06-05 and MW06-06 were replaced in 2008 with a more robust design (MW08-02 and MW08-03). The replacement of the third defective well (MW06-07), at the tailings storage facility, was deferred until verification of the effectiveness of the new well designs in 2009-2010. In 2011, two

monitoring wells were installed. Well MW11-01 was installed on Goose Island adjacent to the Goose pit outline, to replace one of the 2003 wells (MW03-01). Well MW11-02 was installed at the tailings storage facility to replace MW06-07 and to monitor shallow groundwater quality below the basin where tailings are deposited. The well MW08-03 has been partially blocked by an ice bridge since 2010, but attempts to melt the ice have proven somewhat successful and are ongoing. Well MW11-01 was decommissioned in 2012 after being damaged during site operations. Well MW11-02 became obstructed with development materials during the 2012 monitoring program and could not be sampled. Attempts were made in 2013 to remove the material, but these were unsuccessful. This well was replaced in 2014 with well MW-14-01. However, attempts to recover development material from MW-11-02 may continue.

The locations of each former and existing groundwater well are provided in Figure 1.

1.3 PIT WALL SEEPS

Seepage from pit walls commonly occurs in several locations in both the Portage and Goose pits. It was thought that groundwater samples could be readily be obtained directly from the waterfall when sufficient flow occurs. However, samples to date have indicated surface water rather than groundwater flow, so this program has been discontinued.

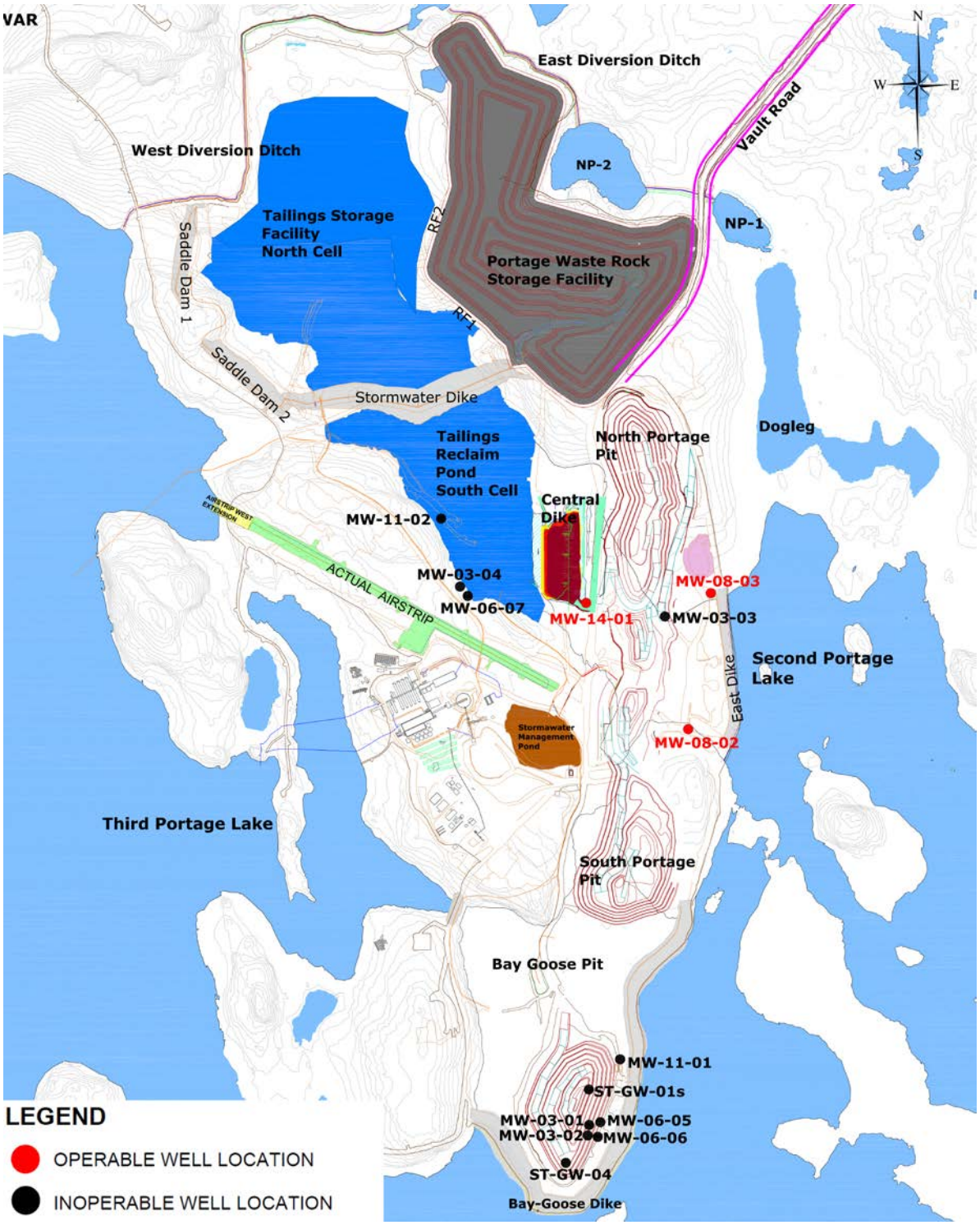
1.4 PRODUCTION DRILL HOLES

When sufficient groundwater flow from production drill holes is encountered, sampling using this method is likely feasible. Although wells with sufficient flow rates only occur on occasion, AEM is of the opinion that this is a viable method, and will continue attempts to sample production drill holes. Since the sampled locations will change each year depending on where flowing groundwater is encountered, drill hole identification numbers and GPS coordinates will be included in each annual report. This source of groundwater has the potential to be viable in determining any mining affects to groundwater, especially in the Portage Pit as it is directly downstream of the inferred groundwater flow path.

1.5 PIT SUMPS

The Goose Pit sump was identified as talik-zone groundwater due to the persistent wet ground and lack of permafrost in this area and a thorough comparison of 2014 sample analysis results with historical groundwater results from site monitoring wells. As a result, this location was added to the sampling network in 2014. However, the Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015.

Figure 1 - Map of former and existing monitoring wells on the Meadowbank Site



2 MONITORING WELL INSTALLATION

Installation details for existing monitoring wells are provided here. Details for decommissioned wells are presented in the Groundwater Monitoring Report for the year of installation.

2.1 2008 WELL INSTALLATION

2.1.1 MW08-02 & MW08-03

The two boreholes drilled for the replacement monitoring wells MW08-02, and MW08-03 were drilled using standard PQ and HQ size coring method. Heated water from the Second Portage Lake was used as drilling fluid during drilling. The boreholes were drilled to 200m depth along a 60 degree angle. Each borehole was cased to 20 m past the anticipated base of the permafrost using HWT flush-joint casing. The geological information used to was based on the core recovered from each borehole. The first 170 meters of the MW08-02 borehole were drilled without core recovery; the screened interval core was collected to confirm the target lithology. The full length of MW08-03 borehole was logged. Agnico Eagle geologists logged the core from both boreholes.

2.1.2 Instrumentation

The MW08-02 & MW08-03 wells were constructed with 1.5-inch diameter, schedule 40 stainless steel pipe and 18 m long 2 inch diameter stainless steel screen. The annulus between the casing and the monitoring well pipe was sealed at the base of the casing (169 m depth) with a pneumatic packer inflated with propylene glycol (a non-toxic and biodegradable liquid with low freezing point). This isolated the annular space between the borehole casing and the monitoring well pipe from the borehole interval below the permafrost. A small diameter double valve pump (DPV) driven by inert nitrogen gas was fixed to the outside of the riser pipe to allow removal of water from the well annulus above the packer to keep this area dry and minimize the potential for frost damage to the outside of the monitoring well pipe. A smaller diameter stainless steel pneumatic packer was installed inside of the monitoring well pipe immediately above the screen interval to prevent freezing of the inside of the monitoring well pipe throughout the permafrost. After sample collection, the inside packer is inflated and a portable DPV pump is used to evacuate water above this packer and keep the well pipe dry between the sampling events. A heating cable was attached to the outside of the monitoring well pipe through the entire anticipated interval of permafrost. The heating cables prevent water from freezing during sampling, and constitute a back-up system to melt the ice inside the monitoring well in case of a packer failure.

2.2 2011 WELL INSTALLATION

2.2.1 MW11-02

Although MW11-02 is planned to be replaced in 2014, installation details are included here because decommissioning has not yet occurred. The borehole was drilled using standard HQ size coring method. Heated lake water was used as drilling fluid during drilling. The borehole was drilled to 81 m depth at an angle of 80 degrees below ground surface. The borehole was cased through the overburden and into the first few metres of bedrock. All cores were recovered and logged by Agnico Eagle geologists.

2.2.2 Instrumentation

MW11-02 was constructed with 1.5 inch diameter, schedule 40 stainless steel pipe and 15.25 m of 2 inch diameter slotted stainless steel screen. The well was installed into an open borehole. The annulus between the stainless steel well and the borehole was filled with approximately 16 m of sand. A bentonite seal approximately 4 m thick was placed on top of the sand. The remainder of the annulus was loosely filled with gravel and a grout seal was placed at the top of the well. Although the ground is not frozen at this location in the talik, it is predicted to freeze in time. For this reason, a heating cable was attached to the outside of the stainless steel pipes above the bentonite seal. The heating cable will allow for thawing of the well in the event of permafrost in the area.

2.3 2014 WELL INSTALLATION

2.3.1 MW-14-01

The borehole was drilled using standard HQ size coring for the installation of the well. The hole angle is 73 degrees and the elevation is 119 m. Water brought from the mine water truck was used as drilling fluid. The borehole was cased with HW casing through the overburden and into the first few meters of fractured bedrock (from surface to 25.5 meter depth). The well was constructed with 1.25 inch (3.2 cm) diameter, schedule 40 stainless steel pipe and 1.25 inch (3.2 cm) diameter slotted stainless steel screen. Screened depth is from 85.85 – 95.05 m from top of casing. Filtering number 10 sand was used to surround the screen and the lower part of the casing. This was followed with bentonite to plug the bottom of the annular space and prevent surface water from entering the well. The remaining part of the annular space was filled with grouting, a mixture of concrete and bentonite. Heat tracing was attached all along the casing to allow the melting of ice when sampling is required.

3 SAMPLING METHODS

Since monitoring results to date have not indicated any effects of mining activity on groundwater quality, the groundwater sampling program will be performed annually using traditional onsite monitoring wells, as well as production drill holes as available. One sample per sampling event will be collected in duplicate and submitted blind (using different reference numbers) to the analytical laboratory. One trip blank and field blank will also be collected per year.

Specific details of sampling methods for monitoring wells and production drill holes are provided here. The collection of samples from production drill holes will occur when flowing conditions are encountered in order to obtain additional samples to assist in the assessment of any potential impacts of mining activity.

3.1 GROUNDWATER WELL MW08-03

3.1.1 Well Preparation for Sampling

At the time of purging and sampling the heat trace cables will be activated to warm the well pipe. Once the new well has been warmed up the pneumatic valve inside the well pipe will be deflated to allow groundwater to flow into the well pipe.

3.1.2 Well Purging

The well is then purged to remove standing water inside the well and to induce the flow of fresh groundwater from the rock formation. Purging is done by lowering a portable double valve sampling pump (DVP) into the well pipe to approximately 10 to 20 meters above the top of the screened interval and activating the DVP. The pump is activated by pumping compressed air into a ¼" Low Density Polyethylene (LDPE) tubing attached to the DVP. The quality of the purged water is to be monitored for pH, electrical conductivity, temperature, water clarity and colour (visual observation) during this activity. A minimum of 3 well volumes (volume of water between the in-well packer and bottom of screened interval) are to be removed prior to sampling or until the monitored parameters stabilize (values remaining within 10% for three consecutive readings).

3.1.3 Groundwater Sampling

Groundwater is to be sampled immediately after purging, by lowering the intake of the DVP tubing to 3 to 5 meters above the screened interval. The same DVP pump and tubing used for purging is to be used for sampling but utilizing compressed nitrogen gas to evacuate water that entered the sampler unit. Nitrogen gas is stable (inert) and avoids alteration of

groundwater chemistry during sampling. Chemical parameters are to continue to be measured during sampling.

A groundwater sample is to be collected in clean, laboratory-supplied containers. Where required, preservatives will be added to the sample bottles prior to sample collection, to minimize chemical alteration during transport to the laboratory. Samples analyzed for dissolved metals are to be filtered through a 45 μm inline filter.

3.1.4 Well Close-Down Procedure

Once the water sample is obtained, the pneumatic valve will be re-inflated and the well water above the valve will be removed using the portable DVP pump. The DVP pump fixed to the outside of the well will also be activated to remove water accumulated in the annulus of the well during purging and sampling (if any). The heating cable will be de-activated and the cap will be replaced on the casing.

3.2 GROUNDWATER WELLS MW08-02, MW11-02, AND MW-14-01

Although MW11-02 may no longer be sampled methods are provided here in the event that the well is able to be unblocked.

3.2.1 Well Preparation for Sampling

Because water is allowed to rise and freeze in place within the well pipe, the heat trace cable activation period will be considerably longer, in the order of 4-7 days, to thaw standing water (ice) present in the well pipe. The effective heating cables in the groundwater wells should allow the water present in the well pipe to thaw in a timelier manner.

3.2.2 Well Purging

Once ice is fully thawed purging is initiated in the same way as for the 2008 wells, by inserting the DVP and tubing at 10 to 20 meters above the screened interval and removing well water by pumping compressed air. Groundwater will be continually pumped from the well until electrical conductivity and pH readings stabilized. This process may require more than 3 well volumes. In consideration of the low hydraulic conductivity of the rock causing a very slow recovery of groundwater level (only a few litres of groundwater can be removed at a time), this process can take up to 4 days to complete.

3.2.3 Groundwater Sampling

Groundwater sampling will be carried out immediately after well purging, in the same manner as for the 2008 design wells (same equipment, elevation of tube intake for water sample, use of nitrogen gas, monitoring of water quality parameters during this process).

Groundwater samples are to be collected in clean, laboratory-supplied containers. Where required, preservatives will be added to the sample bottles prior to sample collection, to minimize chemical alteration during transport to the laboratory. Samples analyzed for dissolved metals are to be filtered through a 45 μm inline filter.

Samples are to be collected in duplicate and submitted as blind duplicates (using different reference numbers) to the analytical laboratory. Duplicate samples are to be analyzed for the same parameters as the original sample specified in Table 1 of Schedule 1 of the Meadowbank Water License.

3.2.4 Well Close-Down Procedure

Once the water sample is obtained, the heating cable will be de-activated and the cap will be replaced on the well.

3.3 PRODUCTION DRILL HOLES – ST-GW-#P

The collection of samples from production drill holes will occur whenever flowing drill holes are encountered and the designed methods will be modified as required based on field testing. Standard methods are provided in Appendix B, and summarized here.

AEM's Senior Environmental Technician or Coordinator will request that the Blast Supervisor (Mine Dept.) notify Environment Department staff when a flowing production well is encountered during regular production (for blasting) drilling (it is not a regular occurrence). Sampling needs to be conducted prior to addition of any explosive material.

Before sampling, three well volumes will be purged from the flowing hole. Production wells are usually 0.17 m diameter and 8.5 m deep so approximately 579 L will be removed.

Analysis of field parameters will be used to assist in determining if sufficient purging has occurred. Values are to be stable (within 10%) for three consecutive readings (in accordance with procedures for monitoring wells).

The sample is to be collected in clean, laboratory-supplied containers. Where required, preservatives will be added to the sample bottles prior to sample collection, to minimize chemical alteration during transport to the laboratory. Samples analyzed for dissolved metals are to be filtered through a 45 μm inline filter.

For each sampling location, GPS coordinates and the drill hole number/blast pattern number will be recorded.

3.4 GOOSE PIT SUMP (ST-GW-04)

Goose Pit sump will no longer be utilized as a Groundwater sampling station as the reflooding of the pit (for closure purposes) has commenced. Mining ceased in Goose pit in March 2015.

Samples from the Goose Pit sump used to be collected directly from the end-of-pipe during pumping of this water to the South Cell TSF. As a precaution to guard against possible contamination due to close proximity to the South Cell tailings reclaim pond, extra purging was conducted. A sample port may need to be installed upstream from the end of pipe to ensure no contamination of samples.

A groundwater sample was collected in clean, laboratory-supplied containers. Where required, a preservative was added to the sample bottles prior to sample collection, to minimize chemical alteration during transport to the laboratory. Samples analyzed for dissolved metals were filtered through a 45 μm inline filter.

A separate container was used to collect water for immediate measurement of field parameters (pH, conductivity).

4 SAMPLE ANALYSIS

4.1 ANALYSIS

These samples will have field parameters taken (pH, turbidity, salinity and conductivity). Analytical parameters will include the following, per Schedule 1, Table 1, Group 2 of the Meadowbank Water License: bicarbonate alkalinity, carbonate alkalinity, total alkalinity, calcium, potassium, magnesium, sodium, hardness, ammonia nitrogen, total kjeldahl nitrogen, nitrate, nitrite, ortho-phosphate, total phosphorus, total organic carbon (TOC), total dissolved organic carbon (DOC), reactive silica, chloride, sulphate, total dissolved solids (TDS), total suspended solids (TSS), total and free cyanide and the following total and dissolved metals: aluminum, antimony, arsenic, boron, barium, beryllium, cadmium, copper, chromium, iron, lithium, lead, manganese, mercury, molybdenum, nickel, selenium, strontium, tin, titanium, thallium, uranium, vanadium and zinc.

4.2 QUALITY ASSURANCE / QUALITY CONTROL

4.2.1 Handling

The following procedures will be followed to provide data quality control:

- Measurement of field parameters at selected intervals until stable readings (within 10% of each other);
- Minimization of the exposure of the sampled water to the atmosphere;
- Use of compressed, inert gas (nitrogen) to evacuate water for sample collection;
- In-situ measurement of sensitive chemical parameters (pH, conductivity, dissolved oxygen, alkalinity, where applicable); and
- Abiding by sample preservation methods (refrigeration and use of preservatives where needed); and specified holding times.

4.2.2 Duplicates, field and trip blank

A duplicate sample will be collected for one monitoring well per sampling event, and submitted as a blind duplicate to the analytical laboratory. Where both results are higher than five times the method detection limit (MDL), the relative percent difference (RPD) will be calculated as:

RPD = absolute difference in concentration/average concentration x 100

USEPA (1994) indicates that an RPD of 20% or less is acceptable. Where one or both results are less than five times the MDL, a margin of +/- MDL is acceptable.

One field and one trip blank will also be collected once a year.

5 REPORTING

An annual groundwater monitoring report will be submitted by Agnico Eagle Mines Limited to the Nunavut Water Board (NWB) by March 31 of the following year. This report will include the following information:

- Installation logs for any new monitoring wells;
- Location in UTM coordinates of all groundwater sample locations;
- Description of the working condition of the existing wells;
- Date of groundwater sampling;
- Details of sampling methods;
- Analytical results including: field data, laboratory analytical data and QA/QC information;
- Comparative assessment of data obtained to date to input values used in the Water Quality Model for the site (relevant salinity parameters); and
- Comparative assessment of parameters indicative of mine impacts to groundwater, with particular regard to tailings (total cyanide and dissolved copper).

APPENDIX A

Standard Operating Procedure for Sampling of Groundwater Monitoring Wells

WORK INSTRUCTION

Purpose:

This procedure is used to ensure that groundwater (GW) sampling is conducted in a safe and orderly manner. All samples need to be taken in the same manner to provide continuity of samples regardless of who is taking the samples. The Environment Department is required to conduct a GW sampling program to determine if there are any mining impacts to the local GW regime. This is in accordance with both our NWB and NIRB permits. In 2013 AEM environment staff will conduct the GW sampling program at Meadowbank.

Groundwater Sampling SOP:

GW sampling consists of measuring field parameters and collecting GW samples within the designated bottles.

Material needed:

Waterra 1 inch
Waterra ¼ inch
2 Genset (Atlas Copco, QAS 30) (GEN 30 and 34)
1 compressor (environment compressor)
3 Nitrogen tanks (JDE number 134720)
Nitrogen regulator
Solinst pump
Clean pails
Cond./pH/Temperature probe (PCStestr 35 or multi-parameter probe)
Water level probe
Control box
Red hose for NO2
Black hose with moisture trap for NO2
Adaptor, Fitting, Ring, Tools
Sampling bottle and syringe

Procedures to be done in 2013 for existing GW Wells

MW-11-02

In accordance with the 2012 Golder Groundwater Technical Memorandum Env Dept staff needs to retrieve a melted waterra that has plugged this well at a depth of 28 meters. This will require the use of at least a 30 meter RW drill rod with a fitting containing external thread. Orbit Gallant will conduct this drilling to remove the blockage (Ask Orbit to drill with size A casing).

Also there is a short on the heat trace cable in this well so the electrician must be informed prior to plug the heat trace to avoid overheating.

MW-08-03

This well has been determined to have an ice blockage, below the existing heat trace, at a depth of 150 meters. To melt the ice, Carlon tubing HDPE is required (about 200 meters).Orbit Garant will thaw the blockage below the heat trace cable with hot water. Once the ice melts we can push the tubing down to continue the purge and characterization of the water prior to obtain a sample. Temperature of the heated water shouldn't exceed 60 °C

MW-08-02

Nothing special. This well was sampled last year using regular unthawing and purging techniques.

Thaw and Purge Procedures

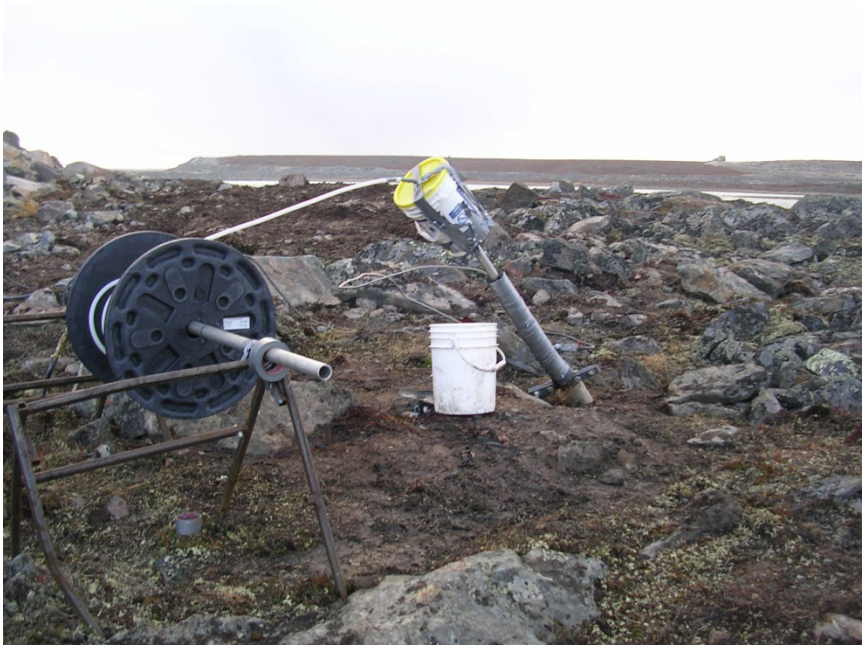
A) Melt the ice in the monitoring well

1- Measure the depth of the ice in the well – use existing well logs to document all activity. This is important for report preparation.
2- Ask for an electrician to plug the heat trace to the generator (Atlas Copco, QAS 30)

3- Monitor the ice and water depth every twelve hours or so.
4- Once the ice level has been melted to a depth of over 150 meters, we can start to purge.

B) Purge the water in the well

1- Place a pail upside down on top of the well to avoid having water flow all over and place an additional pail on the ground underneath to collect the purged water (see photo below).

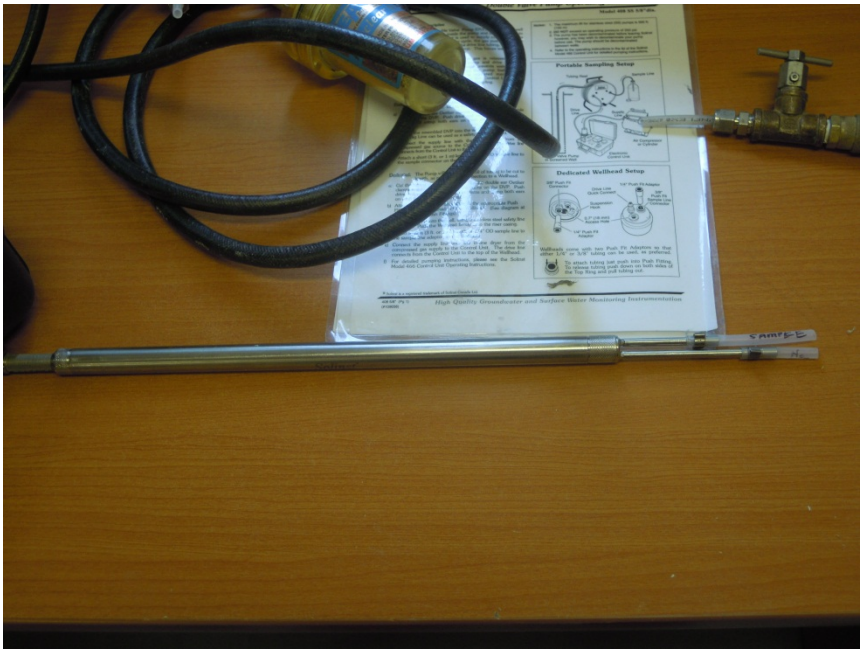


2- Place the 1 inch Waterra into the well to about 30 meters below the water level.
3- Place the rings (the smaller one first and then larger one after) onto the tubing and screw the fitting on the Waterra.
4- Connect the fitting to the red hose and then connect the red hose to the compressor.
5- Plug the compressor into the generator (make sure that the valves are close).

6- Once the compressor reaches 125 psi, open the valve and wait for the water to flow out (can take between 30 seconds to 2 minutes).
7- Once there is no water flowing, close the valve, measure the pH, conductivity, temperature, amount of water purge (by number of pails), level of the water and then, lower the waterra, wait for 10 minutes and start over. This will equal one volume purged.
8- At the end of the day, take the waterra of the well and take the water level.
9- Once you purge 3 times the amount of water in the well and parameters are stabilized (all results within +/-10%), you can sample the well

C) Sample the water in the well

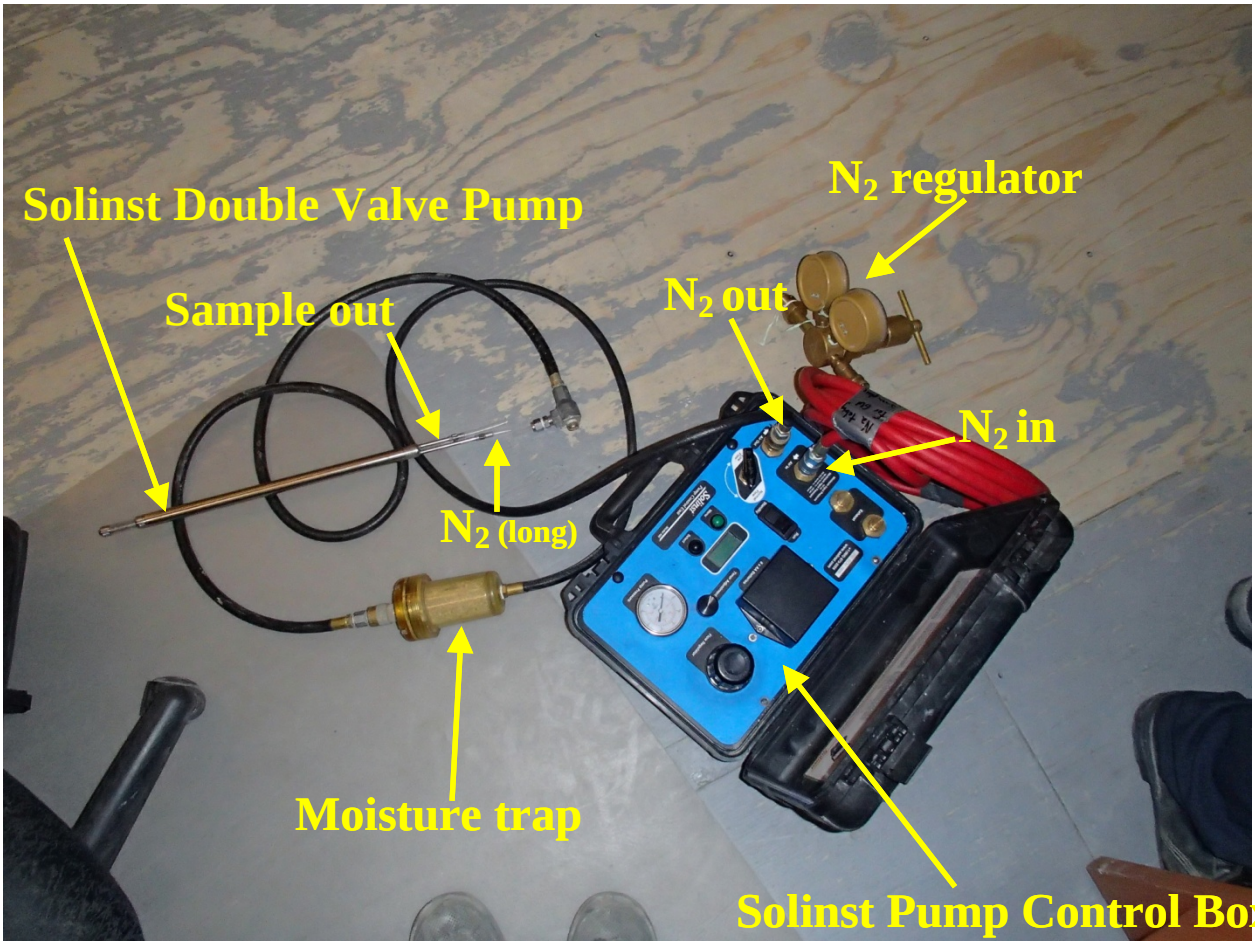
1- Place the ¼ inch double waterra line on the Solinst double valve pump.
2- Tighten the waterra with the rings



3- One Waterra line will be bring the sample water and one will send Nitrogen to the pump. Make sure to identify which line is the one for Nitrogen and which one is the line for water (longest metal tale on the pump is for nitrogen) (see photos).
4- On the nitrogen waterra line, place 2 rings and a bolt and place it on the 90˚adapter and the black hose with the moisture trap.

5- Connect the black hose to the Nitrogen control box (AIR OUT)
6- Plug the red hose to the control box (AIR IN).
7- Plug the other end of the red hose to the ``T`` regulator with the gauge.

8- Connect the regulator to the nitrogen tank and slowly open the Nitrogen tank to a pressure of140 PSI.
9- On the control box press RUN than put the menu on AUTO mode.
10- With the SELECT button adjust the pressure so that when it's pumping the pressure is at 140 PSI and when it's venting, it goes back to 0 PSI.
11- This should take about 5 minutes before there is a water flow.
12- Let it run for 10 to 15 minutes, measure parameters with the PCSTestr 35 or the multi-parameter probe and sample the water. Record all field parameters results.
13- For filtering, place the pumped GW in a clean container, rinse 3 times and use a syringe to sample.


Solinst Double Valve Pump
Sample out
N_2 (long)
Moisture trap
N_2 regulator
N_2 out
N_2 in
Solinst Pump Control Box

Control box

8 AA batteries
250 ECU 5655
+1(905) 873-2255
www.solinst.com
Exhaust
N_2 in, connected to N_2 regulator
Minimum Input Pressure
Maximum Input Pressure
Air In
Run
Standby
8 x AA Batteries
Timer Adjustment
Pressure fluctuates between 0 and 140 psi between drive and purge cycles
Drive – 12s
Normal Flow
Normal flow
Menu
Select
Pump Pressure
Solinst
N_2 out, connected to ¼ tubing attached to Solinst Double Valve Pump (long stainless steel tube)
Control box

Valve and Ring

Take a triplicate for every sample, send 2 to the lab and keep a backup sample.

Follow the SOP for the shipping request..\Shipping\Shipping Samples SOP.doc

Author:		
Environmental Technician	Martin Theriault	
Print Title	Print Name	Signature

Approval:		
Environmental Coordinator	Jeffrey Pratt	
Print Title	Print Name	Signature

APPENDIX B

Standard Operating Procedure for Sampling of Production Drill Holes (Interim)

Procedure for Groundwater Sampling from Flowing Production Drill Holes/Wells

Purpose:

This procedure is to ensure that groundwater (GW) sampling from flowing production drill holes/wells is conducted in a safe and orderly manner. Production holes are drilled to place explosives for blasting. All samples need to be taken in the same manner to provide continuity of samples regardless of who is taking the samples. Using the Environment Department PCSTestr 35 conductivity and salinity readings are to be taken from flowing production wells, when notification is received, and compared to results from previous GW sampling events conducted by Golder (see chart below). If these parameters are determined to be similar we can conclude that the water is representative of area GW.A sample can then be taken. The drilling of production wells involves the use of freshwater and this water will be purged when a flowing well is encountered. It is important to ensure that this water is purged prior to taking a sample (which is why the meter is used – to take continuous samples until it is determined that the water is GW).

Groundwater sampling from production holes SOP:

GW sampling from production holes consists of measuring field parameters (conductivity, TDS and salinity) with the PCSTestr 35 and comparing the results with past results (Golder) from the GW wells. If the results are similar in chemistry to previous results then a sample is collected using the designated sample bottles prior to the addition and use of explosives in the hole. The location, time, depth of hole and procedural notes are documentation that will be required from each sampling event.

Material needed for the job:

Calibrated Multi-parameter PCSTestr 35
Watch
Clean Pail
Sampling gloves
Sampling bottles
GPS
Camera

Procedures to be done in 2013

1- Senior Environmental Technician or Coordinator will request that the Blast supervisor (Mine Dept) notify Env staff when a flowing production well is drilled (it is not a regular occurrence). We need to make sure no explosive material is added to the hole before sampling. Env Dept should have equipment ready and proceed to site upon notification if possible.

2- Before sampling, make sure that 3 well volumes have been purged from the flowing hole. Production wells are usually 0.17 meter diameter and 8.5 meters deep so approximately 579L

needs to have been discharged. It will not always be possible to determine the purged volume due to the time it takes to travel to the location. In field sampling will assist in determining if the GW is representative of the area GW.

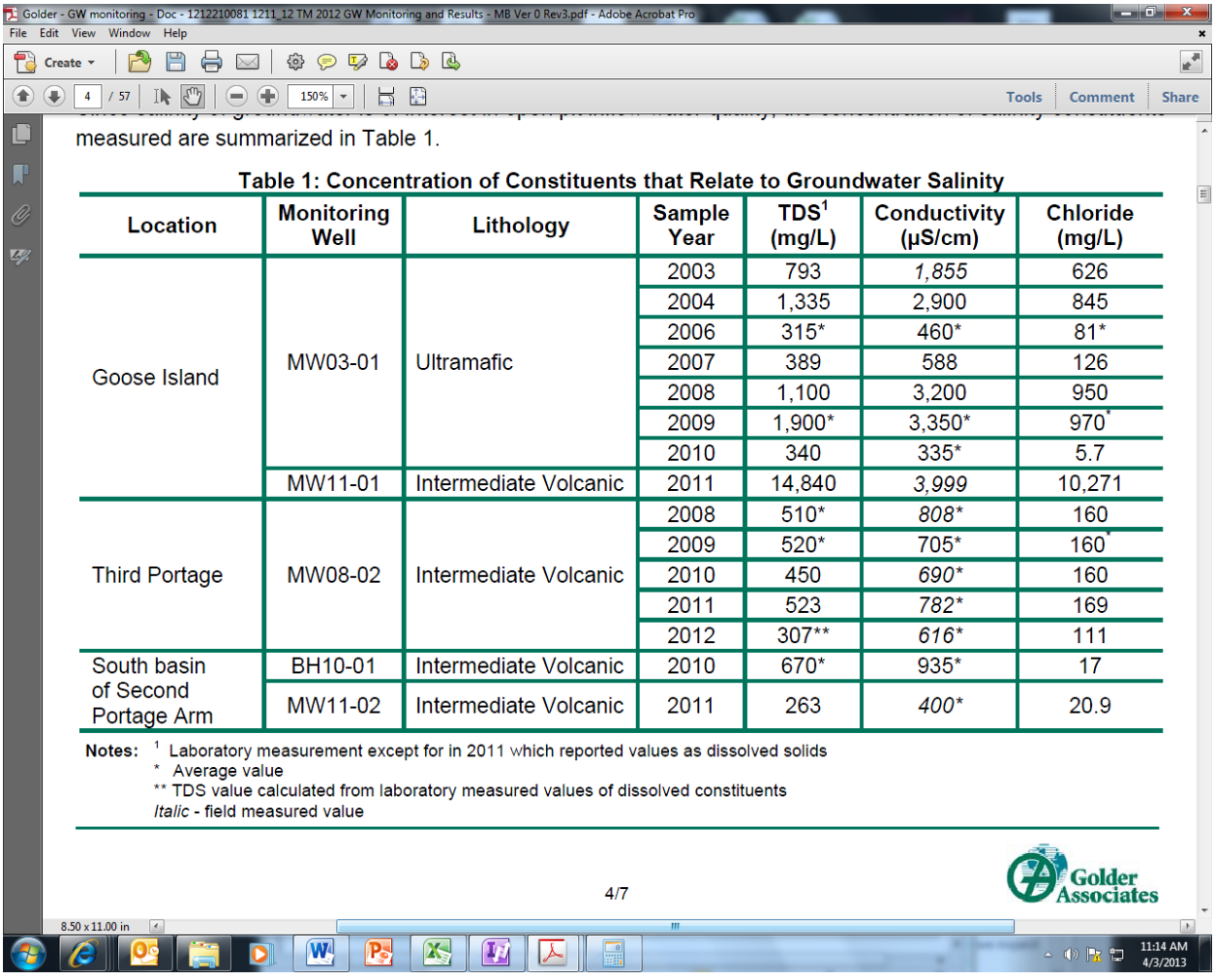
3- Calculate the amount of time needed before sampling according to the flow.

4- Take at least 3 readings during the purging with the multi-parameter probe (conductivity, TDS and salinity) and compare your results with Golder's results (see table below). Parameters need to be stable (within 10% of each other).

5- If results are similar, once the purge is completed, put on the nitrile gloves and sample the hole with the appropriate bottles. For filtering, let the water flow into a clean container, rinse 3 times and use a syringe to sample.

6- Take the GPS coordinates and the identification of the hole (blast pattern) of the sampling location and also take some pictures of the overflowing hole.

Golder's results for TDS, Conductivity and Salinity



measured are summarized in Table 1.

Table 1: Concentration of Constituents that Relate to Groundwater Salinity

Location	Monitoring Well	Lithology	Sample Year	TDS[1] (mg/L)	Conductivity (µS/cm)	Chloride (mg/L)
Goose Island	MW03-01	Ultramafic	2003	793	*1,855*	626
			2004	1,335	2,900	845
			2006	315*	460*	81*
			2007	389	588	126
			2008	1,100	3,200	950
			2009	1,900*	3,350*	970*
			2010	340	335*	5.7
	MW11-01	Intermediate Volcanic	2011	14,840	*3,999*	10,271
Third Portage	MW08-02	Intermediate Volcanic	2008	510*	*808**	160
			2009	520*	705*	160*
			2010	450	*690**	160
			2011	523	*782**	169
			2012	307**	*616**	111
South basin of Second Portage Arm	BH10-01	Intermediate Volcanic	2010	670*	935*	17
	MW11-02	Intermediate Volcanic	2011	263	*400**	20.9

Notes: [1] Laboratory measurement except for in 2011 which reported values as dissolved solids
* Average value
** TDS value calculated from laboratory measured values of dissolved constituents
Italic - field measured value

Golder Associates

Follow the SOP for the shipping request..\Shipping\Shipping Samples SOP.doc

Author:		
Environmental Technician	Martin Theriault	
Print Title	Print Name	Signature

AGNICO EAGLE

MEADOWBANK GOLD PROJECT

TAILINGS STORAGE FACILITY

Operation, Maintenance and Surveillance Manual

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 5
October 2015

TAILINGS STORAGE FACILITY

OPERATION, MAINTENANCE AND

SURVEILLANCE MANUAL

MEADOWBANK GOLD PROJECT

AGNICO EAGLE MINES LIMITED

This Operation, Maintenance and Surveillance Manual has been prepared by Agnico Eagle Mines Limited and is to be used for the operation, maintenance and surveillance of the Tailings Storage Facility at the Meadowbank Gold Project. All Registered Manual Holders are responsible for ensuring that they are using the most recent revision of this document. This Operation, Maintenance and Surveillance Manual, may not be copied in whole or in part without the written consent of Agnico Eagle Mines Limited.

IMPLEMENTATION SCHEDULE

This Plan is immediately implemented.

DISTRIBUTION LIST

AEM - General Manager Meadowbank

AEM- Environment Superintendent

AEM- Mine Operations Superintendent

AEM- Engineering Superintendent

AEM- General Services Manager

AEM- Site Services Superintendent

AEM- Corporate Environment Director

AEM- Health and Safety Superintendent

Golder- Dike Design Engineer

SNC- Dike Design Engineer

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
(first revision)	February 2012	All	All	
V2	August 27, 2013	All	All	
V3	September 15, 2013	All	All	Updated items mentioned by MDRB and the Mine Inspector in the Annual Geotechnical Inspection in September 2013
V4	January 2015	All	All	
V5	October 2015	All	All	

Approved by:

Julie Belanger
Engineering Superintendent

Kevin Buck
Environment Superintendent

TABLE OF CONTENTS

DISTRIBUTION LIST ..... **IV**

DOCUMENT CONTROL ..... **V**

LIST OF TABLES ..... **VIII**

LIST OF FIGURES ..... **VIII**

LIST OF APPENDICES ..... **VIII**

SECTION 1 • INTRODUCTION **1-1**

1.1 Purpose 1-1
1.2 Registered Manual Holders and Revisions 1-1
1.3 Regulatory, CDA and MAC Guideline Requirements 1-1
1.4 Dam Classification 1-2
1.5 Annual Review of Manual 1-2
1.6 Reference Documents and Drawings 1-2

SECTION 2 • ROLES AND RESPONSIBILITIES **2-1**

2.1 Roles, Responsibilities and AuthoritY 2-2
2.2 Required Levels of Knowledge 2-2

SECTION 3 • FACILITY DESCRIPTION **3-1**

3.1 Background 3-1
3.2 Design and Operational Criteria 3-3
3.3 Facility Components 3-3
3.3.1 Perimeter Containment Structures 3-3
3.3.2 Internal Deposition Structures 3-3
3.3.3 Perimeter Water Control Structures 3-3
3.4 Tailings Distribution System 3-3
3.5 Water Management System and Piping 3-5
3.6 Facility Closure 3-5
3.7 Instrumentation 3-5
3.8 Public Safety 3-5

SECTION 4 • OPERATIONS **4-1**

4.1 Operational Philosophy 4-1

4.2 Deposition Planning Criteria and Constraints 4-1
4.3 Water Management 4-2

SECTION 5 • MAINTENANCE 5-1

5.1 Containment Structures 5-1
5.2 Ditches and Sumps 5-1
5.3 Instrumentation 5-1
5.4 Pipelines and Pumps 5-1

SECTION 6 • SURVEILLANCE 6-1

6.1 Inspections 6-1
6.1.1 Routine Inspections 6-1
6.1.2 Special Inspections 6-3
6.1.3 Annual Inspection 6-3
6.2 Instrumentation and survey 6-3
6.2.1 Ground Temperature and Piezometric Level Monitoring 6-6
6.2.2 Anomalous Measurements 6-6
6.2.3 Seepage Monitoring 6-7
6.3 Water Quality 6-7

SECTION 7 • REPORTING AND DATA MANAGEMENT 7-1

7.1 Reporting 7-1
7.1.1 Inspection Documents 7-1
7.1.2 Instrumentation Measurements 7-1
7.1.3 Emergencies 7-1
7.2 Data Management 7-1

SECTION 8 • EMERGENCY PREPAREDNESS PLAN 8-1

8.1 Emergency Procedures 8-1
8.1.1 Operation 8-1
8.2 Emergency Details 8-2
8.2.1 Access to the Project Site 8-2
8.2.2 Emergency Assessment 8-2
8.2.3 Emergency Communication and Actions 8-2
8.2.4 Site Emergency Procedure 8-3
8.2.5 Communication Equipment Location 8-3
8.3 Medical and First Aid Services 8-4
8.4 On Site Equipment and material 8-4
8.4.1 Pumping Equipment 8-4
8.4.2 Mobile Equipment 8-5
8.4.3 Earthwork Material and Equipment 8-1

SECTION 9 • EMERGENCY RESPONSE REFERENCE DOCUMENTS 9-1

SECTION 10 • REFERENCES.....10-1

LIST OF TABLES

Table 1-1 List of Registered OMS Manual Holders.....1-3
Table 1-2 Record of OMS Manual Revisions and Addenda.....1-4
Table 1-3 Regulatory Requirements.....1-5
Table 1-4 Classification of Dams in Terms of Consequences of Failure (after CDA 2007).....1-6
Table 1-5 Tailings Storage Facility Documentation Summary.....1-7
Table 1-6 Listing of Specifications for Tailings Storage Facility.....1-8
Table 1-7 List of Construction Drawings for Embankment Structures.....1-9
Table 1-8 List of Construction Drawings for Infrastructure and Piping.....1-10
Table 2-1 Roles and Responsibilities.....2-1
Table 2-2 Recommended Minimum Knowledge of OMS Manual.....2-4
Table 3-1 Design and Operational Criteria.....3-5
Table 6-1 Surveillance Items and Frequencies.....6-4
Table 9-1 Emergency Response Reference Documents.....9-1
Table 9-2 Potential Effects or Causes of Embankment Failure Mechanisms.....9-1
Table 9-3 Threshold Criteria during Operation.....9-3
Table 9-4 Communication Charts for Each Emergency Level.....9-4
Table 9-5 Responsibilities of Persons for Each Emergency Level.....9-4
Table 9-6 Names and Contact Details (to be updated as required).....9-5

LIST OF FIGURES

Figure 1 AEM Tailings Storage Facility Management Structure.....2-2
Figure 2 Plan of Tailings Storage Facility.....3-2
Figure 3 Spigot Locations.....3-4
Figure 4 Approximate Location of Current Instrumentation.....6-5
Figure 5 Earthwork Material and Equipment Location.....8-1

LIST OF APPENDICES

Appendix I Water Quality and Flow Monitoring Plan
Appendix II Tailings Storage Facility - Inspection Form
Appendix III Dike Failure Scenario Appendices from the ERP

LIST OF ACRONYMS AND ABBREVIATIONS

%	Percent
°C	Degrees Celsius
1:100	1 in 100 years (return period)
2H:1V	Slope of 2 horizontal units to 1 vertical unit
AEM	Agnico Eagle Mines Limited
CDA	Canadian Dam Association
Elev.	Elevation
EPP	Emergency Preparedness Plan
ERP	Emergency Response Plan
g	Gravitational acceleration constant (9.80 m/s^2)
Golder	Golder Associates Ltd.
m	Metre
M	Million
MAC	Mining Association of Canada
OMS	Operation, maintenance and surveillance
SD1	Saddle Dam 1
SWD	Stormwater Dike
TSF	Tailings Storage Facility
tpd	Tonnes per day

LIST OF DEFINITIONS

Active Layer: Ground above the top of permafrost. This layer freezes and thaws seasonally.

Permafrost: Bedrock or soil at a temperature at or below 0^oC for a continuous period of two or more years. It is important to note that permafrost is not permanent. It is also important to note that the term permafrost does not imply the presence or absence of ice in the bedrock or soil.

SECTION 1 • INTRODUCTION

1.1 PURPOSE

This operation, maintenance and surveillance (OMS) manual provides a reference document to be used by the personnel responsible for the operation, maintenance and surveillance of the Tailings Storage Facility (TSF) at the Meadowbank Gold Project that is owned and operated by AgnicoEagle Mines Limited (AEM).

The TSF is the permanent surface storage facility for tailings produced during the operation of the mine. Refer to Section 3.0 for description details of the TSF.

Qualified personnel shall be used for the operation, maintenance and surveillance of the TSF and adequate records shall be maintained for regulatory, general and reference purposes. As the management structure changes, the OMS manual should be revised and distributed accordingly. A primary objective during the early phases of operation and development of the TSF, especially during that of the North Cell, is to optimize these activities for use during subsequent development phases.

This OMS manual addresses the operational issues of the TSF. It does not examine design, construction or closure issues in detail. Details of the design and construction requirements for the TSF are presented in the references provided later in this document. Details on closure are included in the Closure Plan.

1.2 REGISTERED MANUAL HOLDERS AND REVISIONS

Each copy of this OMS manual is assigned a unique identification number.

The AEM Engineering Superintendent is responsible for maintaining an up-to-date list of the registered holders of this OMS manual in Table 1-1.

The AEM Engineering Superintendent is also responsible for the issue of all revisions and addenda to all Registered Manual Holders of this OMS manual. Revisions will be made, as and when required, by re-issuing a complete section, table and/or appendix so that the superseded section, table and/or appendix can be removed and replaced. All Registered Manual Holders are responsible for placing the revisions and addenda in their copy of the OMS manual and for recording receipt of the same in Table 1-2.

1.3 REGULATORY, CDA AND MAC GUIDELINE REQUIREMENTS

This OMS manual sets out procedures to ensure compliance with the AEM regulatory requirements which are summarized in Table 1-3.

The Canadian Dam Association (CDA) Dam Safety Guidelines (CDA 2007) states “Dam operation, maintenance and surveillance encompass a number of activities and constraints defined to ensure that the dam is managed with appropriate regard for safety.” The preparation and use of this OMS manual achieves this requirement. Reference to CDA (2007) was made in the preparation of this OMS manual.

The Mining Association of Canada (MAC) has prepared two reference documents for management of tailings facilities: "A Guide to the Management of Tailings Facilities" (MAC 2008) and "Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities" (MAC 2005). Both of these documents were used in preparation of this OMS manual.

1.4 DAM CLASSIFICATION

Table 1-4 presents the classification information and the following is noted for the perimeter containment structures of the TSF (i.e. Saddle Dams 1 to 5, inclusive, the Stormwater Dike and the Central Dike):

- Loss of life: the embankment is classified as "high" due to the limited number of workers in the Portage and Goose Pits downstream of the Central Dike coupled with AEM's procedures for pit evacuation in the event of an emergency;
- Environmental and Culture Values: the embankment is classified as "high" due to the water license requirements and environmental permitting considerations;
- Infrastructure and Economic Losses (third parties): the embankment is classified as "high" due to the water license requirements and environmental permitting considerations; and
- The dam classification for the TSF perimeter containment structures is determined by the highest of the three ratings above; therefore, these structures are classified as "high" consequence structures.

1.5 ANNUAL REVIEW OF MANUAL

This OMS manual will be reviewed by AEM on an annual basis and revised as necessary to accommodate changes in the condition and operation of the TSF. The Registered Manual Holders of the OMS manual are encouraged to provide comments and suggestions for improvement of the OMS manual and the procedures specified in it to the AEM Engineering Superintendent. The comments and suggestions communicated will be considered in the annual review.

1.6 REFERENCE DOCUMENTS AND DRAWINGS

A summary of the documentation prepared for the TSF, including design reporting, as-built reporting, technical specifications, construction drawings, instrumentation installation reporting and deposition planning, is presented in Table 1-5. The most current technical specifications and construction drawings referenced in Table 1-5 are presented in Table 1-6 to Table 1-8, inclusive. All design and as-built documents can be found in hard copy onsite in the engineering department, as well as in electronic copies on the dikes server.

Table 1-1 List of Registered OMS Manual Holders

Name / Position / Address or Location	OMS Manual Copy No.
General Manager Meadowbank / Bertin Paradis / OFFICE	1
Environment Superintendent / Kevin Buck / OFFICE	2
Mine Operations Superintendent / Brock Johnston / OFFICE	3
Engineering Superintendent / Julie Belanger, Stephane Frechette (asst.) / OFFICE	4
General Services Manager / Alain Hamel / OFFICE	5
Energy and Infrastructure Superintendent / Christian Soucy, Stephane Boucher (asst.) / OFFICE	6
Vice President, Environment / Michel Julien / AEM Toronto Office Corporate Environment Director / Gonzalo Rios / AEM Vancouver Office	7
Health and Safety Superintendent / Norman Ladouceur, Yves Levesque (asst.) / OFFICE	8
Dike Design Engineer / Golder Associates Ltd./ 500 – 4260 Still Creek Drive, Burnaby, BC, V5C 6C6	9
Dike Design Engineer / SNC-Lavalin Inc./ 5500, Boulevard des Galeries, Bureau 200, Quebec, Quebec, G2K 2E2	10
Update as Required	

Table 1-2 Record of OMS Manual Revisions and Addenda

Revision No.	Section	Table	Appendix	Addenda No.	Date of Revision
1	All	All	All	-	February 2012
2	All	All	All	-	August 2013
3	All	All	All	-	September 2013
4	All	All	All	-	January 2015
5	All	All	All	-	October 2015

Table 1-3 Regulatory Requirements

Document	Document Reference and/or No.	Review Date
Territorial Lands Act – Land Lease	Production Lease KVPL08D280	Expires December 27, 2027
Environmental Impact Assessment	NIRB Project Certificate No. 004	Only required if substantial modifications to original application are to be carried out
Water License Type “A”	Nunavut Water Board Water Licence 2AM-MEA0815	Expires July 22, 2025

Table 1-4 Classification of Dams in Terms of Consequences of Failure (after CDA 2007)

Dam Class	Population at Risk [Note 1]	Incremental losses		
		Loss of Life [Note 2]	**Environmental and Cultural Values**	**Infrastructure and Economics**
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	**Permanent**	**10 or fewer**	**Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind highly possible**	**High economic losses affecting infrastructure, public transportation, and commercial facilities**
Very high	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affection important infrastructure or services *(e.g., highway, industrial facility, storage facilities for dangerous substances)*
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services *(e.g., hospital, major industrial complex, major storage facilities for dangerous substances)*

Note 1. Definitions for population risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary – People are only temporarily in the dam-breach inundation zone *(e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).*

Permanent – The population at risk is ordinarily located in the dam-breach inundation zone *(e.g., as permanent residents)*; three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

Note 2. Implications for loss of life:

Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 1-5 Tailings Storage Facility Documentation Summary

Item	Description	Reference
TSF Design Basis	Report	Golder (2008)
Stormwater Dike and Saddle Dam 1 Geomembranes	Technical Memorandum	Golder (2009)
Revised configuration for Saddle Dam 1	E-Mail	Golder (2009; no formal document issued)
Deposition Plan (North Cell)	Report	Golder (2011, 2012)
Deposition Plan (North Cell)	Presentation	AEM (September 2013)
Construction Report TSF	Report	AEM (June 2013)
North Cell Diversion Ditches	Report	AEM (July 2013)
Deposition Plan (North & South Cells)	Presentation	AEM (August 2014)
Central Dike As-Built Report	Report	AEM (January 2016)
Saddle Dam 3 As-Built Report	Report	AEM (November 2015)
Saddle Dam 4 As-Built Report	Report	AEM (November 2015)
Deposition Plans (North & South Cell)	Presentation	AEM (October 2015)
Update as Required		

Table 1-6 Listing of Specifications for Tailings Storage Facility

Item (Prepared By)	Specification No. and Title	Revision No. and Title	Date of Revision
Golder	Specification-TSF Dike Construction	Doc. 795 Rev. 0	October 16, 2009
Golder	Central Dike Design Changes	Doc 1453 1312210034 TME Rev0	April 24, 2014
Golder	Detailed Design Report for Saddle Dams 3, 4 and 5	Doc 1504 1416081 SD3,4 & 5 Design Rev1	May 12, 2015
Update as Required			

Table 1-7 List of Construction Drawings for Embankment Structures

Drawing No. (Prepared by)	Title	Revision No.	Date of Revision
4100-30 to 4100-39 (Golder)	Tailings Storage Facility – Stormwater Dike	0	July 10, 2009
4100-50 to 4100-60 (Golder)	Tailings Storage Facility – Saddle Dam 1	0	July 10, 2009
SD2-SD3-01 to SD2-SD3-13 (Golder)	Tailings Storage Facility –Saddle Dam 2 and Saddle Dam 3	A	August 25, 2010
SD6-01 to SD6-11 (Golder)	Tailings Storage Facility – Saddle Dam 6	A	September 13, 2010
Figure 1—Supersedes Drawing Nos. 4100-30, 4100-31, and 4100-32 (Golder)	Agnico-Eagle Mines Limited, Meadowbank Gold Project Nunavut, Stormwater Dike Staged Layout Plan	N/A	August 5, 2009
Figure 2—Supersedes Drawing Nos. 4100-33, Detail 3 on 4100-34 (Golder)	Tailings Storage Facility Typical Cross-Section and Details	N/A	August 5, 2009
Figure 1—Supersedes Drawing Nos. 4100-51, 4100-52, 4100-53, and 4100-58 (Golder)	Tailings Storage Facility Saddle Dam 1 Rockfill Plan and Liner Details	N/A	August 17, 2009
All drawings in the Construction Report TSF (AEM)	Construction Report Tailings Storage Facility	N/A	June 15, 2013
All drawings in the Detailed Design Report for Saddle Dams 3, 4 and 5 Doc 1504 1416081 SD3,4 & 5 Design Rev1	Detailed Design Report for Saddle Dams 3, 4 and 5	N/A	May 12, 2015
Update as Required			

Table 1-8 List of Construction Drawings for Infrastructure and Piping

Drawing No. (Prepared by)	Title	Revision No. and Title	Date of Revision
All Booster Pump Design Drawings	Booster Pump Design Drawings, MEAD-360	N/A	June 26, 2012
Weekly Update Geotech Planning – Tailing Deposition (AEM)	North Cell Tailings Storage Facility Tailings Deposition Plan	Updated Weekly	N/A
All drawings in the Construction Summary Report North Cell Diversion Ditches (AEM)	Construction Summary Report North Cell Diversion Ditches	N/A	July 27, 2013
All South Cell Infrastructures drawings (AEM)	Reclaim pump drawings 61-430 Pig launcher drawings 61-360	N/A	October 2014
Update as Required			

SECTION 2 • ROLES AND RESPONSIBILITIES

There are several AEM department teams involved in the operation, maintenance and surveillance of the TSF:

The Engineering Department has a team of people that:

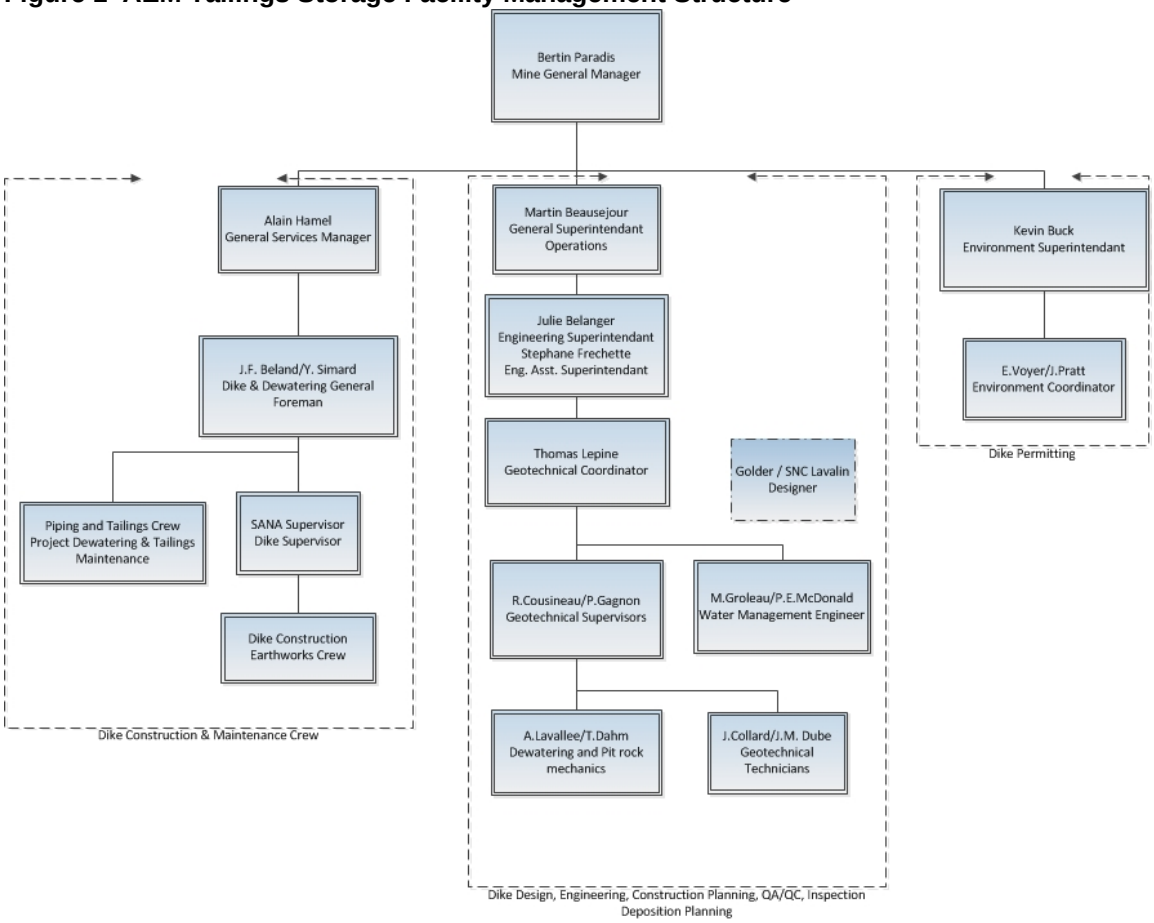
- Plan and oversee the construction of the embankments of the TSF;
- Provides the overall management of the TSF;
- Oversees the design, development, construction and deposition activities of the TSF;
- Monitors the thermistor instrumentation of the TSF;
- Monitors quantity and manages the water of the TSF, including the perimeter water control structures;
- Carries out operation, maintenance and surveillance of the tailings distribution system;
- Conducts visual inspections of the TSF, including the perimeter water control structures;
- Monitors the water level elevations of the perimeter sumps and the embankment slope monitoring points; and
- Coordinates activities and ensure compliance with the regulatory requirements of the TSF.

The Environment Department has a team of people that:

- Monitors the water quality from the sumps of the TSF; and
- Coordinates activities and ensure compliance with the regulatory requirements of the TSF.

The organizational chart of the current management team is shown on Figure 1. This chart shall be updated to reflect changes in management and/or changes in operational criteria in accordance with AEM's overall management and operational requirements.

Figure 1 AEM Tailings Storage Facility Management Structure



Note: To be updated as required

2.1 ROLES, RESPONSIBILITIES AND AUTHORITY

The roles and responsibilities for each AEM position and the authority during the operational cycle of the TSF are listed in Table 2-1. The roles and responsibilities of each position should be updated to reflect changes to the overall management structure.

All site personnel are responsible for informing their Superintendent of any indications of abnormal situations that may be observed.

2.2 REQUIRED LEVELS OF KNOWLEDGE

The recommended minimum levels of knowledge by the various positions are as summarized in Table 2-2. Training of personnel shall be carried out to ensure the minimum levels of knowledge set out in Table 2-2 are attained by all personnel and positions involved in the operation of the facility. AEM's training department, with support from relevant personnel, shall carry out all training. Training shall be logged and registered according to the department protocols.

Table 2-1 Roles and Responsibilities

Position	Role	Responsibility
General Mine Manager	Oversees mine development and planning, operations and permitting	Initiate and oversee emergency or contingency protocols during emergency events. Oversight of Mine, Engineering, and Environment Superintendents tasks and responsibilities as laid out in the OMS Manual. Ensures that proper planning is carried out and that required resources are made available. Oversees and provides input in all matters arising in the operation and management of the mine including the TSF.
Engineering Superintendent /Geotechnical Coordinator	Overall TSF management	Coordinates all TSF management related activities. Coordinates with Environmental Superintendent on environmental issues. Ensures Mining Association of Canada (MAC) compliance. Ensures Canadian Dam Association (CDA) compliance. Ensures monitoring is carried out in accordance with the TSF monitoring program, other applicable programs, approved protocols and frequency. Reviews existing and assesses future monitoring requirements. Reviews construction designs and schedules. Reviews the QA/QC system to meet construction design. Reviews TSF operating and training manuals – assists in completion of manuals. Ensures documentation and records related to TSF development, construction and operations are kept and are up-to-date. Authorizes emergency work in the event of non-compliance or emergency operational requirement. Reports operational issues to the Mine Superintendent. Ensures all systems are properly maintained. Prepares TSF development, construction, QC and activity reports. Coordinates and reviews regular facility inspections by AEM staff.
Dike and Dewatering Foreman	Oversees TSF development and maintenance	Maintains access to the TSF, road surface repairs, dust control and snow removal. Oversees and provides input in construction of the TSF matters. In charge of earthwork construction and piping installation and maintenance.

Position	Role	Responsibility
		Supervises Contractor(s).
Environment Superintendent	Oversees environmental data collection and processing	Liaise with external stakeholders including NIRB, Nunavut Water Board and government agencies Assesses current and future monitoring requirements. Reviews government permits and recommends monitoring for compliance Reviews TSF development and deposition plans Prepares TSF water management reports. Oversees TSF water, collection pond and groundwater sampling in accordance with approved protocols. Interprets environmental (facility water quality) data Monitors compliance with water quality and quality from the TSF, and reports non-compliance events and/or trends to Operations Manager. Supervises Environmental Coordinator. Indicates water quality sampling locations, sample collection protocols and analytical parameters in coordination with the Environmental Consultant. Senior TSF environmental oversight. Acts as AEM's contact for governmental oversight of TSF. Reports environmental issues to the General Manager and Operations Manager. Ensures with Engineering Superintendent TSF instrumentation data collection, processing and reporting. Reviews government permits and recommends monitoring for compliance. Assesses future monitoring requirements. Ensures compliance with regulatory requirements. Validates laboratory test results. Processes laboratory data and prepares summary reports. Ensures compliance with water management protocols. Develops and maintain site wide and TSF water balance. Supervises Environmental Technician.
Geotechnical Engineering Consultant	TSF annual inspections	Provides construction-level design, reports, drawings and technical specifications. Provides deposition planning design and reporting. Communicates through Engineering Superintendent and Environment Superintendent. Performs regularly scheduled Third Party Inspections.

Position	Role	Responsibility
		Performs Special Inspections, as required. Reviews as-built and monitoring reporting. Reviews field quality assurance (QA) and quality control (QC) programs. Reviews geotechnical designs relative to actual field conditions.

Table 2-2 Recommended Minimum Knowledge of OMS Manual

Position	Recommended Minimum Knowledge
General Mine Manager / Assistant Mine Manager	Review of the OMS Manual with an understanding of the operational requirements. Detailed knowledge of emergency response procedures.
Mine Operations Superintendent	Basic knowledge of the OMS Manual, with an understanding of the design and operational requirements. Detailed knowledge of emergency response procedures.
Engineering Superintendent/ Geotechnical Coordinator	Detailed understanding of the OMS Manual, with a complete understanding of the design and operational requirements. Detailed and ongoing review of all monitoring, inspections and embankment safety reviews. Complete understanding of all related technical documents for design, operation, risk assessment and emergency response. Review of the operations manuals on an annual basis. Detailed knowledge of emergency response procedures.
Environment Superintendent	Detailed understanding of the OMS Manual, with an understanding of the design and operational requirements set out in this OMS Manual. Detailed understanding of all operational elements within the facility and their operational and maintenance requirements. Detailed knowledge of emergency preparedness and emergency response procedures.
Environmental Coordinator	Detailed understanding of the OMS Manual, with a complete understanding of the design and operational requirements. Detailed and ongoing review of all monitoring, inspections and embankment safety reviews. Complete understanding of all related technical documents for design, operation, risk assessment and emergency response. Review of the operations manuals on an annual basis. Detailed knowledge of emergency preparedness and emergency response procedures
Process Plant Superintendent	Basic knowledge of the OMS Manual, with an understanding of the design requirements. Detailed knowledge of emergency response procedures.
External Personnel (Consultants and Contractors)	Varied levels of knowledge and understanding depending on involvement. Detailed knowledge of emergency preparedness plan.

SECTION 3 • FACILITY DESCRIPTION

3.1 BACKGROUND

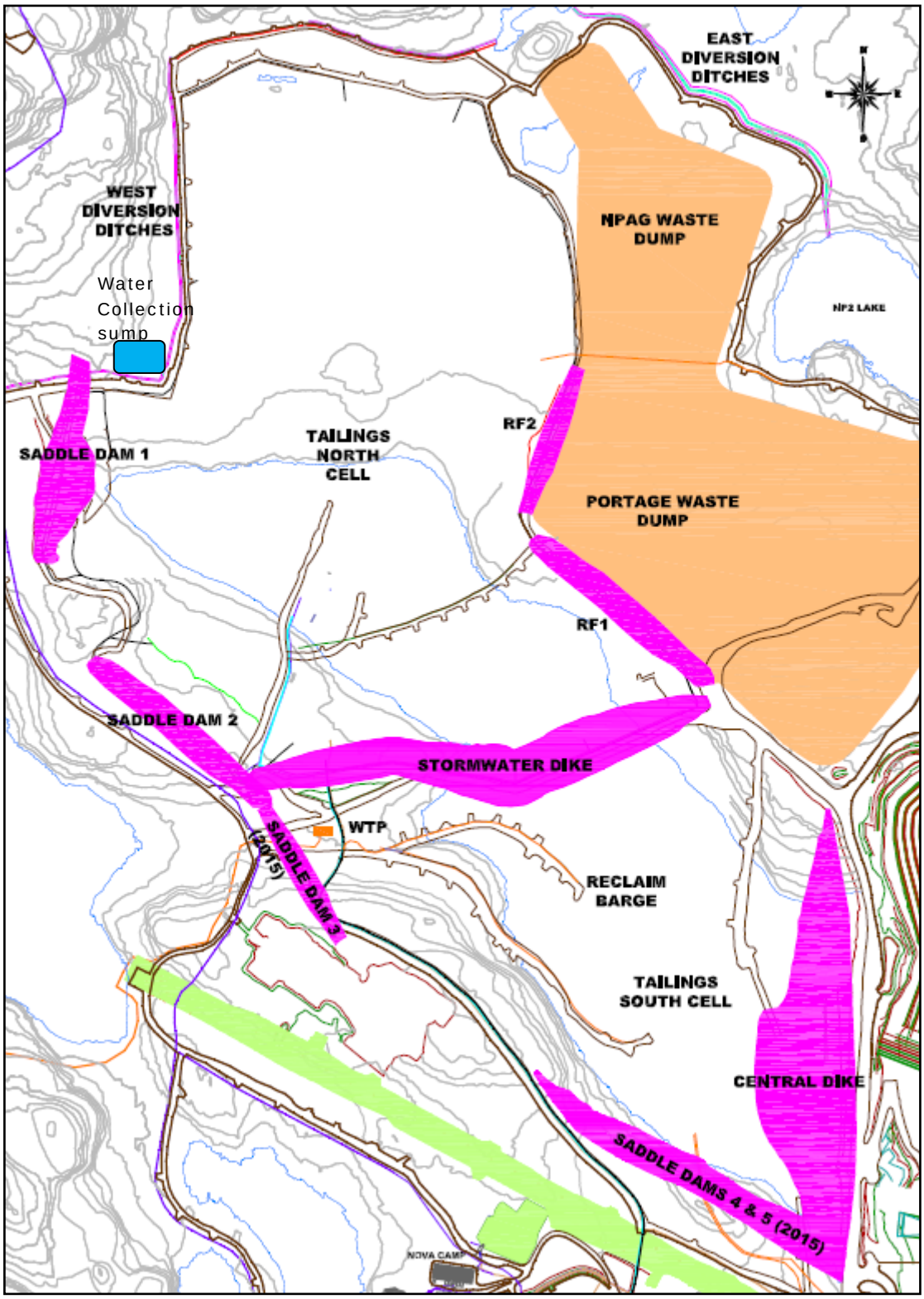
The TSF is the permanent surface storage facility for tailings produced during the operation of the mine. The TSF is located north of the Process Plant Site, as presented on Figure 2, and will be developed in two cells in the following order:

1. North Cell; and
2. South Cell.

The main components of the TSF are:

- Perimeter containment structures (Saddle Dams 1 to 5, inclusive, rockfill structures RF1 & 2 and the Central Dike);
- Seepage and run-off perimeter water control structures;
- Internal deposition structure (Stormwater Dike);
- Deposition infrastructure;
- Dewatering infrastructure;
- Instrumentation; and
- Reclaim water system: supernatant pond and water treatment facility.

Figure 2 Plan of Tailings Storage Facility



3.2 DESIGN AND OPERATIONAL CRITERIA

The main design and operational criteria for the TSF are summarized in Table 3-1.

3.3 FACILITY COMPONENTS

3.3.1 Perimeter Containment Structures

A series of containment structures comprising of Saddle Dam 1 (SD1), to SD5, inclusive, and the Central Dike form the perimeter of the TSF. These structures are shown on Figure 2.

3.3.2 Internal Deposition Structures

To facilitate deposition within the TSF, the Stormwater Dike (SWD) is located within the facility (refer to Figure 2). This structure divides the North Cell and the South Cell.

3.3.3 Perimeter Water Control Structures

The design objective of the perimeter water control structures, comprising of ditches and sumps, is to collect surface water runoff and seepage from the TSF for pumping back to the tailings facility. The purpose of controlling the runoff and seepage from the TSF is to prevent it from reporting to the downstream environment. The perimeter water control structures will be used throughout the operating life of the TSF. These will continue to be used into the post-closure of the project until both the TSF and adjacent ground returns to pre-development permafrost conditions or the surface runoff and seepage waters are of acceptable quality to be discharged directly to the environment.

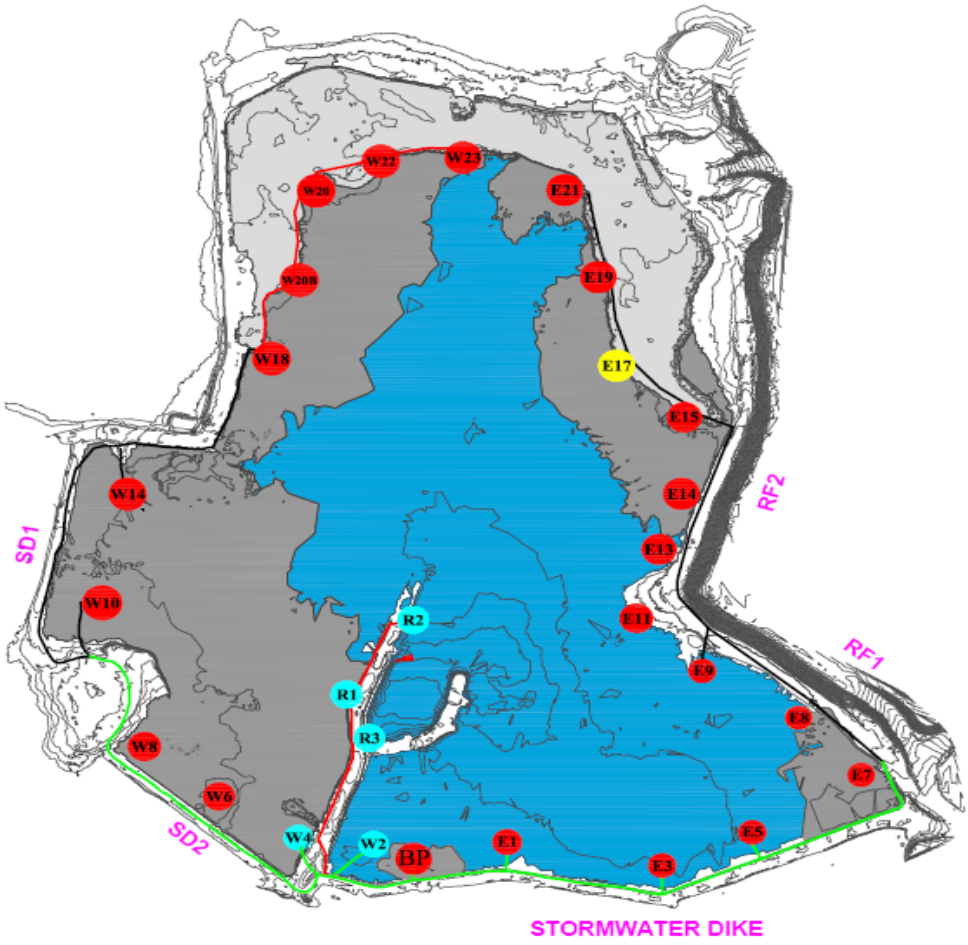
The ditches surrounding the TSF are designed to capture seepage and surface runoff water and provide gravity flow of the water into the sumps.

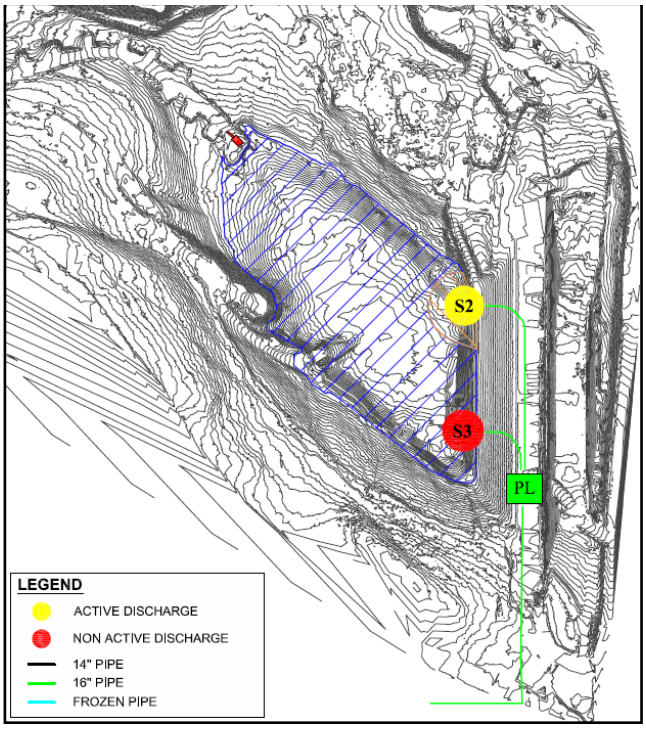
The sumps are collection points for flows from the ditches and the TSF to enable pumping of water to the water treatment plant.

3.4 TAILINGS DISTRIBUTION SYSTEM

The tailings distribution piping system for transporting slurry from the Process Plant to and for deposition into the TSF is presented on Figure 3.

Figure 3 Spigot Locations





3.5 WATER MANAGEMENT SYSTEM AND PIPING

Water is pumped from the supernatant pond to the Mill Plant for recirculation. Water collected from the non-contact perimeter ditches and sumps is generally directed by the diversion ditches or pumped into the environment if the limits are respected. Water collected from the Saddle Dams seepage collection systems are sent directly to the TSF.

3.6 FACILITY CLOSURE

A cover of non-acid generating waste rock will be placed over the TSF to promote drainage from the surface; no pond will be maintained within the facility. The tailings will begin freezing during operations and remain fully frozen into the post-closure period. Additional details are provided in the closure plan.

3.7 INSTRUMENTATION

The perimeter containment structures of the TSF are instrumented with geotechnical instrumentation and monitored during operations. Monitoring will continue during post-closure. Monitoring is performed to confirm performance of the structures relative to the design.

3.8 PUBLIC SAFETY

Public access to the mine site is restricted by security gates and on-site security upon exiting aircraft and vehicles.

Table 3-1 Design and Operational Criteria

Component	Item	Criteria	Source/Comment
Perimeter Containment Structure Design	Life of mine (LOM V2c) Storage Capacity	21.8 Mm^3	Calculated by AEM
	Life of mine total ore	27.6Mt	AEM
	Life of Mine	8 years	AEM
	Canadian Dam Association hazard classification	High	CDA (2007)
	Seismicity for this site: Peak horizontal acceleration based factored 1 in 10,000 year event	0.04 g	Golder (2007)
	Stability: Minimum factor of safety for static load conditions	1.3	Golder (2007)
	Stability: Minimum factor of safety for pseudostatic load conditions	1.1	Golder (2007)
	Embankment crest width	10.0 m (nominal)	Refer to drawings
	Perimeter containment structure downstream side slope*:	1.5H:1V for rock fill	Refer to drawings
	Perimeter embankment	1.5H:1V	Refer to drawings

Component	Item	Criteria	Source/Comment
	upstream side slope*:		
	Interior embankments downstream side slope*:	1.5H:1V for rock fill	Refer to drawings
	Interior embankments upstream side slopes*:	3H:1V	Refer to drawings
Perimeter Water Control Structure Design	Design Event Storage Capacity: Temporary sumps : Perimeter sumps:	1:10 year freshet runoff event 1 :100 year freshet runoff event	Refer to drawings
	Ditch Gradient	Minimum 0.3%	Refer to drawings
Process Plant Rate	Nominal daily processing rate	11,000-12,500 tpd	AEM
Operation	Tailings discharge solids content	52%	AEM
Operation	Average deposited slurry dry density	1.28 t/m^3	Assumed value pending field trials.
Operation	Deposition slope angle for slurry	SC: sub-aerial: 0.45% ; sub-aqueous:4% NC: sub-aerial: 0.45% ; sub-aqueous: 2.36%	Assumed value pending survey.
Ice	Ice entrapment (by volume)	63% (30% pore water and 33% pure ice entrampment)	Assumed value pending field investigations.
Operation	Specific Gravity for tailings solids	1.6	AEM
Operation: Water Control Structures	Perimeter sump recommended Freeboard	Minimum 1.5 m	Refer to drawings
Operation: Water Control Structures	Design Pump Capacity	Sufficient to dewater a sump for the 1:100 design event in a 2 week period.	

*Note: *Fill placement to be in accordance with the relevant specification*.

SECTION 4 • OPERATIONS

Operation of the TSF requires the management of tailings deposition and storage using inputs from the deposition plan and management of water within the facility.

4.1 OPERATIONAL PHILOSOPHY

Tailings are pumped from the process plant and deposited in the TSF as slurry according to the deposition plan. The objectives of the deposition plan are to:

- Develop long tailings beaches upstream of the perimeter structures;
- Maintain the supernatant pond away from the upstream faces of the perimeter structures;
- Receive tailings from the process plant at all times;
- Limit ice entrapment within the deposited tailings; and
- Provide a flexible plan with the realization that the tailings will be variable in properties (e.g. solids content) and having a variable schedule depending on the processing schedule.

The perimeter ditches of the TSF will intercept and route surface water runoff and seepage from the TSF to the sumps. The sumps are to provide short-term water storage prior to pumping to the tailing pond. A practical minimum level of water should be maintained during operations.

4.2 DEPOSITION PLANNING CRITERIA AND CONSTRAINTS

The following constraints were identified as being desirable inputs into the deposition planning work:

- During winter months, deposition would use a “pull back”;
- Limit switching between tailings deposition lines so to reduce line flushing requirements;
- Changing between deposition points on a given line will, in general, consist of stopping the flow of tailings in the line, redirecting it through a bypass, flushing the line with water for cleaning and the relocation of the deposition point followed by the reinstatement of tailings flow through the deposition line; and
- All pipelines should be flushed of tailings and fully dewatered prior to periods of non-use to reduce the likelihood of materials and/or water freezing within the pipelines.

Operating Criteria and constraints should be reviewed periodically and updated in the OMS Manual as required (Table 3-1).

4.3 WATER MANAGEMENT

The perimeter ditches will intercept and route runoff and seepage from the TSF to the sumps. The diversion ditches redirect runoff water away from the TSF to the environment. The sumps will provide short-term storage prior to the pumping of the water to the tailing pond. A practical minimum level of water within the sump should be maintained during operations. The maximum operating water level for a given sump is 1.5 m below the sump rim.

SECTION 5 • MAINTENANCE

Maintenance at the TSF is important for safe, continuous operation, and integrity of the facility.

The objectives of the maintenance program are to review and identify maintenance requirements, executing corrective measures and timely repairs of the containment structures, perimeter water control structures, facility access, and infrastructure.

5.1 CONTAINMENT STRUCTURES

Erosion of the rock fill embankments is not expected. However, it is expected that periodic maintenance and re-sloping especially following thawing at the start of each summer may be required at times during operations.

The SWD, as it is an internal structure, is tolerant to settlement. Maintenance during the summer is expected once the frozen materials thaw. Grading, reshaping and nominally compacting additional material should be expected.

The exposed liner should be inspected during the summer season. Repairs shall be done for any damage during that season.

5.2 DITCHES AND SUMPS

Flows may erode the ditches and/or sumps. Sediment, snow and/or ice may accumulate in the ditches and sumps and will require removal to maintain operational functionality and provide storage capacity. Removal of excessive material deposits from the ditches and sumps should be performed as required. The ditches and sumps will require routine monitoring for signs of deterioration and to address any cleaning and maintenance that is required.

Pumps located at the temporary and perimeter sumps will require maintenance based on Manufacturer's specifications and recommendations.

5.3 INSTRUMENTATION

The instrumentation of the TSF shall be maintained to enable collection of the data. Repair, replacement and installation of additional instrumentation should be expected during the development of the TSF.

5.4 PIPELINES AND PUMPS

Maintenance on pumps and tailing pipes should be performed during Mill Plan scheduled shut-down periods or when they are not in operation. General inspection of the pipes should be performed on a regular basis. The heat tracing of the tailings distribution and dewatering pipelines will require maintenance. After each change of deposition point, the pipeline is cleaned and drained with a pig. The pipes are inspected after the cleaning.

SECTION 6 • SURVEILLANCE

The principal objective of the TSF surveillance program is to identify conditions that would compromise the integrity of the facility well in advance of problems occurring and adjusting the design and/or operation to reduce risk. The TSF surveillance program focuses on four areas of interest:

1. Stability and deformation of the perimeter containment structures;
2. The thermal conditions beneath and within the TSF;
3. The quantity and quality of seepage from the TSF; and
4. Material movement and placement (locations and quantities of all material types being deposited, disposed and placed) in the TSF.

Table 6-1 (see Section 6.2) was developed to determine the items which will be monitored, the monitoring frequency and the responsible party. The items should be monitored at a frequency such that project commitments and/or requirements are satisfied and such that trends may be developed for optimization of the operation of the TSF. Table 6-1 should be reviewed and updated as required while maintaining the project commitments.

6.1 INSPECTIONS

A series of regularly scheduled inspections is required to ensure that the TSF facility is performing as intended and to identify problems and issues so that necessary corrective actions may be implemented in a timely manner. Surveillance tasks include visual inspections, monitoring of instrumentation and water levels and preparation of written and photographic documentation.

The main types of inspections are as follows:

- Routine inspections – performed by AEM geotechnical team;
- Monthly or Bi-Monthly Inspection – performed by AEM geotechnical team;
- Special Inspections – performed by AEM and the Geotechnical Engineering Consultant depending on the event; and
- Annual Inspection – performed by a Geotechnical Engineering Consultant familiar with the design and operation of the facility.

6.1.1 Routine Inspections

Routine visual inspections are to be carried out by AEM personnel at the TSF to assess operational status of various elements of the facility. The frequencies for these inspections are as follows:

- In areas of active deposition: daily; and

- In areas without deposition: monthly.

Inspections of the TSF perimeter containment structures and water control structures are to be conducted and documented. Inspection forms used to conduct and document these inspections are included in Appendix II.

The following is a list of general information which should be recorded during each inspection:

❖ Water Control Structures (by Engineering department):

- Sump water elevation (staff gauge readings) noted and reviewed to ensure normal freeboard;
- General dewatering pipeline condition, signs of leaks or abnormal conditions; and
- Depth of flow in ditches, inspection of ditches and downstream berm condition, signs of potential seepage.

❖ Perimeter Containment Structures (by Engineering department):

- Inspection of the general condition of interior and perimeter embankment crest, toe, and slopes, looking for: settlement, erosion, seepage, cracking, liner deterioration, animal burrows or other abnormal conditions;
- Description and status of embankment construction activities; and
- Inspection of embankment slopes for any signs of instability.

❖ Tailings Distribution System (by Engineering department and Dikes and Dewatering General Foremen):

- General pipeline condition, signs of leaks or abnormal conditions;
- Deposition location point and beach elevation relative to spigot elevation;
- Length of beach; and
- Pipeline flow, slurry density, pipeline pressure.

Documentation of the routine inspections of the TSF perimeter containment structures should be submitted to the Geotechnical Coordinator following each inspection.

The completed Perimeter Containment Structures and Water Control Structures inspection forms are stored in an electronic data base system for the TSF. Hard copies of the inspection forms are catalogued and stored on site.

6.1.2 Special Inspections

Special inspections may be required in addition to the routine inspections such as during, or at the time of: unusual climate events such as heavy rain, rapid snowmelt, anomalous instrumentation readings or significant seismic events. The Geotechnical Engineer or Geotechnical Technician shall perform the special inspection immediately at the time of the event and shall notify the Geotechnical Engineering Consultant.

6.1.3 Annual Inspection

Annual inspections shall be carried out by a qualified Geotechnical Engineering Consultant who is familiar with the design and on-going operation of the TSF. The objective of the inspections is to carry out a detailed review of the conditions of the facilities and facility operation during the spring freshet and prior to freeze up.

The Geotechnical Engineering Consultant issues an inspection report to AEM containing observations and recommendations. This report provides information to be used to revise the operation, maintenance and surveillance programs as necessary and to assist in planning for future operation of the facility.

6.2 INSTRUMENTATION AND SURVEY

Instrumentation is installed to monitor the stability and deformation of the perimeter containment structures, ground temperature, seepage, water quality and to monitor operational performance. Instrumentation is to be maintained, replaced, added, extended and relocated during the development of the TSF; therefore this section should be updated regularly. The current instrumentation locations are shown on Figure 4. Current instrumentation for the TSF includes thermistors. Piezometers are installed at Central Dike. Survey of the water and tailing elevation are also taken at different locations in the TSF.

The instrumentation and survey levels are to be read and recorded at the frequencies shown in Table 6-1.

Table 6-1 Surveillance Items and Frequencies

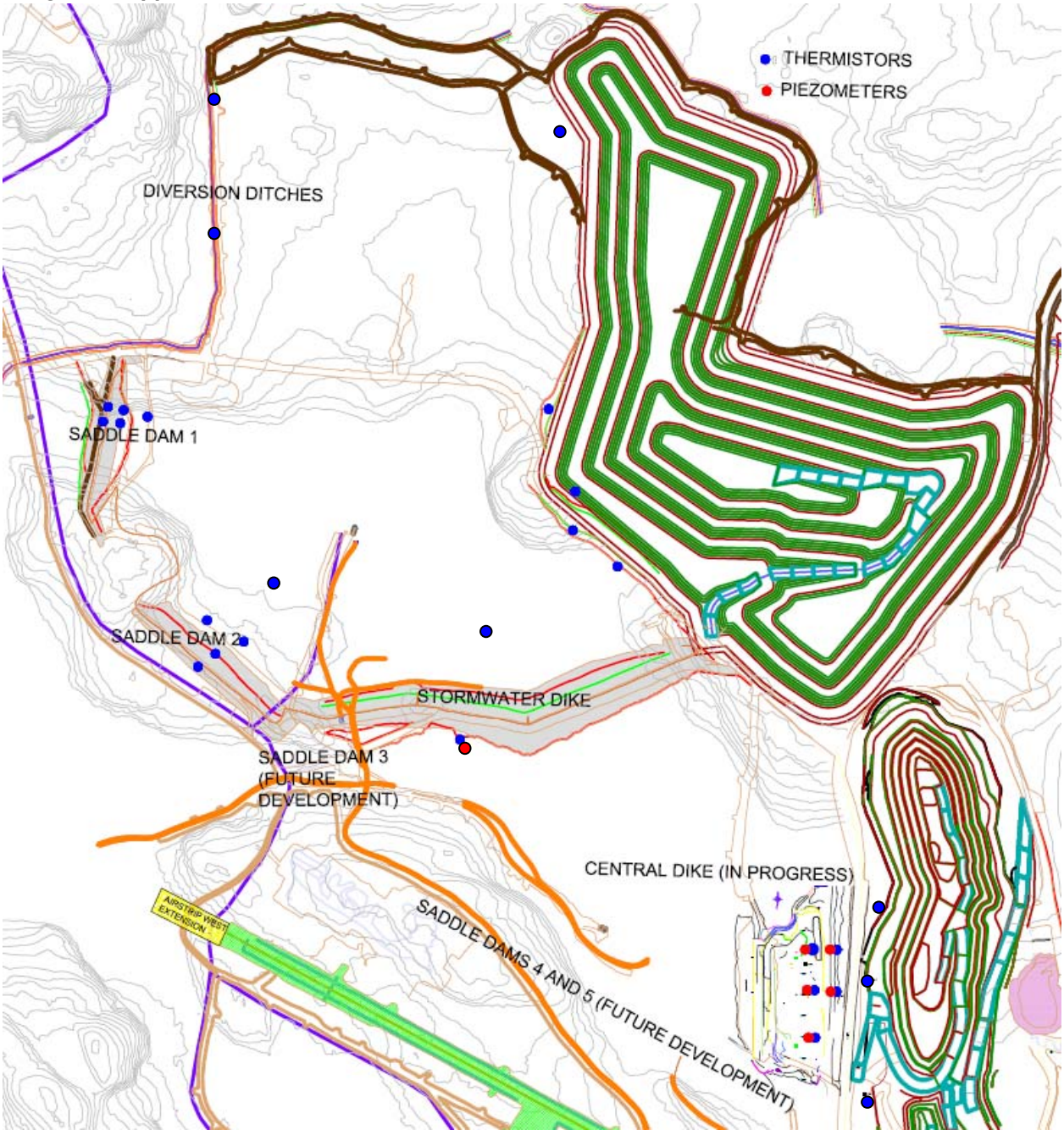
Instrumentation	*Monitored By*	*Reported To*	*Frequency*
Thermistors and Piezometers	• Manually by Engineering and Environment Personnel	Engineering and Environment Superintendent Geotechnical Coordinator	Weekly during winter and every three (3) days during the summer
Survey	• Manually by Engineering Personnel	Engineering and Environment Superintendent Geotechnical Coordinator	Daily during freshet; and Monthly during non-freshet period

The instrumentation is to be monitored by the responsible party and at the frequency shown on Table 6-1 and at any other periods of extended rainfall or run-off. Immediate readings of all instrumentation shall be carried out following a significant seismic or climatic event.

The instrumentation data shall be analyzed and summarized by the engineering and environmental departments.

The instrumentation readings are to be reviewed by the Geotechnical Engineering Consultant performing the third party inspections.

Figure 4 Approximate Location of Current Instrumentation



6.2.1 Ground Temperature and Piezometric Level Monitoring

Thermistors have been installed in the area of the TSF to measure ground temperatures. Piezometers have been installed at Central Dike to measure the piezometric level in the ground. Additional thermistors and piezometers will be installed in the future during operations and closure.

Maintenance and calibration of the instruments and extensions should be carried out according the Manufacturer's recommendations.

Data presented for the thermistors and piezometers should include:

- Time plots (presenting all thermistor nodes on each string); and
- Temperature vs. depth/elevation plots over time.

The plots shall indicate the instruments reference number, date of measurements, elevation, and depth.

6.2.2 Anomalous Measurements

Anomalous instrumentation data includes the following:

- Thermistors:
    - Increase or decrease in measurements (over two or more readings) that cannot be explained by seasonal temperature variations or instrument malfunction.
- Piezometers:
    - Sudden increase or decrease in measurements (over two or more readings) that cannot be explained by normal variation of the piezometric level or instrument malfunction.

If anomalous readings are observed, the following actions should be taken:

1. Inspect the embankment where possible and appropriate;
2. Check data, reductions and calculations for accuracy and correctness;
3. Re-read to verify the reading;
4. Check readout equipment to verify that it is functioning correctly;
5. Verify calibration;
6. If instrument has stopped functioning, notify the Engineering Superintendent immediately. If considered critical, a replacement instrument should be installed;
7. If the anomalous reading is confirmed, a detailed review of the effects of the reading should be carried out based on the specific inspection and design or remedial actions should be implemented if determined necessary by the Engineering Superintendent; and

8. Increase monitoring frequency to assess progression of anomaly.

6.2.3 Seepage Monitoring

The seepage monitoring performed for the TSF comprises of visual inspections of the perimeter water control structures, the quantity tracking of water pumped to and from the TSF, rate of seepage and water quality of seepage through the embankment, and testing water samples collected from the perimeter sumps.

Visual inspections should document sediment, ice and snow deposits in the ditches and sumps.

Anomalous measurements of the seepage may occur and include the following:

- Increase or decrease in pump rates that are inconsistent with rainfall or runoff events;
- Sediments present in the seepage water; and
- Changes in seepage location, flow and quality.

If anomalous readings are observed, the following actions should be taken:

1. Inspect the water control structure area;
2. Check data, reductions, and calculations for accuracy and correctness;
3. Re-read;
4. Check readout equipment to verify that it is functioning correctly;
5. Verify calibration;
6. If the anomalous seepage measurement is confirmed, a detailed review of the effects of the increased seepage should be carried out based on the specific inspection and design or remedial actions should be implemented if determined necessary by the Engineering Superintendent;
7. Manage the seepage properly by collecting it, then pumping the seepage and sending it to a treatment facility, treating it if necessary, then finally discharging the seepage through a final discharge point; and
8. Increase monitoring frequency to assess progression of anomaly.

6.3 WATER QUALITY

The quality of water collected in the sumps and sampled from the water sampling locations is to be monitored. The monitoring plan available in Appendix I summarizes water quality and water flow monitoring to be conducted for the Meadowbank gold project.

SECTION 7 • REPORTING AND DATA MANAGEMENT

7.1 REPORTING

7.1.1 Inspection Documents

All inspection documents and reviews shall be submitted to the Engineering Superintendent and the Geotechnical Coordinator and accessible to all in the local network.

7.1.2 Instrumentation Measurements

Instrumentation measurements (thermistors and piezometers) and water quality results collected shall be reported to the Engineering Superintendent and the Geotechnical Coordinator. Pumping rates during dewatering and operation shall be reported to the Engineering Superintendent and the Geotechnical Coordinator.

7.1.3 Emergencies

All documents regarding instrumentation and inspection during an emergency situation and prior to the emergency shall be made available to all parties involved including the General Manager, Assistant General Manager, Environment Superintendent, Engineering Superintendent, Geotechnical Coordinator, Process Plant Superintendent, Mine Operations Superintendent, Maintenance Superintendent, and the Geotechnical Engineering Consultant.

7.2 DATA MANAGEMENT

All surveillance records including visual embankment inspections, instrumentation measurements, flow, and water quality results shall be stored in an electronic library or database system which is easily accessible to staff involved with the TSF. Hard copies shall be catalogued and stored on site. Examples of surveillance data stored, but not limited to, are:

- Routine operation inspection reports, perimeter containment structures visual inspections, water control structure inspections and water management inspections,
- Special Inspections;
- Annual Inspections;
- Instrumentation Measurements;
    - Thermal- thermistor data;
    - Piezometer data; and

- Water quality testing results.

SECTION 8 • EMERGENCY PREPAREDNESS PLAN

The Dam Safety Guidelines prepared by the Canadian Dam Association (2007) states that “A dam which does not impose an unacceptable risk to people or property, and which meets safety criteria that are acceptable to the government, the engineering profession and the public is a safe dam”.

This guiding principle has been taken into account for the design of the TSF embankments and the emergency procedures.

The TSF perimeter containment structures are classified as a “High Consequence of Failure” (CDA 2007) as discussed in Section 1.4.

To respond to possible hazards and emergencies involving the TSF, emergency response plans have been designed. This section provides a summary of the actions, triggers and measures in the event of an emergency.

In case of an emergency, the documents listed in Table 9-1 shall be referenced. The Emergency Response Plan (ERP) shall also be referenced. The Dike Failure Scenario Appendices from the ERP are included in Appendix III.

8.1 EMERGENCY PROCEDURES

The purpose of the Emergency Preparedness Plan (EPP) is to present a basic procedure for responding to potential failure mechanisms. The procedure identifies various measurable or observable effects or causes of the failure mechanisms and identifies the appropriate people to notify. Potential failure mechanisms are summarized in Table 9-2 with potential measurable and observable causes and effects.

8.1.1 Operation

Table 9-3 summarizes the triggers for implementing the EPP with respect to the potential measurable and observable effects or causes of the various failure mechanisms during operations.

Table 9-4 indicates the chain of communication to follow so persons in charge are notified for different states of emergency.

Table 9-5 indicates the responsibilities of persons for each emergency level in terms of who performs the decision making, mobilization, and action to be taken.

Table 9-6 indicates the names and contact numbers of the persons in charge during an emergency event.

8.2 EMERGENCY DETAILS

In the unlikely event of a catastrophic dike breach that could endanger workers the Code 1 procedure described in Section 8.2.4 would be followed to warn all workers of the situation. Then an evacuation of the affected areas and pits would be carried out and directed by the ERT Team in person and over the emergency channel. In the event of an embankment failure, the following information should be used during the emergency response:

Project Name: Meadowbank Gold Project

Perimeter Containment Structure Names: SD1, SD2, SD3, SD4, SD5, Central Dike

Owner's Name: Agnico Eagle Mines Limited (867) 793-4610

Site Location: Latitude: 65°01'07''N Longitude: 96°04'26''W

8.2.1 Access to the Project Site

- 80 km north of the Hamlet of Baker Lake;
- Site accessible by all-weather private road from Baker Lake; and
- Site accessible by aircraft and helicopter.

	Name	Phone Number
Local Charter Company:	Calm Air International Ltd.	Baker Lake : (867) 793-2873
Local Helicopter Company:	Kitikmeot Helicopters Ltd	(867) 983-2544
Charter Aircraft Company:	Nolinor Aviation	(450) 476-0018

8.2.2 Emergency Assessment

In case of an event, emergency assessment will be done first by AEM Geotechnical Engineering personnel and the Engineering Superintendent on site. Assessment will be done according the criteria stated in the Table 9-2 and 9-3.

8.2.3 Emergency Communication and Actions

In case of an event, after the emergency assessment, the persons involved in the emergency response team need to be notified following the chain of command stated in Table 9-4. Contact details of each person are available in Table 9-6.

According to the nature of the event, a decision and action plan will be taken by the persons notified. The action plan will be defined according to the level of emergency and the cause of the event. The

immediate action plan will be taken with material and equipment available on site, as listed in Section 8.4.

8.2.4 Site Emergency Procedure

As specified in the Emergency Response Plan, Ver. 9, Section 4:

In the event of an immediate emergency that is or could impact persons or equipment, the employee will have to follow our emergency procedure:

- Emergency is initiated - by calling **6911** on desk type phones, or calling on two-way radio on **"Working Channel" – Code 1 – Code 1 – Code 1.**
- All communication stops except for those involved with the Emergency – i.e.: First Aid Room attendants, Medics, ERT as required.
- All work stops in First Aid Room / Clinic – and in affected area – depending on seriousness of Emergency – the whole site.
- First Aid Room Attendant / Medic will answer the phone and/or radio.

  Note: if the First Aid Room Attendant / Medic do not answer, then Security Guard will answer and/or a Supervisor on radio will answer so that Emergency Response can be initiated.
- **Responder –** will ask where the medic is required.
- **Caller –** will give a brief description of the Emergency – name, location and what is wrong and/or required.
- **Responder –** will confirm location and details of incident and activate the **ERT** team. Security will be notified by responder and a page will be sent out to all **ERT** team members on site. (All **ERT** team members on site now carry pagers).
- The person at the casualty(s) will administer First Aid if trained to do so.
- Incident Commander Center will be immobilized as to ensure that communications, transportation, and effective deployment of **ERT** resources are conducted. It is mandatory that the Official In-Charge be notified immediately.
  - Transportation will be arranged to meet at the **ERT** hall by the two large doors for medical gear and **ERT** team members.

The **ERT** team (minimum of 6 team members) will assemble as quickly as possible. (Expectation – when the pager goes off – all **ERT** team members will make their way expediently to the **ERT** hall).

8.2.5 Communication Equipment Location

Communication equipment can be found at the following locations:

- Phone land lines are located in the main office;
- Base station radios are located in the main office;

- Drills will have either base station radios or handhelds—depending on their distance from camp and will have satellite phones available; and

- Emergency Communication Plans (including emergency contact numbers) are located adjacent to all phones and radios and in each drill.

8.3 MEDICAL AND FIRST AID SERVICES

In case of injury the medic and First Aid station are located in the Service Building. The first aid channel on the radio is 1.The nearest hospital is located in Baker Lake.

Health Center:	Baker Lake Health Center	*Phone #:*	(867) 793-2816 (867) 793-2817

8.4 ON SITE EQUIPMENT AND MATERIAL

8.4.1 Pumping Equipment

The following is a list of onsite pumping equipment available for use during an emergency event:

Unit Number	Description	Model
61PWA01	Dewatering pump #1	Godwin model HL250M
61PWA02	Dewatering pump #2	Godwin model HL250M
61PWA03	Dewatering pump #3	Godwin model HL250M
61PWA04	Dewatering pump #4	Godwin model HL250M
61PWA05	Dewatering pump #5	Godwin model HL250M
61PWA06	Dewatering pump #6	Godwin model HL250M
61PWA07	Pit Dewatering pump #7	Godwin model CD80M
61PWA08	Pit Dewatering pump #8	Godwin model CD80M
61PWA09	Dike Dewatering pump #9	Godwin model CD100M
61PWA10	Dike Dewatering pump #10	Godwin model CD103M
61PWA11	Dike Dewatering pump #11	Godwin model CD103M
61PWA12	Dike Dewatering pump #12	Godwin model CD103M
61PWA13	Pit Dewatering pump #13	Godwin model HL5MS
61PWA14	Pit Dewatering pump #14	Godwin model HL5MS
61PWA15	Bay-Goose Seepage dewatering pump #9	Godwin model CD103M
61PWA16	Bay-Goose Seepage dewatering pump #10	Godwin model CD103M
61PWA17	Bay-Goose Seepage dewatering pump #11	Godwin model CD103M
	Bay-Goose Seepage dewatering pump #12	Godwin model CD103M

Note: To be updated as required

8.4.2 Mobile Equipment

The following are lists of onsite mobile equipment of AEM and FGL available for use during an emergency event:

AEM Mobile Equipment List (to be updated as required)

MODEL	EQUIP. #
LOADING	
307 (SS)	BAC03
330D (SS)	BAC04
345D	BAC05
385C	BAC06
345DL	BAC07
PC1250	BAC08
390	BAC09
RH120	BAC10
RH120	BAC11
CAT6030	BAC13
IT14G (SS)	LOA01
IT14G	LOA02
992G	LOA03
992G	LOA04
420E (SS)	LOA05
966H (SS)	LOA06
TC44H (SS)	LOA08
966H (SS)	LOA09
980H (SS)	LOA10
420E	LOA11
980H	LOA12
992K	LOA13
980K	LOA15
IT14G	LOA16
DOZER	
D8T	DOZ01
D9T	DOZ02
D8R (SS)	DOZ03
D9T	DOZ05
D9T	DOZ06
D9T	DOZ07
834H	DOZ08
D6T (SS)	DOZ09
GRADER	
16H (SS)	GRA01
160H (SS)	GRA02
16M	GRA03
16M	GRA04
16M	GRA05
HAMMER	
V56	HAM01
V56	HAM02
GENSET	
GEH220-2	GEN26
D200P3	GEN27
ATV	
	ATV02
	ATV03
	ATV05

MODEL	EQUIP. #
HAULING	
777F	HTR01
777F	HTR02
777F	HTR03
777F	HTR04
777F	HTR05
777F	HTR06
777F	HTR07
777F	HTR08
773E	HTR09
777F	HTR11
777F	HTR12
777F	HTR14
773D	HTR15
785B	HTR20
785B	HTR21
785B	HTR22
785D	HTR23
785D	HTR24
785D	HTR25
785C	HTR26
785C	HTR28
785D	HTR29
785D	HTR30
DRILL	
DM45E	RBD01
DM45E	RBD02
DM45E	RBD03
DM45E	RBD04
CM785	RBD05
DML	RBD06
DML	RBD07
DML	RBD08
BUS	
H77 (SS)	BUS01
E-350 (SS)	BUS02
E-350 (SS)	BUS03
VAN E350	BUS04
32006-S (SS)	BUS05
(SS)	BUS09
E-350	BUS06
27-May-10	BUS08
INTER PB105	BUS10
	BUS11
	BUS12
COMPACTOR	
	CPT01
(SS)	CPT02
EMERGENCY VEHICULE	
SNOWCAT	SNC01

MODEL	EQUIP. #
DEWATERING PUMP	
HL250M	PWA01
HL250M	PWA02
HL250M	PWA03
HL250M	PWA04
HL250M	PWA05
HL250M	PWA06
CD80M	PWA07
CD80M	PWA08
CD100M	PWA09
CD103M	PWA10
CD103M	PWA11
CD103M	PWA12
HL5MS	PWA13
HL5MS	PWA14
HL125M	PWA16
HL125M	PWA17
FUSION	
	FUS01
	FUS02
TRUCK	
T800	TRK01
TRUCK (SS)	TRK05
FRD WATER (SS)	TRK07
SEPTIC (SS)	TRK08
CEMENT (SS)	TRK11
Truck (SS)	TRK12
TRUCK (SS)	TRK13
FUEL	TRK14
GARBAGE (SS)	TRK15
FIRE TRUCK	TRK16
FUEL	TRK17
S.Plow (SS)	TRK18
S.Plow (SS)	TRK19
Fountain Tire	TRK20
Service	TRK21
LUBE TRUCK	TRK22
SHOP	TRK23
FUEL	TRK24
Service Truck	TRK25
LUBE TRUCK	TRK26
CEMENT	TRK27
PUMP	TRK28
FUEL	TRK29
WATER	TRK30
Service Truck	TRK31
LUBE TRUCK	TRK32
FIRE TRUCK	TRK33
ECHANICAL SERVICE TI	
SERVICE	WMM02

MODEL	EQUIP. #
PICKUP	
F-350	PCK01
F-350	PCK03
F-350	PCK04
F-350	PCK05
F-350	PCK06
F-350	PCK08
F-350	PCK09
F-350	PCK10
F-350	PCK11
F-350	PCK12
F-350	PCK14
F-350	PCK15
F-350	PCK16
F-350	PCK17
F-350	PCK18
F-250	PCK19
F-250	PCK20
F-250	PCK21
F-350	PCK22
F-350	PCK23
F-250	PCK24
F-250	PCK25
F-250 (SS)	PCK26
F-250 (SS)	PCK27
F-250	PCK28
F-250	PCK29
F-250 (SS)	PCK30
F-250	PCK31
F-250 (SS)	PCK32
F-250	PCK33
F-250	PCK34
F-250 (SS)	PCK35
F-250 (SS)	PCK36
F-250	PCK37
F-250	PCK38
E-350	PCK39
F-250	PCK40
F-250 (SS)	PCK41
F-250	PCK42
F-350	PCK43
F-250	PCK44
F-350	PCK45
F-250	PCK46
F-250	PCK47
F-250	PCK49
F-250	PCK50
F-250 (SS)	PCK51
F-450 WH	PCK52

MODEL	EQUIP. #
PICKUP	
F-250	PCK53
F-250	PCK54
F-250	PCK55
F-250	PCK56
F-250 (SS)	PCK57
F-250	PCK58
F-250	PCK59
F-250	PCK60
F-250 (SS)	PCK61
F-250	PCK62
F-250	PCK63
F-250	PCK64
F-350	PCK65
F-550	PCK66
F-250	PCK67
F-250	PCK69
F-250 (SS)	PCK70
F-250	PCK71
F-250	PCK72
F-250	PCK73
F-250	PCK74
F-450	PCK75
F-250	PCK76
FORK LIFT	
HYSTER RH35 (SS	FKL02
CAT (WH)	FKL03
CAT	FKL05
CAT (SHOP)	FKL06
740DR321T	FKL07
ETDR40TT	FKL08
HYSTER	FKL09
CAT 1255C	FKL10
CAT R80	FKL11
CRANE	
120T (SS)	MCR01
80T (SS)	MCR02
35T (SS)	MCR03
25T (SS)	MCR05
200T (SS)	MCR06
MULE	
OBSOLETE	VSE01
Mule	VSE02
Mule (SS)	VSE05
Mule	VSE06
Kubota	VSE08
Kubota (SS)	VSE12
Kubota	VSE13
WELDING MACHINE	
400D	SMD01
WITH AIR PACK	SMD02
500P W/T AIR	SMD03

MODEL	EQUIP. #
FROST FIGHTER	
IDF-350	HEA01
ALMAND MH-1000	HEA02
ALMAND MH-1000	HEA03
ALMAND MH-1000	HEA04
ALMAND MH-1000	HEA05
IDF-350	HEA06
IDF-350	HEA07
IDF-350	HEA08
IDF-350	HEA09
IDF-350	HEA10
IDF-350	HEA11
IDF-350	HEA12
IDF-350	HEA13
IDF-350	HEA14
IDF-350	HEA15
IDF-350	HEA16
IDF-350	HEA17
IDF-350	HEA18
IDF-350	HEA19
IDF-350 (SS)	HEA20
IDF-350 (SS)	HEA21
IDF-350 (SS)	HEA22
IDF-350 (SS)	HEA23
IDF-350 (SS)	HEA24
IDF-350 (SS)	HEA25
IDF-350 (SS)	HEA26
MOBILE TANK	MFT01
LIGHT TOWER	
AL5080D	LGT01
L-20	LGT02
L-20	LGT03
L-20 (SS)	LGT04
L-20	LGT05
L-20	LGT06
L-20	LGT07
L-20	LGT08
LTC4	LGT09
LTC4	LGT11
LTC4	LGT12
LT5000-4MH SS	LGT18
HYSTER HANDLER	
GTH844	TPA01
GTH844	TPA02
HR45 (SS)	TPA03
1056C (SS)	TPA04
1056D (HW)	TPA05
BOAT ENGINE	
	ENG56
	ENG57

MODEL	EQUIP. #
TRAILER	
TANKER (SS)	TRL01
B DUMP (SS)	TRL03
LOW BED (SS)	TRL04
LOW BED (SS)	TRL05
F. TANK (SS)	TRL06
F. TANK (SS)	TRL07
L BOY (SS)	TRL08
FIRE PUMP TRL	TRL09
DISPATCH COM	TRL10
DISPATCH COM	TRL11
DISPATCH COM	TRL12
DISPATCH COM	TRL13
DISPATCH COM	TRL14
DISPATCH COM	TRL15
DISPATCH COM	TRL16
DISPATCH COM	TRL17
DISPATCH COM	TRL18
DISPATCH COM	TRL19
DISPATCH COM	TRL20
DISPATCH COM	TRL21
STEAMER (SS)	TRL22
TOWHAUL TRL	TRL25
F. TANK	TRL27
GENIE	
GS3232	SCI05
S85 (SS)	SCI06
Z-45/25	SCI07
Z-45/25 (SS)	SCI08
S85 (REN07)	SCI10
S85	SCI11
S85	SCI12
S125	SCI13
S125 (SS)	SCI14
32' (SS)	SCI15
32' (SS)	SCI16
SKID STEER	
262C	SKD01
753	SKD02
262C	SKD03
262C	SKD04
SNOW BLOWER	
SNOW BLOWER	SBL01
SNOW BLOWER	SBL02
SNOW BLOWER	SBL03
COMPRESSOR	
	COM01
SULLAIR	COM02
QGD25 QINCY	COM03
2545 IR	COM04
2545 IR	COM05

FGL Mobile Equipment List (to be updated as required)

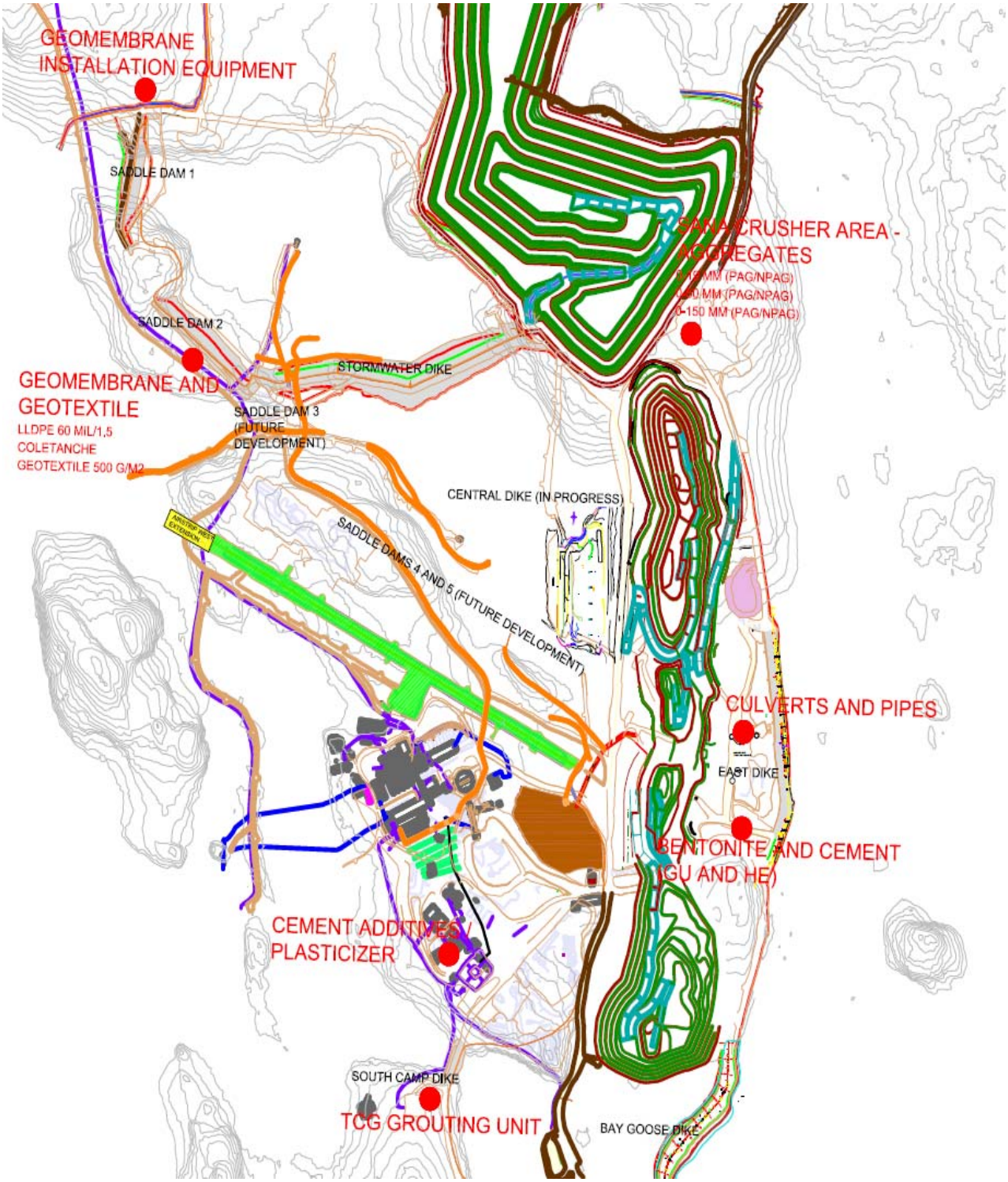
Qamanittuaq SANA

EQUIPEMENT FROM THE CONTRACTOR	MODEL	NUMBER
Excavator	CAT 365	1
Excavator	CAT 345	3
50 T Haul truck	CAT 773F	5
Bulldozer	CAT D8T	2
Compactor 20T	Hamm	1
Loader	Komatsu WA600	1
Loader	CAT 988	1
Loader	CAT 980	1
Fuel truck and water truck	Western Star	1
Truck and trailer	Western Star	1
Drill	Rockmaster RM115	2

8.4.3 Earthwork Material and Equipment

Figure 5 presents the earthwork material, including geomembrane and cement, available on site in case of an emergency.

Figure 5 Earthwork Material and Equipment Location



SECTION 9 • EMERGENCY RESPONSE REFERENCE DOCUMENTS

Table 9-1 Emergency Response Reference Documents

Document	Current Revision
Emergency Response Plan	Updated by AEM. Version 9, November 2014
Emergency Preparedness Plan	In TSF OMS Manual, Version 5, October 2015

Note: To be updated as required

Table 9-2 Potential Effects or Causes of Embankment Failure Mechanisms

Embankment Failure Mechanism	Potential Measurable and Observable	
	Causes	Effects
Overtopping	(1) Slurry/water level within the cell rises. (2) Embankment crest settlement	Increase of seepage leading to erosion of downstream foundation soils. Increase in seepage pumping rate during operations Increase in turbidity / suspended solids of seepage
Internal Erosion	(1) Loss of tailings water, erosion through embankments (2) Loss of mineral soil foundation at defect in embankment section.	Sinkhole observable at crest Increase in seepage pumping rate during operations Increase in turbidity / suspended solids of seepage
Slope Instability	(1) Ice or wave forces, or traffic on crest, seepage, weakness of foundation soils (2) Earthquake seismic event	Increase in settlement and/or settlement rate Increase in displacement and/or displacement rate of embankment toe Cracks along the embankment crest Sloughing of the face Bulging of embankment toe

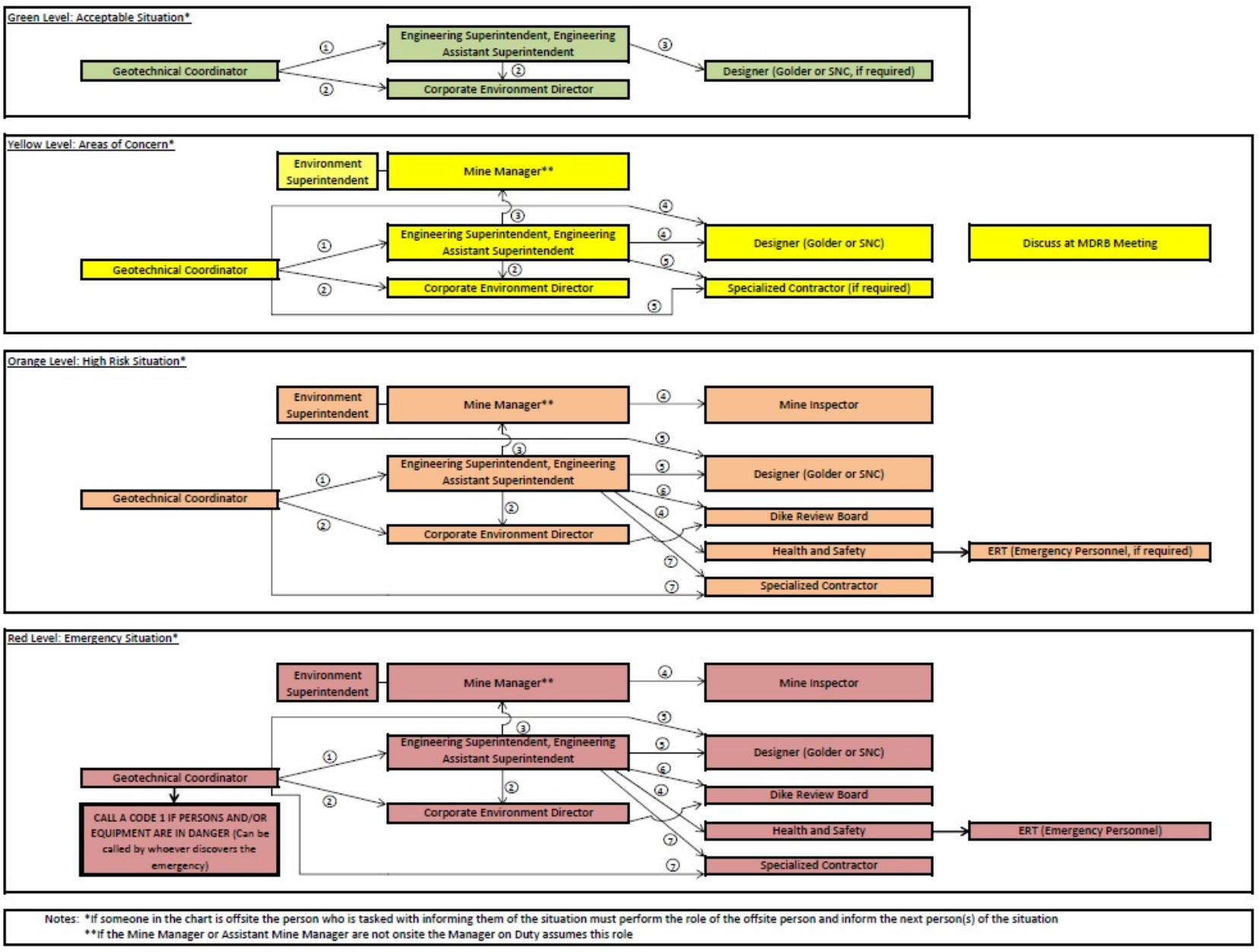
Embankment Failure Mechanism	Potential Measurable and Observable	
	Causes	**Effects**
	or blasting	
Unexpected settlements	Consolidation of foundation soils or embankment fills	Potential slurry/water overtopping the embankment leading to erosion of downstream foundation soils. Increase in seepage pumping rate during operations Increase in turbidity / suspended solids of seepage

Table 9-3 Threshold Criteria during Operation

		Threshold Criteria During Operation			
		Green Acceptable Situation	**Yellow Areas of Concern**	**Orange High Risk Situation**	**Red Emergency Situation**
Criteria	Cumulative crest settlement from operations start up	No settlement observed	< 0.2 m	> 0.2 m and < 1.0 m Increasing rate of settlement	> 1.0 m Increasing rate of settlement
	Downstream toe displacement	No displacement observed	Affecting seepage collection system	Loss of roadway	Loss of roadway
	Shear crack along rockfill embankment (differential settlement)	No shear crack observed	< 0.4 m deep	> 0.4 m and < 0.8 m deep	> 0.8 m deep
			< 5 m length along the dike	> 5 m and < 10 m length along the dike	> 10 m length along the dike
	Tension crack embankment alignment at crest	No tension crack observed	< 0.25 m deep	> 0.25 m and < 1 m deep	> 1 m deep
			< 0.10 m wide across the dike	> 0.10 m and < 0.20 m wide across the dike	> 0.20 m wide across the dike
			< 5 m length along the dike	> 5 m and < 10 m length along the dike	> 10 m length along the dike
	Sloughing along downstream rockfill embankment face	No sloughing observed	Observed	Observed and worsening from yellow situation	Observed and worsening from orange situation
	Embankment lateral cumulative deformation	No deformation observed	< 0.1 m	> 0.1 m and <0.25 m	> 0.25 m
	Seepage through embankment	No seepage observed	< 1/3 pumping rate capacity	> 1/3 and < 2/3 pumping rate capacity	> 2/3 pumping rate capacity
	Increase of seepage rate	No increase in seepage rate	< 5% per day over five consecutive days	> 5% < 10% per day over four consecutive days	> 10% per day over three consecutive days
	Turbidity of seepage water	No turbidity observed	Turbidity observed for first time	Turbidity observed and source of sediments matching cut-off wall or foundation till mineralogy	Turbidity observed and source of sediments matching cut-off wall or foundation till mineralogy
	Sinkhole on crest	No depressions or sinkholes on crest observed	Localized depression of embankment crest	Observed	Well developed
Action Required			Monitor as normal All cracks filled or repaired If cracks re open implement engineering review Identify source of turbidity	Implement engineering review Suspend activities on embankment crest at chainage of concern Intensify monitoring at chainage of concern	Remove personnel and equipment from pit and suspend activities
Personnel Notified		Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder, if required).	Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder), Specialized Contractor (if required), Mine Operations Manager, Environment Superintendent, Mine Manager, Discuss at MDRB Meeting.	Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder), Specialized Contractor, Mine Operations Manager, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel, if required).	Geotechnical Coordinator, Engineering Superintendent, Engineering Assistant Superintendent, Corporate Environment Director, Designer (Golder), Specialized Contractor, Mine Operations Manager, Environment Superintendent, Mine Manager, Dike Review Board, Mine Inspector, Health and Safety, ERT (Emergency Personnel).

Table 9-4 Communication Charts for Each Emergency Level

Communications are rated to indicate in which order responsible persons should be notified in the case where a person needs to advise more than one person



Notes: *If someone in the chart is offsite the person who is tasked with informing them of the situation must perform the role of the offsite person and inform the next person(s) of the situation
**If the Mine Manager or Assistant Mine Manager are not onsite the Manager on Duty assumes this role

Table 9-5 Responsibilities of Persons for Each Emergency Level

	Decision Making	Mobilization	Performing the Action to be Taken
Green Acceptable Situation	Geotechnical Supervisors	Geotechnical Supervisors	Geotechnical Team*
Yellow Areas of Concern	Geotechnical Supervisors Geotechnical Coordinator Superintendent Engineering Assistant Superintendent Designer (Golder or SNC)	Geotechnical Supervisors Geotechnical Coordinator	Geotechnical Team* Specialized Contractor (if required)
Orange High Risk Situation	Geotechnical Supervisors Geotechnical Coordinator Engineering Superintendent Engineering Assistant Superintendent Designer (Golder or SNC) Corporate Environment Director Dike Review Board Mine Manager Health and Safety (if required)	Geotechnical Supervisors Geotechnical Coordinator Engineering Superintendent Engineering Assistant Superintendent	Geotechnical Team* Specialized Contractor ERT (if required)
Red Emergency Situation	Geotechnical Supervisors Geotechnical Coordinator Engineering Superintendent Engineering Assistant Superintendent Designer (Golder or SNC) Corporate Environment Director Dike Review Board Mine Manager Health and Safety	Geotechnical Supervisors Geotechnical Coordinator Engineering Superintendent Engineering Assistant Superintendent Mine Manager Health and Safety	Geotechnical Team* Specialized Contractor ERT

*The Geotechnical Team consists of the Geotechnical Coordinator, the Geotechnical Supervisors, the Dewatering and Pit Geotechnical Engineer/Technician, Water and Tailings Management Engineers, and the Geotechnical Technicians.

Table 9-6 Names and Contact Details (to be updated as required)

Internal Emergency Response Contact Information Chart		
Position	**Name/Location**	**24-Hour Contact #**
Geotechnical Supervisors	Patrice Gagnon / Rebecca Cousineau	Ph: 819-759-3555 ext 6726 cell: 418-376-0975 / 647-888-7856
Geotechnical Coordinator	Thomas Lepine	Ph: 819-759-3555 ext. 6837 cell: 418-473-8077
Engineering Superintendent	Julie Belanger	Ph: 819-759-3555 ext. 6721 cell: 819-856-1667
Engineering Assistant Superintendent	Stephane Frechette	Ph: 819-759-3555 ext. 6721 cell: 819-856-3152
General Superintendent – Mine Operations	Martin Beausejour	Ph: 819-759-3555 ext. 6767 cell: 819-355-2913
Corporate Environment Director	Gonzalo Rios	Ph: 604-608-2557 ext. 6537
Designer (Golder)	Golder Burnaby: Dan Walker, Fiona Esford, Paul Bedel Golder Montreal: Yves Boulianne, Annie Beaulieu	Burnaby Office: 604-296-4200 Montreal Office: 514-383-0990
Specialized Contractor	SANA (FGL Group)	Onsite Ph: 819-759-3555 ext. 6963 Ph: 418-615-0559
Environment Superintendent	Kevin Buck	Ph: 819-759-3555 ext 6838 Cell: 819-856-1956
Mine Manager	Bertin Paradis	Ph: 819-759-3555 ext. 6843 cell: 819-355-9348
Dike Review Board	Anthony Rattue Norbert Morgenstern Don Hayley	anthony.rattue@bell.net norbertm@ualberta.ca don.hayley@icloud.com
Mine Inspector	Martin VanRooy	Martin.vanRooy@wscc.nu.ca
Health and Safety	Normand Ladouceur	Ph: 819-759-3555 ext. 6720 cell: 819-860-6258
	Yves Levesque (asst.)	Ph: 819-759-3555 ext. 6720 cell: 819-856-9051
ERT (Emergency Personnel)	Emergency personnel available on site to assist with spill and emergency response activities	Coordinated by the Emergency Measures Counsellor
Incident Commander	André Rouleau	Ph: 819-759-3555 ext. 6809 cell: 819-355-2191 Channel #1
	Normand Ladouceur	Ph: 819-759-3555 ext. 6720 cell: 819-860-6258 Channel #1
Emergency Measures Counsellor	André Rouleau	Ph: 819-759-3555 ext. 6809 cell: 819-355-2191
Health Professionals / Medical Clinic	Medical Clinic 1	Ph: 819-759-3555 ext. 6734
	Medical Clinic 2	Ph: 819-759-3555 ext. 6751
AEM Management Representative	Bertin Paradis	Ph: 819-759-3555 ext. 6843 Cell: 819-355-9348
Human Resource Superintendent	Robert Chartrand	T: 819.759.3555 x 6723 M: 819-856-0426

SECTION 10 • REFERENCES

Canadian Dam Association (CDA) 2007. Dam Safety Guidelines.

Golder Associates Ltd. (Golder) 2008. Detailed Design of Tailings Storage Facility, Meadowbank Gold Project. December 17, 2008. Doc. 784 Ver. 0.

Golder 2009. Stormwater Dike and Saddle Dam 1 Geomembranes, Meadowbank Gold Project. July 20, 2009. Doc. 917 Ver. 0.

Golder 2011. 2011 Tailings Deposition Plan Update, Meadowbank Gold Project. July 18, 2011. Doc. 1272 Ver. 0.

Golder 2015. 2015 Detailed design report for Saddle Dams 3, 4 and 5. Meadowbank Gold Project. May 12, 2015. Doc. 1504 Ver. 1.

Mining Associate of Canada (MAC) 2005 Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities.

Mining Association of Canada (MAC) 2008. A Guide to the Management of Tailings Facilities. Second Edition.

AEM, Emergency Response Plan, Ver.9, November 2014

Appendix I

Water Quality and Flow Monitoring Plan

Appendix II
Tailings Storage Facility - Inspection Form

All parts of this inspection form should be completed. Adverse conditions should be described and location stated. Additional information and relevant photographs should be attached.

Inspecting Officer: *Report No.:* _____ *Inspection Date:* _____

DAM/DIKE INFORMATION:

Dam ☐ Dike ☐ _____ Crest Elevation: _____ Head Pond Elevation _____
Tailing elevation _____

DAM / BERM

A) Crest

cracking	☐ none	☐	
settlement	☐ none	☐	
erosion	☐ none	☐	
other movement	☐ none	☐	

B) Downstream Slope and Toe Area

erosion	☐ none	☐	
settlement	☐ none	☐	
bulging	☐ none	☐	
sloughing	☐ none	☐	
slope protection	☐ good	☐	
animal burrows	☐ none	☐	
seepage	☐ none	☐	location 1: _____
			rate: ☐ damp ☐ trickle ☐ steady ____ (L/s)
			clarity: ☐ clear ☐ muddy
			sample taken: ☐ yes ☐ no
			location 2: _____
			rate ☐ damp ☐ trickle ☐ steady ____ (L/s)
			clarity ☐ clear ☐ muddy
			sample taken ☐ yes ☐ no
			type: _____
sand boils	☐ none	☐	location(s) _____

C) Upstream Slope and Tailings Surface

erosion	☐ none	☐	wave induced		☐ surface runoff	
			location(s):			
			degree	☐ minor	☐ moderate	☐ severe
geomembrane	☐ none	☐				
settlement	☐ none	☐				
bulging	☐ none	☐				
sloughing	☐ none	☐				
slope protection	☐ good	☐				
slope vegetation	☐ none	☐				
animal burrows	☐ none	☐				
sinkholes	☐ none	☐				
tailings surface	☐ water covered	☐				

DAM / DIKE INSTRUMENTATION: (plot any newly installed instrumentation on relevant plans and cross-sections)

	Operational	Damaged	Measurement Taken
☐ none	☐	☐	☐
☐ piezometers	☐	☐	☐
☐ monitoring well	☐	☐	☐
☐ survey stakes	☐	☐	☐
☐ other Thermistors (4)	☐	☐	☐ every 3-4 days

COMMENTS AND RECOMMENDATIONS:

☐ Action Required: ☐ none ☐ further monitoring ☐ immediate remediation
☐ Plan or Sketch Attached _____
☐ Photographs (number) _____

Review Officer: _____ Review Agency: _____ Date Reviewed: _____ (DD/MM/YR)

REVIEW COMMENTS: ☐ ***none***

Appendix III
Dike Failure Scenario Appendices from the ERP

Dike Failure Scenarios

1. **Dewatering Dikes (removed)**
2. **Central Dike**
3. **Saddle Dams**
4. **Storm water Dike**

Appendix 2

Central Dike

Central Dike

The Central Dike system is comprised of a Central Dike, a series of perimeter dikes, and the natural basin of the northwest arm of Second Portage Lake, as shown on the general mine site plan provided at the beginning of this document. The Central Dike cross-section consists of:

- A rockfill embankment, constructed from run-of-mine waste rock, placed in lifts and compacted, with the upstream face designed at 3H:1V and 2H:1V and the downstream face designed at a 1.5H:1V slope;
- An upstream two zone granular filter and inverted granular filter along the foundation;
- A bituminous liner with appropriate cover on the upstream face and part of the foundation;

A central or upstream key trench; The Central Dike is a high consequence structure, based on Dam Safety Guidelines (CDA, 2007). Slope stability analyses show that the dike will meet or exceed design FoS for stability under static and pseudostatic earthquake load conditions. Consequently, the probability of failure of the Central Dike is considered to be very low.

For information on the consequences and monitoring/action for the various embankment failure modes possible at the Central Dike see Table A.2 below.

Table A.2: Meadowbank Tailings Storage Facility Summary of Consequences and Proposed Monitoring / Action for Rare Event Based On Water Retaining Embankment Failure Modes Identified in ICOLD Study (1995)

Failure Mode	Scenario	Consequence	Monitoring/Action
Overtopping	(1) Pond Level rises because of restricted outflow (excessive inflow is a far less likely scenario). Water will spill at the low point on the dike system, which will depend on the construction schedule.	Water spills over the crest but, as this crest is both wide and comprises coarse compacted rock fill, minimal damage to the dike is credible. There will be considerable warning time prior to overtopping given the design freeboard and the storage volume.	Adjust decant and/or deposition rate. Add spillway in Central Dike, Saddle Dam, or natural ground.
	(2) Dam crest settles more than available freeboard over a distance of (say) 50m or so. This scenario requires unexpected foundation condition, such as glacial lake clay deposit. Settlement would occur upon placement of rock fill during dike raise construction. Freeboard is greatest immediately after a raise and this scenario is therefore unlikely to occur.	Water and tailings spill over crest and if settlement was rapid might erode the crest. Travel of tailings will be dependent on volume of water available, and level of thaw. Tailings would only go to the pit, and not reach the lake.	The situation envisaged is unlikely. This scenario would develop slowly during construction of the dike. Crest settlement would be evident at least several weeks before an overtopping event occurred. Easily observed cracks should be evident during summer period, but could be hidden during the winter. Systematic crest settlement monitoring is appropriate, and included in the design. Production and addition of tailings to the Tailings Storage Facility could be stopped to maintain freeboard. A spillway could also be constructed. The tailings deposition plan maintains a long beach between the dike and the pond, which provides additional freeboard to overtopping of the dike by pond water.

Internal Erosion	(1) Dike Section: Upstream bituminous liner contains defects arising from undetected damage during installation. May lead to loss of water, but filter retains tailing.	Loss of water into the rock fill. This is not a catastrophic failure mode, because the rock fill of the dike will be stable, and at its worst, would lead to temporary suspension of mining. Plus the bituminous liner does not propagate a tear like a plastic liner, so undetected damage is typically small and does not grow. Also, the foundation slopes down towards the tailings, so seepage impounds in the rock fill and will tend to reduce further seepage	Not necessary to monitor directly. Will become evident as possible seepage at dike toe. QA/QC program during construction is the main defence against this scenario.
	(2) Dike Section: Upstream bituminous liner contains defects arising from undetected damage during installation. This defect occurs at the same location as a filter defect.	Loss of tailings and water into the rock fill. This is not a catastrophic failure mode, because the rock fill of the dike will be stable, and at its worst, would lead to temporary suspension of mining. Accumulation of ponded water within the rock fill would decrease the head difference driving flow, thereby limiting the potential for a catastrophic failure.	Not necessary to monitor directly. Will become evident as possible intensive seepage at dike toe, and potentially as tailings fines within seepage downstream of the toe. QA/QC program during construction is the main defence against this scenario.
Seepage within Embankment	Seepage on its own is not a credible failure scenario. The rock fill is pervious so seepage will daylight on the downstream face. Flow through the rock fill will not lead to instability. Any seepage related failures must include internal erosion, see above.	No credible consequences.	No scenario specific monitoring required.
Seepage within Foundation	If the till foundation had a zone of more pervious soil (e.g. gravel seams) and the more pervious zone was preferentially exposed to water pressure, then normal seepage would transmit an unexpectedly high fraction of the reservoir head into the downstream part of the dike foundation. This scenario requires construction defects in filters, liner, and cut off trench fill.	This failure mechanism has caused other embankment failures elsewhere because of straightforward pore pressure induced instability. However, it is unclear that it could cause failure of the Central Dike because of its large width compared to the retained water head. The most likely consequence is downstream toe slumping requiring a localized stabilizing berm.	If this mechanism arises it should show itself gradually as the tailings and water level increase in the basin by buildup of pore water pressures in the foundation. This would be detected during routine monitoring of piezometers installed in the foundation. Pressure relief wells could be installed in the foundation during operations. The tailings deposition plan maintains a long beach between the pond and the dike. This will reduce seepage gradients beneath the dike. In addition, the tailings act as an upstream blanket on the bottom of the TSF to limit seepage into the foundation.

Internal Conduit Rupture	There are no water off take works or other structures extending through the dikes.	Not applicable.	Not applicable.
Slope Instability	(1) Normal Operation: The rockfill has high frictional strength and the design widths make it conservative. Slope failure requires failure in the foundation, which would then extend into the overlying dike.	A foundation failure would cause a rotational slip or sliding failure until equilibrium was reached. This mechanism would limit access along the dike until repaired. Failure through the rock fill will not necessarily compromise the tailings or water retaining function of the dike.	Initial stages of failure should be observable as tension cracks in dike crest and movement at dike toe. Walk-over inspection of dikes by a trained inspector is an appropriate monitoring strategy. Survey of crest, face and toe is also appropriate. If movements associated with increases in foundation pore pressures are discovered, then construction could be stopped or staged to allow pore pressure dissipation. Placement of rockfill as a downstream toe berm could help prevent failure.
	(2) Earthquake Induced: Occurrence of an extreme earthquake, a very rare event.	The extreme earthquake loading for site is a low magnitude event. A large earthquake would not be expected to cause a catastrophic failure, rather the dike would settle. The Central Dike rock fill is placed in the dry and compacted, and will therefore have limited settlement. This would not be a failure situation. The crest is also erosion resistant for earthquake induced wave action in the impounded water.	No monitoring is necessary. Dike should be inspected following any earthquakes felt on site.
Liner Failure Due To Foundation Movement	Differential horizontal movement of the dike due to pit wall failure. Creates a breach in the liner and filter. Pit wall failure is unlikely based on assessments of pit wall stability and the setback between the pit and the toe of the dike. Also, the liner and rock fill can withstand significant deformation, making this an unlikely scenario.	Tailings and water escape into the dike rock fill, but pond there because the foundation slopes towards the dike, rather than the pit. It is noted that the tailings pond is operated approximately 500 metres away. Rapid escape of water will therefore be limited.	No enhanced monitoring. Prism monitoring program and visual inspection sufficient. Movement would be evident in setback area between dike and pit. Tailings at face of dike may be excavated to allow repair of liner, or placement of filter material. Other options include freezing tailings at face of dike.
Unexpected Settlements	The foundation till is expected to consolidate during construction and operations. There is no credible mechanism for a large degree of unexpected settlement following construction required to eliminate freeboard and release tailings/water.	A large settlement could lead to water flowing through the rock fill, but this would not cause failure of the rock fill. It could also be readily repaired by placing more end-dumped rock fill, and extending the liner, in a manner similar to the periodic raise.	No enhanced monitoring required, as excessive settlement would be apparent from prism monitoring data, and visual inspection.

A.2.1 Failure Scenario during Operations

In the case of failure of the Central Dike during operations, the 'worst-case' scenario would involve a flow of unfrozen water and tailings in association with a catastrophic failure of the dike in the later stages of mining when personnel and machinery are working in the open pit directly down-stream of the Tailings Storage Facility (TSF).

Potential Effect

The failure of the Central Dike could result in the sudden release of dike material and tailings from the TSF into that portion of the Portage Pit immediately adjacent to the dike. This could potentially result in loss of life. This would result in cessation of mining activities, either temporarily or permanently.

There would be no effect on the receiving environment water quality, fish or fish habitat because tailings would be contained within the pit and the dewatering dikes and the area would not yet be flooded.

Mitigation, Management and Monitoring

The calculated FoS for this failure mode, under static and pseudo-static conditions, are above design criteria in the Dam Safety Guidelines (CDA, 2007). Consequently, the probability of such a failure developing is low. Based on the tailings deposition plan, it is expected that the tailings pond will typically be 500 m or more from the face of the Central Dike. Furthermore, thermal modeling indicates the tailings and Central Dike will be frozen or partially frozen, and that the facility will tend to the frozen state in the long term. Therefore, a catastrophic failure of the Central Dike without some form of prior dam distress providing a warning of deteriorating conditions is not considered a credible catastrophic failure mode.

Mitigation against such a failure mode occurring will be to construct the Central Dike to design so that it is physically stable under all loading conditions. A comprehensive quality control and quality assurance program will be undertaken during dike construction to confirm foundation conditions, material type and quality, and to adjust designs as necessary to accommodate actual or unexpected conditions found at site.

- A management plan was developed for the operation of the tailings facility, and includes appropriate operational controls and monitoring activities. During operations, instrumentation will be installed to monitor not only the physical performance of the Central Dike itself, but also the performance of the TSF. The instrumentation installed and to be installed includes thermistors to monitor the thermal regime in the dike and foundations, and deposited tailings.

- Piezometers to measure pressure and to infer flow through the dike and foundation materials

- Prisms to monitor deformations within the dike.

If necessary, the stability of the foundation materials and of the dike during operations can be enhanced through the construction of a stabilizing toe berm or through freezing.

A.2.2 Failure Scenario during Closure

In the case of failure of the Central Dike during or following closure, the 'worst-case' scenario would involve a catastrophic failure of the dike and the release of tailings into the lake.

Potential Effect

Failure of the Central Dike during or following closure is not expected to result in loss of life, as mining operations will have finished.

Under this scenario, a catastrophic failure of the Central Dike could result in the sudden and unexpected release of dike material and tailings into the Portage Pit lake area. This could potentially produce a wave of sediment laden water that could over-top the East Dike.

Such a scenario would destroy fish habitat along the dike face and smother benthic habitat outwards from the failure area. Suspended solids and dissolved metals would increase in the water column and would cause displacement of fish and possible toxicity of some bottom sediments, depending on how much tailings material was lost. The new face would be subject to chronic erosion of fine tailings material until such time as a new, stable dike face could be established. Failure of the dike would not cause a change in water level. Impacts would be localized because the Central Dike is situated in the upper part of a blind arm of the lake with an extremely limited drainage area and low turnover. Consequently, transport of suspended sediment away from the area would be restricted and the area of impact would be relatively small.

Mitigation, Management, and Monitoring

The calculated FoS for the Central Dike design are greater than design criteria for post closure for static and pseudo-static (earthquake) conditions. Consequently, the likelihood of a failure occurring is low. Furthermore, thermal modeling indicates the tailings and Central Dike will progressively freeze, and that the facility will tend to the frozen state in the long term. Freezing will increase dike and tailings stability and decrease tailings mobility, and therefore this is not considered a credible catastrophic failure mode.

Mitigation against such a failure mode occurring will be to construct the Central Dike to the design so that it is physically stable under static and pseudo-static loading conditions, and to monitor during the mine life to assess the overall performance of the dike and the TSF. Data gathered during the operational period of the TSF can be used to re-evaluate the performance of the Central Dike structure in the context of longer term stability post closure.

Appendix 3

Saddle Dams

Saddle Dams

Five Saddle dams will be constructed around the limits of the tailings basin. Two Saddle Dams were built between 2009 and 2011, the three other Saddle Dams have been built in 2015. The saddle dam locations are shown on the general mine site plan provided at the beginning of this document. The saddle dams will be constructed by dumping a rockfill berm with a crest width of 30 m to allow haul truck traffic. The Saddle Dams will be re-sloped, with a minimum 15 m crest width. The downstream face will be angle of repose, or 1.32H:1V (Horizontal:Vertical), and the upstream face will be 3H:1V. The Saddle Dams will have an upstream two-zone granular filter and a liner. There is a potential for release of attenuation water, reclaim water, or tailings to Third Portage Lake in the event of an overtopping or catastrophic failure.

For information on the consequences and monitoring/action for the various embankment failure modes possible at the Saddle Dams see Table 2.2 for the Central Dike.

3.1 Failure Scenario during Operation

Depending upon the phase of operations, breach or complete failure of a Saddle Dam could result in the uncontrolled release of Attenuation Pond water, Reclaim Pond water or tailings to Third Portage Lake. There is also the possibility of the Saddle Dams being overtopped through the formation of a wave resulting from a slope failure within the Portage Waste Rock Storage Facility and the sudden release of waste rock into the TSF.

A tailings beach will be formed on the toe of each Saddle Dam. As a result, the Reclaim Pond will be pushed away from the Saddle Dams. As the tailings and Saddle Dams are expected to freeze, and freezing will reduce the chance of tailings reaching Third Portage Lake, failure of the Saddle Dams with release of tailings to Third Portage Lake is not considered to be credible.

An overtopping or breach failure of the section of the Saddle Dams located just south of the intersection with the Stormwater Dike could potentially result in flow of Reclaim Pond water and/or tailings toward Third Portage Lake.

Potential Effect

Should an overtopping event or breach occur in a Saddle Dam, water flowing toward Third Portage Lake would consist of Reclaim Pond water which is predicted to exceed Metal Mining Effluent Regulations (MMER) guidelines for a number of constituents.

As a worst case of failure resulting in a dam breach, the total predicted Reclaim Pond volume of 0.75 Mm^3 could be released towards Third Portage Lake. The Saddle Dams would not be expected to fail due to overtopping. This failure mode is not expected to release a considerable volume of water to Third Portage Lake. Given the size of Third Portage Lake, the impacts to water quality and on fish from a release of Reclaim Pond water would likely be localized.

A worst case scenario would also involve the flow of non-frozen tailings into Third Portage Lake. The distance between the toe of the Saddle Dams and Third Portage Lake is on the order of 150 m to 300 m. Such a scenario would destroy fish habitat and smother benthic habitat outwards from the failure area. Suspended solids and dissolved metals would increase in the water column and would cause

displacement of fish and possible toxicity of some bottom sediments, depending on how much tailings material was lost.

Mitigation, Management, and Monitoring

The dams are designed according to Dam Safety Guidelines (CDA, 2007), and were and will be constructed under controlled conditions. A comprehensive quality control and quality assurance program was and will be undertaken during construction to confirm foundation conditions, material type and quality, and to adjust designs as necessary to reflect actual conditions found at site. The dams are predicted to eventually freeze, which will enhance stability. Therefore, failure of Saddle Dams by overtopping, full breaching or foundation and slope failure is not considered to be credible.

With respect to slope stability failure, the Saddle Dams are constructed of rockfill, which has high shear strength. Slope stability failures must therefore occur through foundation soils. The calculated FoS for slope stability failure modes through foundation soils are above the design criteria in the Dam Safety Guidelines (CDA, 2007) for static and pseudo-static conditions. Consequently, the probability of such a failure developing is low.

The tailings are expected to freeze, and freezing will reduce the chance of tailings reaching Third Portage Lake. The distance from Saddle Dam 1 to Third Portage Lake is about 300 m at its closest point. Leaks of supernatant water and or tailings from the South Saddle Dam would be most likely to occur during operations. Leaks would be visible, and could be mitigated during operations.

3.2 Failure Scenario during Closure

At closure Reclaim Pond water will be pumped to an Attenuation Pond, the basin behind the Saddle Dams will be drained and filled with run-of-mine, acid-buffering ultramafic waste rock (NPAG). The rock is expected to freeze over time. Failure of the Saddle Dams following closure is not considered to be credible. Further, the lack of water will reduce mobility of tailings if failure occurs.

Potential Effect

No effects to water quality, fish or fish habitat is expected.

Mitigation, Management, and Monitoring

As described previously, the dams were and will be designed to meet Dam Safety Guidelines (CDA, 2007). The dams were and will be constructed under controlled conditions. During the construction of the dams a comprehensive quality control and quality assurance program was and will be undertaken to confirm foundation conditions, material type and quality, and to adjust designs as necessary to reflect actual or unexpected conditions found at site. Monitoring during operations will ensure the Saddle Dams perform as intended. The dams will eventually freeze, which will enhance stability. Therefore, post-closure failure of the Saddle Dams by full breaching or foundation and slope failure is not considered to be credible.

Appendix 4

Stormwater Dike

Stormwater Dike

The Stormwater Dike is located at the northwest end of Second Portage Lake, within the TSF as shown on the general mine site plan provided at the beginning of this document. The location of the Stormwater Dike was selected to optimize the storage capacity of the main tailings basin, and of the Portage Attenuation Pond. The dike separates the tailings basin from the Attenuation Pond until approximately 2014 at which point the tailing deposition will start in the South tailing Cell. At the end of mine life, any remaining water will be treated within the TSF and released once discharge criteria are met.

The Stormwater Dike was constructed using rock fill, with a upstream slope of 3H: 1V and a downstream slope at angle of repose for rock fill. The minimum crest width is 12 m. Final crest is at elevation 150.0 m. The dike has a filter zone placed on the south face, underlying an impermeable element of bituminous geo-membrane. The maximum height of the dike is about 13 m. At the maximum cross section, the width of the base of the dike is approximately 95 m.

For information on the consequences and monitoring/action for the various embankment failure modes possible at Storm water Dike see Table 2.2.

4.1 Failure Scenario during Operation

If slope failure of the Stormwater Dike were to occur when tailings are at their maximum elevation in the main tailings basin, and if the tailings are not frozen, this could potentially result in the sudden flow of tailings into the Attenuation Pond area. This in turn could potentially result in the development of a wave which overtops the Saddle Dam at the northwest end, releasing tailings and reclaim water to Third Portage Lake.

Potential Effect

A breach or failure of the Stormwater Dike may cause a wave-induced overtopping of the Saddle Dam at the northwest end. The Saddle Dam would not be expected to fail due to a single overtopping wave event.

This failure mode is not expected to release water to Third Portage Lake. The distance between the toe of the Saddle Dam and Third Portage Lake is on the order of 150 m, so tailings would likely settle out. The potential impacts on Third Portage Lake water quality, fish and fish habitat would likely be minor, localized and short-lived.

Mitigation, Management, and Monitoring

The Stormwater Dike was designed to meet Dam Safety Guidelines (CDA, 1999). The upstream side slopes were designed to allow machine traffic, and are therefore highly conservative with respect to slope stability. The dike was constructed in the dry under controlled conditions. During the construction of the dike a comprehensive quality control and quality assurance program was undertaken to confirm foundation conditions, material type and quality, and to adjust designs as necessary to reflect actual conditions found at site. The dike will eventually freeze, which will enhance stability. Therefore, failure of the dike due to overtopping is not considered to be credible.

4.2 Failure Scenario during Closure

The Stormwater Dike will be covered by tailing on both upstream and downstream side, to equal out the different elevations. At closure Reclaim Pond water will be pumped to an Attenuation Pond, the basin behind the Saddle Dams and Stormwater Dike will be drained and filled with run-of-mine, acid-buffering ultramafic waste rock (NPAG). The rock is expected to freeze over time. Failure of the Stormwater Dike following closure is not considered to be credible. Further, the lack of water will reduce mobility of tailings if failure occurs.

Potential Effect

No effects to water quality, fish or fish habitat is expected.

Mitigation, Management, and Monitoring

The Stormwater Dike was designed to meet Dam Safety Guidelines (CDA, 1999). The dike was constructed under controlled conditions. During the construction of the dike a comprehensive quality control and quality assurance program was undertaken to confirm foundation conditions, material type and quality, and to adjust designs as necessary to reflect actual or unexpected conditions found at site. Monitoring during operations ensure the Stormwater Dike performs as intended. The dike will eventually freeze, which will enhance stability. Therefore, post-closure failure of the Stormwater Dike by full breaching or foundation and slope failure is not considered to be credible.

AGNICO EAGLE

MEADOWBANK GOLD PROJECT

Operation & Maintenance Manual
Sewage Treatment Plant

In Accordance with Water License 2AM-MEA1525 & 8BC-TEH0809

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 5
September 2015

EXECUTIVE SUMMARY

The Nunavut Water Board (NWB) has issued Type A Water License 2AM-MEA0815 to Agnico Eagle Mines Limited (AEM) for the Meadowbank Gold Project site authorizing the use of water and the disposal of waste required by mining and milling and associated uses. In September 2015, AEM received the renewed Type A Water License 2AM-MEA1525.

AEM has prepared the following document which summarizes the operational and maintenance procedures to be followed at the sewage treatment plant.

This report documents the stand alone Operation & Maintenance Manual – Sewage Treatment Plant, as specified under Water License 2AM-MEA0815 Part D, Item 19 and includes the following requirements:

- The manual was prepared in accordance with the "Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996", and adapted for the use of a mechanical sewage treatment facility;
- The manual includes contingency measures in the event of a plant malfunction;
- The manual includes sludge management procedures; and
- The manual incorporates the Operation and Maintenance Manual requirements of 8BC-TEH0809, Part D, Item 10.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA1525, Part B, Item 16, the proposed implementation schedule for this Plan is outlined below.

This Plan will be immediately implemented (September 2015) subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

AEM Internal:

- Site Services Superintendent
- Site Services General Foreman
- Environmental Superintendent
- Environmental Coordinator
- STP Operator

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	08/11/07			Operation and Maintenance manual
2	July 2012			Complete review of Operation and Maintenance Manual
3	February 2013			Complete review of Operation and Maintenance Manual
4	April 2013			Change in sampling frequency and parameters of analysis
5	September 2015	3.4	13	Remove option of incinerating food and kitchen grease

Version 5

Prepared By: _____
Environmental Department

Approved by:
_____
Kevin Buck
Environment Superintendent

TABLE OF CONTENTS

1 INTRODUCTION 7
1.1 Purpose 7
1.2 Brief Description of the Project 7
1.3 Contact Information 7

2 BACKGROUND AND DESCRIPTION 8
2.1 History of Sewage Treatment at Meadowbank 8
2.2 Description of Treatment Plant 8
2.3 Sewage Generation and Composition 10

3 OPERATION AND MAINTENANCE 12
3.1 Wastewater Collection 12
3.2 Sludge Management 12
3.3 Stormwater Management Pond 12
3.4 Normal Operational and Maintenance Procedures 13
3.4.1 Chemicals used in the Treatment Process 13
3.4.2 General Operation & Maintenance and Sampling Procedures and Frequency 13
3.5 Record Keeping 14
3.6 Safety Procedures For Operators 15
3.7 Controlling Access to STP 15

4 EMERGENCY RESPONSE 16
4.1 Fire 16
4.2 Spill 16
4.3 Plant Malfunction 16

LIST OF FIGURES

Figure 1 – Flow Diagram 10

LIST OF APPENDICES

Appendix A: Seprotech RBC Operations Manual
Appendix B: Nordikeau RBC Operations Manual
Appendix C: Sample Daily/Monthly Record Sheets
Appendix D: Site Services Protocols and Procedures

1 INTRODUCTION

1.1 PURPOSE

This sewage treatment plant (STP) operation and maintenance (O&M) manual for the Meadowbank Gold Project has been prepared in accordance with the Nunavut Water Board Type A Water License 2AM-MEA1525 and is based on the "*Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996, prepared by the Department of Municipal and Community Affairs, NWT*". The manual has been adapted for the use of a mechanical sewage treatment facility.

This manual is a component of the Meadowbank Environmental Management System. The objectives of this plan are summarized as follows:

1. To define the location, design and operating procedures to be used in the treatment of sewage generated at the Meadowbank Mine; and
2. To provide monitoring requirements for the STP.

1.2 BRIEF DESCRIPTION OF THE PROJECT

The Meadowbank Gold Project, operated by Agnico Eagle Mines Ltd. (AEM), is located approximately 70 kilometres north of the Hamlet of Baker Lake, in the Kivalliq Region of Nunavut. The center of operations is situated at 65^{o} 01' 9.12''N latitude and 96^{o} 04' 1.91''W longitude on NTS map sheet 66H/1. The site has been actively mining since March 2010.

Gold will be extracted using traditional open pit mining methods during the roughly five year remaining mine life (2018). Access to the site is via an airstrip at Meadowbank and via an all-weather access road from the Hamlet of Baker Lake. On-site facilities will include a mill, power plant, maintenance facilities, tank farm for fuel storage, water treatment plant, sewage treatment plant, and accommodation and kitchen facilities for 550 people.

1.3 CONTACT INFORMATION

The individuals responsible for the operation of the sewage treatment plant for the Meadowbank Gold Project are the following:

Site services Superintendent	819-759-3555 ext 6803
STP Operator	819-759-3555 ext 6758
Environmental coordinator	819-759-3555 ext 6747

2 BACKGROUND AND DESCRIPTION

2.1 HISTORY OF SEWAGE TREATMENT AT MEADOWBANK

The sewage treatment plant (STP) at Meadowbank first went into operation on May 15, 2008. It is located on the northern end of the mine site in a prefabricated structure adjacent to the accommodations camp. The proximity of the system to the camp optimizes the wastewater inputs. The treated wastewater is discharged into a small attenuation pond (formerly known as Teardrop Lake – now as the Stormwater Management Pond). It is less than 2m deep, and fishless. This water body is located between the plant site and Portage Pit, within the mine footprint, and is also used as a storm water management pond for the Meadowbank site. This wastewater is pumped periodically (when near capacity of the pond) with mill tailings or directly to the Tailings Storage Facility (TSF). There is no discharge of treatment effluent to the natural environment.

2.2 DESCRIPTION OF TREATMENT PLANT

A Rotary Biological Contactor (RBC) sewage treatment system has been installed at Meadowbank. Four RBC units are installed at site; the Seprotech L333 Rotordisk model, and three Biodisk LJ100 units. These units are designed to remove solids, organic material a limited amount of nutrients from the wastewater (sewage and grey water).

The main unit, the Seprotech L333, and two (plus one backup) Biodisk LJ100 units, run in a parallel series. An 80 m^3 capacity equalization tank is utilized prior to the treatment units and serves as an equalization tank to manage peak flows of influent (morning and evenings). The treated effluent from both systems passes through a U.V. disinfection system and flows to a common lift station (station 3) prior to discharge.

The operation of the RBC system is based on a continuous flow of wastewater through a series of stages. As wastewater flows through the RBC system, each successive RBC stage receives influent with lower contaminant concentrations than the previous. In general, treatment of wastewater by an RBC system includes the following processes:

- Aeration and mixing via rotating disks;
- Biological reactions on disk surfaces; and
- Sloughing of solids from rotating disks.

Prior to entering the RBC, untreated wastewater, as a pretreatment, passes through a screen system to provide for course solids removal prior to primary clarification. Wastewater can then flow into the RBC units, where it comes in contact with disks attached to a rotating shaft. The disks can be configured and corrugated in various patterns to provide increased surface area and enhanced structural stability as they rotate through the wastewater. Aeration and mixing occurs as the shaft and associated disks rotate through the wastewater. The disks provide surfaces on which microorganisms can react with ambient air and wastewater to convert ammonia to nitrate (termed nitrification) and reduce the Biological Oxygen Demand (BOD). As wastewater flows through the disks, sloughing of solids accumulated on the disks occurs by displacement and gravity. After the treatment process within the RBC is complete, the resulting wastewater is directed to settling tanks. These tanks are necessary for secondary clarification. The settled solids remaining after secondary clarification is termed sewage sludge.

The Meadowbank RBC units are housed within an insulated tank with an insulated cover and are equipped with immersion heaters to ensure efficient operation under Northern adverse weather conditions. See below for Photographs of the system and Figure 1 for a flow diagram of the system.

Photo 1 – RBC units

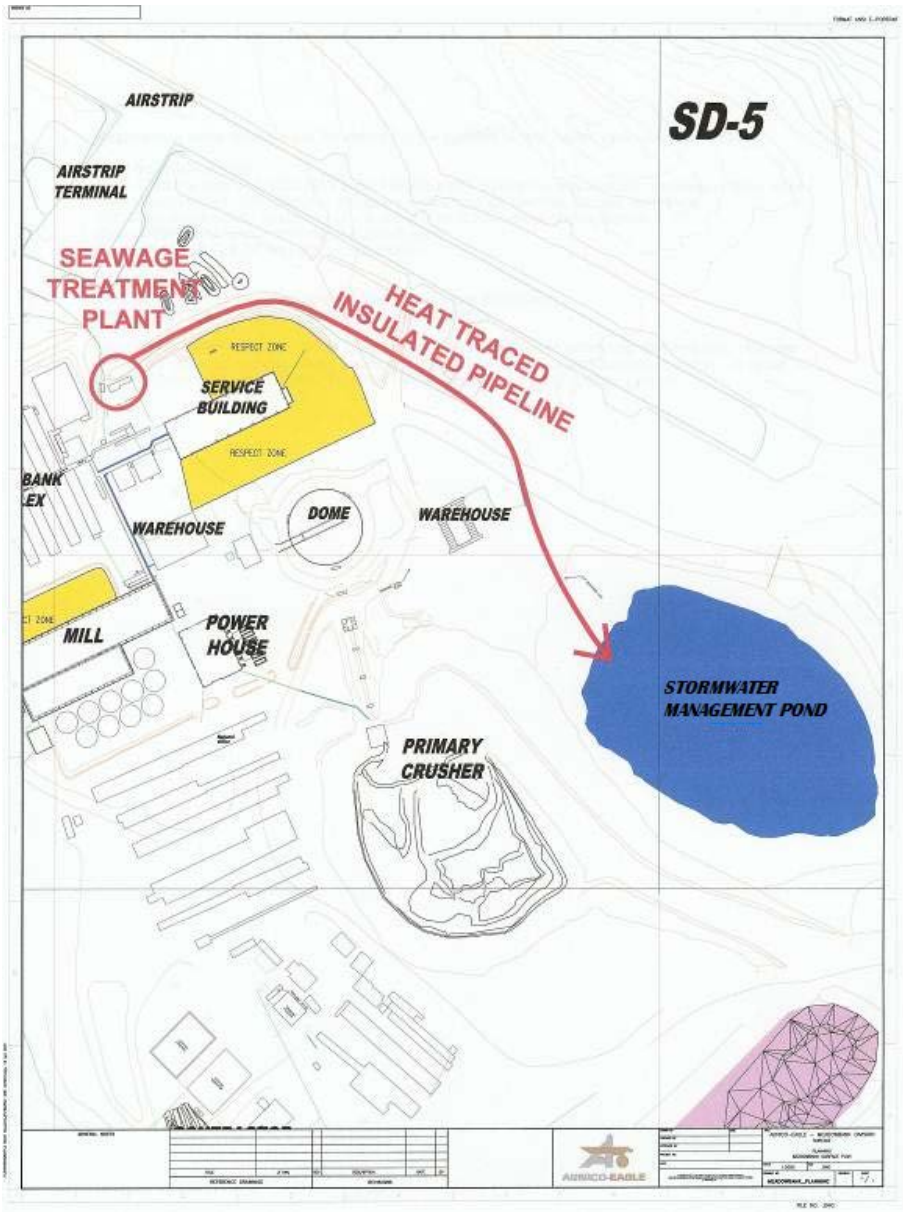


Figure 1 – Flow Diagram

2.3 SEWAGE GENERATION AND COMPOSITION

The STP at Meadowbank is capable of handling 188 m^3 per day. With a biological oxygen demand (BOD) of approximately 350 mg/L, the L333 has a capacity up to 105 m^3, and the two Biodisks, operating in a series, another 27.5 m^3 each. These units provide primary and secondary treatment.

On average between 100 m^3 and 120 m^3 of sewage and grey water is generated at site each day. Daily records are maintained of the amount of sewage and grey water generated.

The composition of the sewage and grey water entering the plant and the composition water exiting the units are monitored monthly (to determine plant efficiencies). Initially, STP Operations and Maintenance Manual stated that samples were taken weekly to make sure the units are operating correctly. In February 2013, AEM reduced sampling frequency to once every two weeks and to once per month in May 2013. The reasons for this sampling frequency reduction are;

- Sampling data from the last three years certainly indicates that units are operating as designed and show little variability in the results;
- Raw sewage stream basically doesn't change;
- Operators do daily operational inspection and perform weekly maintenance and repairs, if necessary. The daily operational inspections identify problems efficiently and quickly and have proven to be as effective as sampling;
- If there is major problem or failure in the RBC it would be most likely due to changes in the influent (raw sewage) i.e. high strength sewage (BOD high) killing bacteria in the RBC. In this case, there would be visible effluent problems (part of daily operational checks), low dissolved Oxygen (part of daily operational checks) and increased odours that the operator would note. If this occurs, a sample will be taken to try to determine the source of the problem;
- RBC effluent is not discharged to the environment; and
- Sampling weekly or bi-weekly at this point is not necessarily and does not provide any more useful data than a monthly sampling and the daily operational checks provide.

Average results for 2012 are presented in Table 1 to provide an example of the characteristics of the raw sewage (influent) and the effluent discharged from the RBC treatment units. Sludge generated as a result of the treatment process is collected and disposed of with mill tailings in the TSF. All monitoring results are contained in AEM's Annual Reports submitted to the Nunavut Impact Review Board and the Nunavut Water Board.

Table 1: Untreated and treated Water Quality from the STP (Influent and Effluent) – average for 2012

Parameter	Units	STP-IN (Influent)	STP-LJMIX (Effluent from combined LJ)	STP-SEP (Effluent from Seprotech)
BOD-5	mg/L	230	18	11
COD	mg/L	500	80	71
TSS	mg/L	161	27	21
Nitrate	mg N/L	0.02	24.17	22.12
Nitrite	mg N/L	0.01	1.29	0.45
pH		7.72	5.65	5.07
Total Phosphorus	mg/L	11.6	10.6	10.8
Ammonia	mg N/L	93	13.9	8.2
NTK	mg N/L	112	19.36	12.16
Fecal Coliforms	cfu/100 ml	4 846 666	721	84
Total Coliforms	cfu/100 ml	15 875 000	2458	1236

3 OPERATION AND MAINTENANCE

3.1 WASTEWATER COLLECTION

All sewage and grey water generated at Meadowbank is drained by gravity pipelines to a specific lifting station, then pumped through a heat traced insulated pipeline to the STP equalization tank. The number of lifting stations, and the building they service, is provided below.

- Lifting station 1 services the grey water generated from the kitchen grease trap, laundry room; this is strictly a grey water line that connects to lifting station 3;
- Lifting station 2 services the dormitory accommodations in trailer units # 1 to 11; this is the main sewage line;
- Lifting station 3 services the discharge line to the storm water management pond;
- Lifting station 4 services the service building; this line connects to the main line;
- Lifting station 5 services the mine operation office; this line connects to the main line;
- Lifting station 6 services the power plant; this line connects to the main line;
- Lifting station 7 services the mill; this line connects to the main line;
- Lifting station 8 services the assay laboratory; this line connects to the main line;
- Lifting station 9 services the dormitory accommodation in trailer unit # 12 and Site services building; this line connects to the main line;
- Lifting station 10 services the nova camp sewage;
- Lifting station 11 services the nova camp grey water; and
- Lifting station 12 services the gym and construction/training area.

In addition to the sewage generated from the buildings above, a sewage holding truck picks up sewage three times per week from storage tanks at the Exploration Camp, the Emulsion Plant, the old Nahanni lunch room, the north gate washroom, the primary crusher washroom, and the airport washroom. This material is deposited into Lift Station # 2 which flows to the treatment plant.

3.2 SLUDGE MANAGEMENT

Sludge from the STP treatment units is pumped and transferred to the TSF as required. Sludge and other settled solids is also removed from Lifting Station # 2 and deposited at the TSF as required.

3.3 STORMWATER MANAGEMENT POND

AEM has built up the depth of this pond through construction of low permeability roadways around the perimeter of the pond. These roadways operate as dikes to increase capacity of the pond to better manage storm water and STP discharge flows. The treated sewage from the STP is pumped through a heat traced insulated pipeline to lifting station # 3 and then into the storm water management pond. When full the storm water pond is pumped to the TSF.

3.4 NORMAL OPERATIONAL AND MAINTENANCE PROCEDURES

The sections below outline the general operational and maintenance procedures at the plant; further details are available in the manufacturers' operating manuals in Appendix A (Seprotech), Appendix B (Biodisk) and in the Site Services protocols and Procedures - Appendix D.

AEM recognizes that in order to keep a properly functioning STP, certain material must be kept out of the influent raw sewage. These items are:

- Food and other kitchen grease are removed from the sewage in the kitchen via a grease trap. The grease trap is manually cleaned to keep this material out of the sewage treatment plant influent and the recovered grease is co-disposed with the mill tailings in the TSF.
- Camp rules and purchasing practices prohibit anti-bacterial soap products from being used on site to protect the biological activity in the RBC units.

3.4.1 Chemicals used in the Treatment Process

The dry bacteria product, BEC105, is used in the treatment process to stimulate biological activity when needed.

3.4.2 General Operation & Maintenance and Sampling Procedures and Frequency

The STP at Meadowbank went into operation in May 2008. The following are the general Operation & Maintenance and sampling procedures that have been employed since the plant's start up. Further details of Operation & Maintenance procedures are provided in the equipment operating manuals and in Site Services Protocols and Procedures (Appendix A, B, and D).

Daily

A daily inspection of the sewage collection system, heat traced pipelines, and treatment plant is conducted to ensure there are no spills or incidents to report.

Inspection and sampling sheets are completed every second day for each of the RBC units; these forms include:

- Daily weather observations;
- Discharge volumes;
- Turbidity;
- Dissolved Oxygen and pH measurements in the final discharge of the treatment units; and
- Visual observations of the final discharge.

Example daily/monthly record sheets are provided in Appendix C.

Weekly

Maintenance inspections and repairs, if necessary, of bearings, pumps and hoses in the STP are conducted weekly.

Monthly

Influent (sewage and grey water) and effluent sampling of the final discharge from the Seprotech and Biodisk RBC units is conducted monthly. Parameters include:

- Ammonia
- Ammonia-nitrogen
- Total Kjeldahl Nitrogen
- Biological Oxygen Demand (BOD_5)
- COD
- Nitrate
- Nitrite
- Faecal Coliforms
- Total Coliforms
- pH
- Total Suspended Solids
- Total Phosphorus

Sample monitoring for Phosphorus in the treated effluent has been discontinued because the units do not have Phosphorus removal capability. AEM will continue to monitor Phosphorus in the influent sewage.

Every 6 Months

An inspection of the chain linkage in the RBC units will be conducted every 6 months and the gear oil is changed.

Annually

On an annual basis, each of the tanks will be pumped out for maintenance and cleaning purposes. Depending on the accumulation of sludge in the tanks it may be done more often or as required.

3.5 RECORD KEEPING

Records of the operational and maintenance and sampling procedures are kept daily in order to assist in the evaluation of the effectiveness of the sewage treatment plant.

The following is recorded on a daily basis:

- Volume of any effluent discharged to environment;
- Sewage volume collected; and
- Details of any maintenance undertaken at site.

The record sheets are kept in the Sewage Treatment Plant office.

3.6 SAFETY PROCEDURES FOR OPERATORS

Employees working in the STP facility must be trained prior to commencement of work so that they are aware of the health and safety risks as well as the operational procedures associated with the STP. The following are two very important safety rules:

- No person shall drink the water in the plant or the water that is discharged from it;
- Working with sewage requires adequate protection for operators. This includes wearing steel toed boots, hard hat, safety vest, protective glasses and protective gloves; and
- All authorized personnel working in the STP must have received Hepatitis A and B vaccine.

Eye and hand wash are located in the plant for use in the event of accidental contact with unprotected hands or face due to splashing or other causes.

3.7 CONTROLLING ACCESS TO STP

Access to the STP at Meadowbank is restricted to authorized personnel only. All doors to the plant are locked, with only authorized persons having keys. Signs are posted on the STP entrance doors notifying all people that the entrance to the STP is for authorized personnel only.

No fencing is used to control access to the STP. Due to the remote nature of Meadowbank, there is no concern of non-mine personnel attempting to access the site.

4 EMERGENCY RESPONSE

4.1 FIRE

In case of fire at the STP, the on-site emergency response team would be notified as per AEM protocol. Instructions from the on-site emergency response team would be followed by all personnel at the STP. Further details of fire response are provided in the "*Emergency Response Plan*".

4.2 SPILL

In the event of a spill at the STP, the on-site emergency response team would be notified as per AEM protocol. Instructions from the on-site emergency response team would be followed by all personnel at the STP. Further details of spill response are provided in the "*Spill Contingency Plan*".

4.3 PLANT MALFUNCTION

In the event of a failure of one of the three operating RBC's (i.e. Seprotech and 2 LJ100's) there is a backup LJ100 unit available at all times.

The following other contingent measures can be applied by AEM in the event of an RBC malfunction at the Meadowbank Sewage Treatment Plant for more than 24 hours:

- Cut back on allowable camp water until the malfunction is corrected and use the equalization tank to retard the peak flow to the remaining RBC unit;
- Shut down the malfunctioning RBC unit until the malfunction is repaired and use only one of the two parallel units until repairs are completed;
- Shut down all water use in the camp until the repairs are complete; and
- Bypassing untreated STP influent around the malfunctioning RBC unit and holding this untreated influent in a holding tank or lined pond on site until the repairs are complete is another contingent measure that could be applied. The untreated sewage would then be pumped back to the STP when the unit is repaired. This will require the coincidental restriction of water use to minimize the volume of untreated influent being bypassed.

Appendix A: Seprotech Operation and Maintenance Manual

Seprotech Systems Incorporated
2378 Holly Lane, K1V 7P1
Ottawa, Ontario, Canada
Telephone (613) 523-1641
Fax (613) 731-0851

INSTALLATION, OPERATION AND MAINTENANCE

MANUAL

NOTICE

The enclosed materials are considered proprietary of Seprotech Systems Inc. No assignments either implied or expressed, of intellectual property right, data, know how, trade secrets or licenses of use thereof are given. All information is provided exclusively to the addressee for information purposes and is not to be reproduced or divulged to other parties, nor used for manufacture or other means or authorize any of the above, without the express written consent of Seprotech Systems Inc. The acceptance of this document will be construed as an acceptance of the foregoing conditions.

TABLE OF CONTENTS

1.0 SITE INSTALLATION OF ROTORDISK® SEWAGE TREATMENT PLANTS: 4
1.1 – CONCRETE TANKAGE FOR ROTORDISK® 4
1.2 - DIRECTION OF SHAFT ROTATION 6
1.3 - RECYCLE for ROTORDISK® 7
1.4 - SUMMARY OF OPERATION 8

2.0 - ROUTINE VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS 9
2.1 - PRIMARY SETTLING TANK (PST OR PRIMARY "CLARIFIER") 9
2.2 - ROTORZONE 10
2.3 - 'BATHTUB RING' 10
2.4 - FINAL SETTLING TANK (FST OR FINAL "CLARIFIER") 10
2.5 - MONITORING OF DISCHARGE FLOW RATE 10
2.6 - OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL 11
2.7 - FREQUENCY OF INSPECTION 11

3.0 - STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL 11
3.1 - STORAGE CAPACITIES 11
3.2 - DETERMINATION OF ACCUMULATED SLUDGE VOLUMES 11
3.3 - SLUDGE REMOVAL 12
3.4 - POTENTIAL CONSEQUENCES OF OPERATING ROTORDISK® UNITS PAST DESIGNATED MAXIMUM SLUDGE STORAGE LEVELS 12
3.5 - FRONT VIEW SCHEMATIC OF ROTORDISK® 14
3.6 - PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS (summary) 15
3.7 - START-UP PROCEDURES OF ROTORDISK® 16

4.0 - STORAGE OF ROTORDISK® SEWAGE TREATMENT EQUIPMENT 18

5.0 - ASSEMBLY PROCEDURE OF ROTORDISK® COMPONENTS SUPPLIED BY SEPROTECH SYSTEMS INCORPORATED 18

6.0 - ROUTINE MECHANICAL MAINTENANCE OF ROTORDISK® SEWAGE TREATMENT PLANTS 22
6.1 - MOTOR: 22
6.2 - REDUCER: 22
6.3 - BEARINGS: 22
6.4 - SPROCKETS AND CHAIN: 22
6.5 - COUPLING: 22

7.0 - TROUBLE SHOOTING 23
7.1 - MECHANICAL HARDWARE 23
7.2 - ROTORDISK® PROCESS 24

8.0 - MAINTENANCE PROGRAM – Do's and Don'ts 27
8.1 - DO'S 27
8.2 - DON'Ts 28

9.0 - INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE ROTORDISK® AND OTHER EQUIPMENT SUPPLIED 29
9.1 - INSTALLATION & MAINTENANCE DETAILS FOR ROLLER CHAIN DRIVES 29
9.2 - PROCEDURE FOR ASSEMBLING BEARINGS AND PILLOW BLOCKS 32
9.3 - GREASE CLASSIFICATION 34

10 - LIMITED WARRANTY 35

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.0 SITE INSTALLATION OF ROTORDISK® SEWAGE TREATMENT PLANTS:

IMPORTANT: READ THIS INSTALLATION PROCEDURE PRIOR TO START-UP.

1.1 - Concrete Tankage for ROTORDISK®

If the ROTORDISK® unit supplied is to be encased in concrete tankage, the site preparation is as follows:

The unit is lowered into the concrete tankage, the pipe at the end of the unit is placed into the opening of the intermediate wall between the primary and final settlement chambers and lowered onto the anchor bolts (contractors supply).

Unit is to be lifted only at lifting points by use of hooks and spreader bars.

All anchor bolts (contractors supply) should be correctly located in concrete in a vertical position. In addition, all bolts should include a levelling nut.

All anchoring and levelling of ROTORDISK® unit on site is to be done by customer/contractor. When the unit is set onto the anchor bolts in the concrete tank, it must be levelled to a slope of no more than 3/4" in 20' along the length. The unit is then centred in the tank and completely bolted down.

After the unit has been bolted down, check alignment of shaft and sprockets and clearances of couplings where applicable prior to start-up, failure to do so may void manufacturer's warranty. Refer to this ROTORDISK® manual for details. If required, the contractor must perform levelling.

All hydraulic piping, to and from the unit, is to be supplied and installed by customer/contractor.

All input electric and hydro hook-ups to be done by customer/contractor to local governing regulations and a signed approval sent to SEPROTECH SYSTEMS INCORPORATED. Under no circumstances must electrical connections, junction boxes or equipment pertaining to the electrical function of the unit be installed in the ROTORDISK® tank.

SEPROTECH SYSTEMS INCORPORATED will supply a man on-site to assist customer/contractor at a specified rate and at customer/contractor discretion.

If unit is not shipped completely assembled assembly instructions and drawings will be supplied. (As shown)

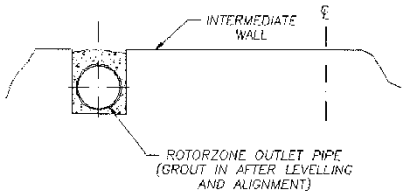


Figure a - **ROTORDISK®** tank outlet through intermediate wall between settlement tank chambers.

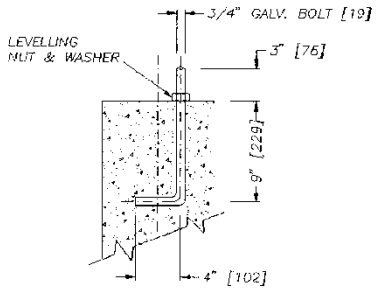
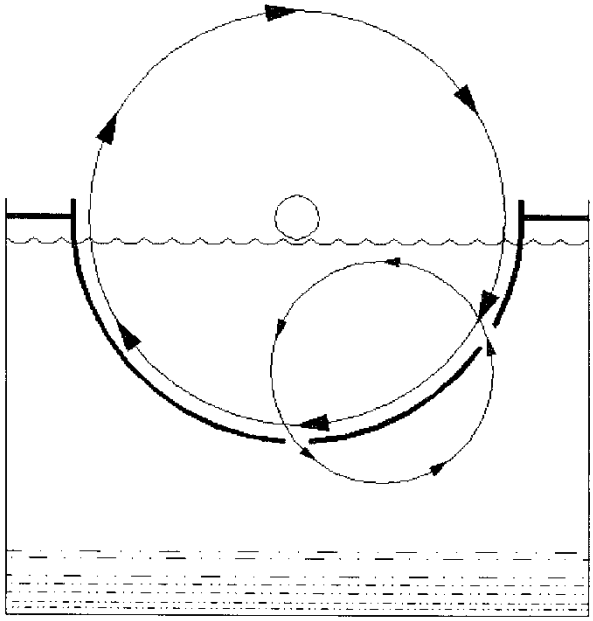


Figure b - anchor bolt detail for **ROTORDISK®** tank.

1.2 - DIRECTION OF SHAFT ROTATION



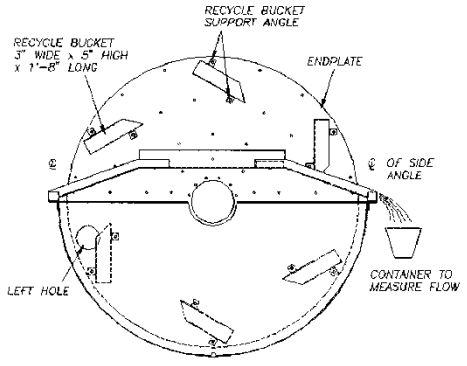
The direction of shaft rotation should be such that disks mounted on shaft will enter water on the side where inlet to "Rotorzone" is located. The electric motor driving the shaft should be wired accordingly.

1.3 - RECYCLE for ROTORDISK®

1.4.1 Recycle buckets are mounted on the last stage of the ROTORDISK®. These buckets rotate at the same speed as the disks. See the attached elevation view of the recycle buckets and trough on the Rotorzone tank.

1.4.2 As the disks rotate, the buckets scoop-up treated wastewater. As this wastewater falls into the recycle trough, it is exposed to the atmosphere, where it absorbs fresh oxygen. The wastewater then cascades on one side of the trough through a narrow steel channel and mixes back with the contents of the Primary Clarifier, thereby introducing fresh dissolved oxygen in the Primary Clarifier. See the section of diskbank assembly showing buckets and recycle trough.

1.4.3 The set-up described above is comprised of the recycle buckets and recycle trough, is what we term as our D.O. re-circulation device. This is especially advantageous to preventing septic conditions from occurring in the Primary Clarifier in small flow or low flow situations.



SECTION OF DISKBANK ASSEMBLY SHOWING 8 BUCKETS AND RECYCLE TROUGH

1.4 - SUMMARY OF OPERATION

(ROTORDISK® systems designed for BOD/SS/Ammonia/Nitrate removal)

The sewage plant (as supplied by SEPROTECH SYSTEMS INCORPORATED) is comprised of three (3) main components: the primary settling tank, the RBC tank, and the secondary settling tank.

Raw sewage is pumped and/or gravity flows into the primary settling tank (PST). When the sewage is pumped into the plant, pumping must simulate conditions encountered in gravity fed systems. Indeed, over a 24-hour period, the plant is designed to handle a flow rate corresponding to the Average Daily Flow (ADF) and can accommodate for two Peak Daily Flow (PDF) periods of two (2) hours per day. Each PDF event can be at a maximum of three times ADF.

In the PST, sedimentation separates heavy solids from the bulk of the liquid and the supernatant enters the aerobic section through the inlet slot located at the front section of the RBC tank.

The aerobic section is made up of four stages. The 1st stage is mounted on one common shaft. This 1st stage is comprised of one (1) to three (3) disk banks. The normal colour of the bacteria in the 1st stage is dark brown. This is the stage where most of the BOD removal by biological oxidation occurs. The succeeding 2nd, 3rd, and 4th stages are mounted on the rest of the shaft or another common shaft. Each stage has one (1) to three (3) disk banks. It is in the 2nd stage that further BOD is removed, and if the BOD is removed to approximately 30 mg/l, nitrification will follow. As such, in the 3rd stage, nitrifying bacteria (those which convert ammonia (NH_3) in the form of ammonium ions (NH_4^+) into nitrite (NO_2^-) and, ultimately, nitrate (NO_3^-) predominate in the 3rd and 4th stages. The 4th and last aerobic stage has recycle buckets that introduce both fresh dissolved oxygen into the primary settling tank and nitrifying bacteria present in the recycled water.

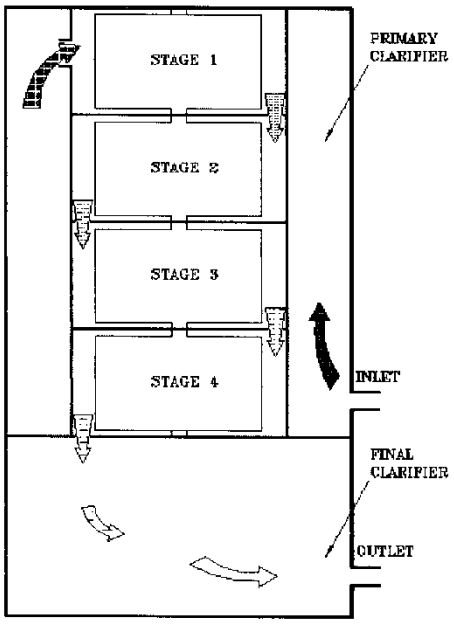
The rotation of the disks in and out of the water provides a mean of air and heat transfer from the ambient air to the water. The transfer of air to the water is important for aerobic bacteria to remove BOD and ammonia. The transfer of heat to the water is important to maintain the water at an optimum temperature of 15 °C and above such that BOD and ammonia removal rates by the bacteria are maximized (removal rates are a function of the water temperature). Because maintaining a temperature that provides acceptable removal rates is important to the process, RBC's are installed indoors and ambient air is maintained at 15 °C and above.

In the secondary settling tank, remaining suspended solids as well as sloughed off biomass from the disks settles and is pumped to the primary settling tank via sludge return pumps.

Chemical dosing of alum facilitates the coagulation and flocculation of aluminium phosphate resulting in the removal of phosphorus. Sodium bicarbonate can be used to maintain the pH balance throughout the process.

2.0 - ROUTINE VISUAL CHECKS ON PHYSICAL AND BIOLOGICAL FUNCTIONING OF ROTORDISK® & DESCRIPTION OF TREATMENT PROCESS

ROTORDISK® sewage treatment plants have three major steps in the purification process. In the primary settling tank, gross solids separate from the flow by either sinking or floating. In the Rotorzone, dissolved pollutants are broken down to simple, non-pollutant compounds by the bacteria ("biomass"), which grows on the rotating disks. The final settling tank permits gravity separation of spent biological growth, which continually sloughs off the disks in the Rotorzone preceding it.



2.1 - PRIMARY SETTLING TANK (PST OR PRIMARY "CLARIFIER")

The accumulation of floating scum on the surface of the primary clarifier is normal. It is proportional to the accumulation of settleable solids at the bottom of the tank. Periodic (9-12 months) removal of sludge at the bottom of the tank is required for proper operation of the Unit.

If no sludge, measuring device is available; the accumulation of 9"-12" depth of scum on the surface is a good indication that it is time to remove the accumulated deposits of sludge from the bottom of the tank(s).

2.2 - ROTORZONE

The Rotorzone is subdivided into four sections, with disk banks in each. The wastewater first enters the Rotorzone in the section marked "1" in the sketch (furthest away from the inlet to the plant). The flow then proceeds through sections 2, 3, and 4 before entering the final settling tank.

The accumulation of biological growth will be greatest in section 1, and gradually decrease through subsequent sections. Generally, the growth will be thick, and often filamentous ("stringy"), in section 1, becoming thinner and more compact through sections 2-4.

The colour of the growth will typically be dark brown to black in Section 1. Some grey growth may also be noticed, depending on the relative load and type of wastewater being treated. Growth in sections 2-4 will typically vary from medium brown to a light brown or tan growth in section 4.

In a well-functioning unit with the appropriate feed of wastewater, there will be an earthy, humus-like ("musty") smell inside the unit. A substantial sour, "sewage" smell may be an indication of sub-optimal conditions in the treatment process.

2.3 - 'BATHTUB RING'

The wastewater flows by gravity within a ROTORDISK® Plant thus the water level is relatively constant. Changes in water level of 1" to 2" are not unusual due to surge flows entering the unit. The evidence of this is a 'bathtub ring' 1" - 2" above the normal level. A 'bathtub ring' higher than this, suggests partial or complete flooding of the unit has occurred since the last check. If so, the (gravity or pump) discharge system should be checked for blockages or mechanical malfunction. Another condition, which can lead to the level of water rising to levels greater than 1" – 2"; is if the plant is fed by pumps, which exceed, the design limits of the plant (i.e., ADF over a period of 24 hours including a maximum of two (2) PDF events no longer than 2 hours each).

2.4 - FINAL SETTLING TANK (FST OR FINAL "CLARIFIER")

The effluent near the outlet at the backside of the final clarifier should be relatively clear and colourless and relatively free of suspended matter. Clarity can best be judged by scooping a small volume of the final effluent into a clear glass container. This is particularly true of larger units where the depth and dark colour of the tank walls may make clarity hard to determine. (Note: Although the risk of infection is very small, the wearing of rubber gloves is a rational safety precaution when hand-scooping the effluent for a clarity check. This is particularly true if there are open cuts on the hands.)

Although the final effluent itself should be relatively clear, some floating matter may accumulate on the surface of the final clarifier. This is normal, and will typically be much less than the accumulation of floating scum in the primary clarifier.

2.5 - MONITORING OF DISCHARGE FLOW RATE

The plant is equipped with a flow meter located on the influent pipe. This instrument is equipped with a counter that allows tracking of the total volume of clean effluent discharged by the plant.

2.6 - OPERATING PARAMETERS ADJUSTABLE ON THE CONTROL PANEL

Sludge pumps should be set to operate for 15s every 3h. Making changes and adjustments to the default plant's operating parameters requires a good understanding of the wastewater treatment process and should therefore only be performed by qualified and trained staff. Please contact SEPROTECH SYSTEMS INCORPORATED if assistance is needed to optimise the operation of the plant.

2.7 - FREQUENCY OF INSPECTION

Visual checks every week should be sufficient. However, for better preventative maintenance of the wastewater treatment plant and thus the capital investment, a daily walk through is often the preferred frequency of visit. Many owners prefer the visual and audible (look and listen) walk through. A standard operator checklist should be prepared and used by the person responsible for periodic maintenance of the plant at every visit. SEPROTECH SYSTEMS INCORPORATED can assist in preparing such checklist upon request.

3.0 - STANDARD RECOMMENDATIONS AND PROCEDURES FOR SLUDGE REMOVAL

3.1 - STORAGE CAPACITIES

A design feature of ROTORDISK®, which contributes greatly to overall simplicity of the process, is the sizing of clarifiers to accommodate static internal sludge storage for extended periods. Depending on such factors as raw wastewater solids concentrations, and design organic loading in a given application, maximum sludge storage levels will typically be reached in 6-9 months of operation.

This period is based on calculated rates of initial decomposition of raw and biological solids, and, upon operating experience, indicating the degree of auto-digestion/compacting, which proceeds during the storage period. The 6-9 month period will be shortened to the extent that design hydraulic and waste loads are exceeded. It will be lengthened to the extent that flows and waste load are less than those designed for.

3.2 - DETERMINATION OF ACCUMULATED SLUDGE VOLUMES

The accumulation of maximum storage capacities can be indirectly monitored through visual observation of the thickness of the scum blanket on the surface of the primary clarifier. When the scum blanket has matured to a height of approximately 7"-10", this is a good indication that sludge accumulations at the bottom of both clarifiers are at or near maximum levels, and that sludge withdrawal is indicated.

A more accurate procedure of determining sludge levels is to directly measure actual accumulations, and compare these to the maximum storage capacities listed on the "Details" section of the general arrangement drawing for the ROTORDISK® model in question.

A variety of sludge measuring devices is commercially available. The two most common are the weighted hollow tube type, and, the (electronic) turbidity-change detector type. The former is less

costly, relatively easy to use, and more appropriate because of the low frequency with which measurements need to be made in a ROTORDISK® unit.

Whatever means of measuring the sludge may be selected; it must be kept in mind that the sludge is not a firm solids substance. Domestic wastewater sludge is mostly trapped water and other liquids. Only to determine sludge levels by "feeling" for a solid layer with a stick or pole. The settled sludge is far more liquid than the surface scum, which is perhaps 30-40% solids, by volume.

Irrespective of the type of device used, sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone trough.

Once an average sludge height has been determined, multiply by the surface area of the clarifier in question to determine the existing volume of stored sludge. Compare to maximum design capacity listed on the general arrangement drawing. If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

3.3 - SLUDGE REMOVAL

A pump-out truck of the same type that pumps out septic tanks normally does the sludge removal. For smaller ROTORDISK® units, the entire liquid contents of the treatment plant can be withdrawn. For larger installations, the haulage contractor should be instructed to get the suction hose directly to the bottom of the tanks and withdraw the sludge only, while taking as little of the supernatant as possible. Once the primary sludge is withdrawn from the primary settlement tank, the supernatant of the secondary clarifier can be transferred to the primary settlement tank to expose the secondary sludge. The suction hose should be placed down at a multiple number of points to help ensure complete removal of accumulated sludge deposits. Floating surface scum should also be removed. Haulage contractors should be given a brief description of the unit and its operation if they are not already familiar with it. A particular point to emphasise is that the biological growth on the disks should not be washed off, but should be left in place. The exception to this is if the disks have accumulated excess biomass due to sludge pump out being delayed past the indicated intervals.

Sludge removed from the unit is normally hauled away by the pumping truck and disposed of at municipal facilities, or, by controlled spreading on farmland. On-site disposal in shallow trenches and/or some form of on-site volume reduction (prior to export) may be feasible or desirable depending on the specific opportunities and limitations afforded by the site of a given installation.

3.4 - POTENTIAL CONSEQUENCES OF OPERATING ROTORDISK® UNITS PAST DESIGNATED MAXIMUM SLUDGE STORAGE LEVELS

Sludge accumulations should be removed once they reach indicated maximum storage levels, because failure to do so could result in lowered treatment efficiency, and possibly cause serious damage to the structure of the Rotating Assembly and drive unit. The potential for problems is as described below and depicted in the attached sketches.

Figure (c) shows a unit operating with sludge build-ups at or near maximum storage levels. This will cause no problem since the storage heights are designated so that flows through the primary clarifier will not disturb the sludge layer. Characteristics of wastewater reaching the Rotorzone at this time (and since start-up) will be in the range of 180-200 mg BOD/l and 50-250 mg SS/l. The

supporting structure of the rotating assembly is over designed for the amount of biological build-up which will occur on the disks under this operating condition, and the shear force of the rotation through the trough water will limit the thickness of growth.

However, if sludge is allowed to accumulate past designated storage heights, flow through the primary clarifier will begin to disturb the sludge blanket, and thus carry loads of solids and dissolved organic matter into the Rotorzone which are not anticipated in the design of the unit (Figure d). The pollutant load reaching the biomass on the first stage of disks will overload that biomass (in terms of F:M ratio), and force a change in its activity and growth. The biomass becomes more gelatinous, and does not shear off as well with disk rotation. Additionally, the biomass will readily adsorb and entrap the extra solids with the sum effect being an increase in weight on the rotating assembly that considerably exceeds that which its design is based on.

This tendency reaches its extreme if sludge is allowed to accumulate to the point where it will be disturbed by-, and caught up in -, the re-circulation pattern created by the two slots in the trough on the first section of the Rotorzone (see Figure e).

The sludge will have characteristics in the order of 20,000 mg TSS/l and 10,000 mg BOD/l, so it is obvious that even a minor amount of this material caught up in the re-circulation flow will significantly increase the concentration of the waste stream entering the Rotorzone. If, for example, the sludge was caught up in the recycle flow at a ratio of as little as 1:10 or 1:15, the resulting concentration would be sufficient to produce a considerable first-stage overload on an amount of disk area selected based on normal concentrations.

The resulting build-up of poorly-shearing gelatinous biomass and trapped solids would pose a serious potential for strain on the drive unit, and for structural damage to disk bank assemblies and shaft, in spite of them being considerably over designed for loads anticipated in normal operation.

Clearly, these potential problems should be avoided by the removal of sludge once it reaches the level specified as maximum for the ROTORDISK® unit in question.

3.5 - FRONT VIEW SCHEMATIC OF ROTORDISK®

UNIT OPERATING AT-, AND ABOVE-,
RECOMMENDED MAXIMUM SLUDGE STORAGE LEVELS

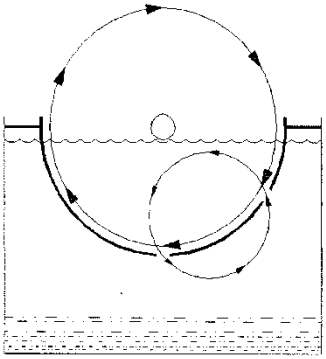


Figure c-unit operating at maximum sludge storage levels. Neither influent flows, nor re-circulating flows, disturb sludge blanket.

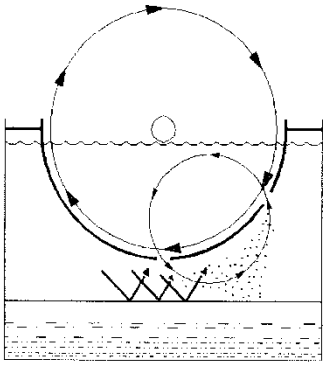


Figure d- unit operating with excess accumulations. Influent flows may disturb sludge blanket and increase BOD and solids loads to Rotorzone to levels above treatment design.

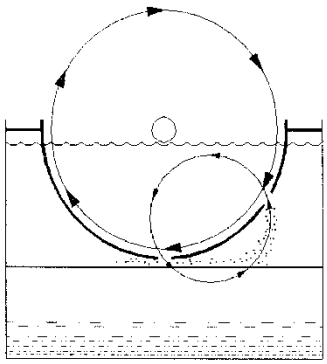


Figure e-Unit operating with excess sludge accumulated to base of Rotorzone. Both influent flows and re-circulation flows will disturb and carry sludge solids. Increase in BOD and solids loads entering Rotorzone will be substantially above design treatment levels, increase accumulated masses on rotating assembly, produce potential for damage to structure and drive unit.

3.6 - PUMPOUT PROCEDURES FOR ROTORDISK® TREATMENT SYSTEMS (summary)

Using suction hose, floating or surface scum should be removed first. Place the suction hose directly to the bottom of the tank and withdraw sludge only, while taking as little as possible of the volume of waste liquid above the sludge blanket (supernatant).

Move the hose at a multiple number of points along the bottom of the settlement tanks. Do not wash off biological growth (biomass) on the disks. The exception to this is excess accumulated biomass on the disks due to an overdue sludge pump-out. Excess accumulated biomass is when a disk bank is 100% fully covered with biomass and the colour is grey with a slight odour.

Keep a record of all pump-outs to arrive at an actual normal operating interval for sludge pump-outs. For systems with several flow meters, it is also beneficial to note the total flow generated between pump-outs.

3.7 - START-UP PROCEDURES OF ROTORDISK®

WARNING: A VALVE LOCATED AT THE BOTTOM OF THE DENITRIFICATION TANK AND EQUIPPED WITH A REMOTE ACTUATION MECHANISM WAS PROVIDED WITH YOUR UNIT. THIS VALVE:

- Needs to be OPEN: when the plant is first filled with water, during draining if the plant ever requires such operation and during subsequent refilling operations. FAILURE TO OPEN THIS VALVE DURING FILLING AND DRAINING WILL RESULT IN SERIOUS DAMAGE TO THE PLANT. This is because, during a filling operation, the water rising in the PST would push the denitrification tank upwards while it is empty (this tank wouldn't have had a chance to fill with water until the water level reaches the inlet slot between the PST and the aerobic ROTORDISK®. Th open valves provide a mean of filling the PST and the through (denitrification tank included) at the same time.

- Needs to be CLOSED: during normal operation of the plant. Indeed, the denitrification section contains water already partly treatment thus this water and that contained in the PST shouldn't mix. FAILURE TO CLOSING THIS VALVE DURING NORMAL OPERATION OF THE PLANT WILL RESULT IN A POOR QUALITY EFFLUENT.

The ROTORDISK® sewage treatment plant is based on a fixed film treatment process referred to as the Rotating Biological Contactor (RBC). In this process, micro-organisms or bugs are attached and grown on the surface of a media, the quantity of bugs being directly proportional to the amount of food in the wastewater. When starting up a new system, it will normally take about two weeks to get organic removal from the wastewater and three to four weeks to establish the nitrification process at normal domestic sewage temperatures. The method of and effluent discharge during system start-up should be discussed and thoroughly communicated with the environmental authority. The primary sedimentation tank and RBC of the system should, preferably, be filled with fresh water before admitting wastewater to the system. A flow less than design is not a problem. The biomass will develop themselves on the media. If there is a small flow only a portion of the disk will have biomass. As the flow increases the amount of biomass will increase.

Seeding a ROTORDISK® with activated sludge, although not required, can be accomplished. The activated sludge should be at the same temperature as the influent. Sudden changes in wastewater temperature cause biomass sloughing. In most cases, the use of domestic waste as a seed culture has provided the required biomass for continuous operation. When seeding the ROTORDISK® with activated sludge is decided, the primary sedimentation tank and RBC of the system should first be filled with fresh water (preferably) and the activated sludge added to the RBC. The RBC should be rotating at all times. The wastewater introduced to the tank needs to have only 20% of the disks covered with waste. This can already provide the needed wetting and still provide some time to reach normal operating levels when source flow is introduced. The final clarifier does not need to be filled with anything.

Alternately, seeding can be accomplished using dry bacteria and a source of organic carbon such as raw molasses or sugar. This can be done, for example, in situations where wastewater or activated sludge are not available and the plant needs to be ready to treat wastewater very shortly after it begins receiving it. By simulating the conditions encountered in wastewater (where large amounts of organic carbon and bacteria are present), biomass will establish on the ROTORDISK® and the plant can thus be prepared to work under actual conditions before these are actually encountered. SEPROTECH SYSTEMS INCORPORATED can help find appropriate supplies of both dry bacteria and raw molasses.

The preferred start up is the introduction of source wastewater at design or less than design loading. The disks need to be rotating at all times. When the disks are rotating and wastewater is introduced the biomass will develop and the pollutants will be removed.

The practice of starting up a sewage plant with a charge of septage or activated sludge may be appropriate for suspended growth systems where sludge return is an essential and necessary part of the process. However, start-up with septage is not an appropriate practice for fixed film systems such as the Rotating Biological Contactor process and is not recommended. This is especially true of the ROTORDISK® process and its static, internal storage of sludge.

Studies have shown that the natural start-up time for a ROTORDISK® is 2 1/2 – 3 weeks (normal temperatures and BOD reduction only), and that it has already developed sufficient biomass for 50% removals in only 1 week. These are time frames significantly shorter than respective ones for suspended growth systems. Thus there is little rationale for "pre-starting" a ROTORDISK® unit with septage.

Further, septage contains solids that are already well digested, and therefore not subject to further digestion-compaction in the storage zones. This contrasts to the fresh solids, which will undergo considerable digestion-compaction in the 6 – 9 months after initial settlement. Therefore, a charge of septage would contribute disproportionately to the accumulation of sludge levels, and necessitate a shorter interval to the first pump-out of the unit.

The ROTORDISK® concept of static sludge storage contributes greatly to its overall operation and maintenance simplicity. Following the above guidelines and recommendations will help ensure that the trouble-free simplicity of ROTORDISK® is maintained.

4.0 - STORAGE OF ROTORDISK® SEWAGE TREATMENT EQUIPMENT

If the unit is not to be operated for an extended period, then the motor-reducer assembly (drive unit) should be removed from its mound and stored at room temperature in a reasonably dry area (unless the whole unit is being stored in such an area).

Additionally:

1. Reducer: The input shaft should be given several turns once a month to re-lubricate the upper bearings.

NOTE: Some reducers are shipped to site filled with synthetic lubrication. Otherwise, fill the reducer with the lubricant (see reducer section of installation & maintenance instructions).

2. Motor: The motor has a tendency to take on moisture when not in operation. It requires no attention during storage, but before it goes into operation the insulation should be measured using a Meger. It should be at least 1.0 mega-ohm. If below 1.0 mega-ohm, it has taken on excessive condensation, and must be dried out before being operated. (Note: any electrical contractor or repair shop commonly understands these terms and procedures).

3. Support bearings on main ROTORDISK® shaft(s) should be re-lubricated prior to start-up.

4. The system should not be installed and operated in water. In the absence of sewage inputs and normal biological activity, freezing and consequent mechanical damage would be a distinct possibility. Water level in the primary settlement tank to be dropped to below the bottom of the Rotorzone tank level, if freezing of the tank contents is possible.

5.0 - ASSEMBLY PROCEDURE OF ROTORDISK® COMPONENTS SUPPLIED BY SEPROTECH SYSTEMS INCORPORATED

1. Upon receipt of mechanical components:

   a. Check packing list for any missing items on delivery.

   b. Motor/Reducer is shipped loose, for assembly on the reducer flange. The reducer is shipped completely filled with synthetic lubricant.

   c. Bearing components are shipped as a set. Open only when ready for assembly to avoid moisture contamination.

   d. Chain and sprockets are shipped as a set. Check for the following:

   -Large sprocket bushing (O.D.) fits into the large sprocket bore.
   -Large sprocket bushing bore (I.D.) fits the Rotordisk® shaft drive end.
   -Small sprocket bore (I.D.) fits on the reducer output shaft.
   -Cottered chain fits or matches the teeth on the sprockets.

   e. Coupling (applicable only to split-shaft ROTORDISK® is shipped as a set. Check the coupling hubs to ensure they fit the center stub ends of the ROTORDISK®shafts.

f. Disk banks are shipped pre-assembled on the shaft by SEPROTECH SYSTEMS INCORPORATED and are shipped on A-frames. Handle with care, as the Fiberglass of the disk banks is brittle.

g. Hardware (bolts, nuts, washers) for mounting the following items are provided:

-Bearings
-Reducer
-Recycle trough

2. If, for any reason, the diskbanks must be removed from the shaft, the procedure for remounting them is as follows:

If disk banks are 5 ft. in diameter or larger (supplied in semicircular sections)

Mount them on shaft(s) as shown on Dwg.# GL-28D, with 1/2-20NFX1-1/2 Bolts. Connect two half sections with two connecting plates (see sketch of typical mounting details) Remove outer nuts on required tie rods, fit connecting plate on tie rods over the end plates, then fasten them together with nuts and washers.

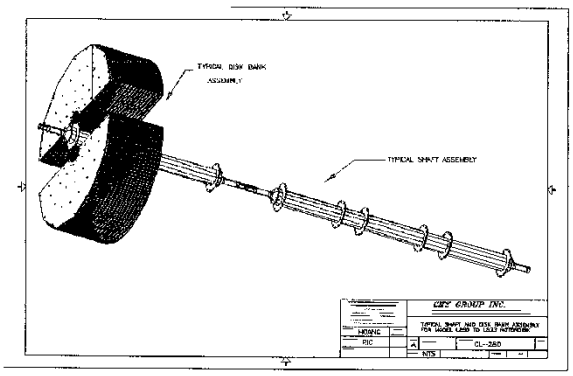


Figure f - typical mounting of disk banks on the shaft(s).

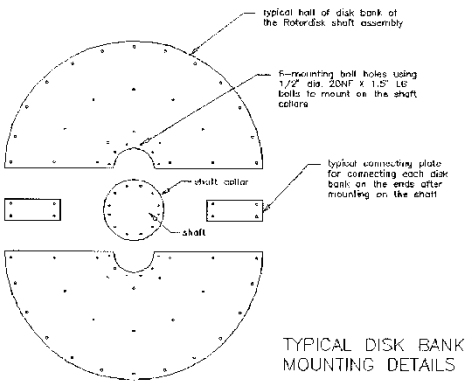


Figure g - exploded view of disk bank mounting parts.

3. Mount Bearings on Shaft(s).

   a) Bearing should be mounted at the centre of stub end. Follow bearing manufacturer's installation instructions.
   b) Use of the bearing fixing rings: one bearing of each pair is "fixed", the other "floating". Install the fixed bearing on the drive end of the shaft and the floating bearing on the non-drive end.

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in the manual, using a bearing locking tool or equal. See installation, operation and maintenance instructions section of this manual regarding bearings.

4. Mount coupling hubs on their respective shafts (if applicable) so that hub face is flush with the end of its shaft (for direct drive and 'L' models). See installation, operation and maintenance instructions section of this manual regarding couplings.

5. Install shaft(s) in ROTORDISK® tank.

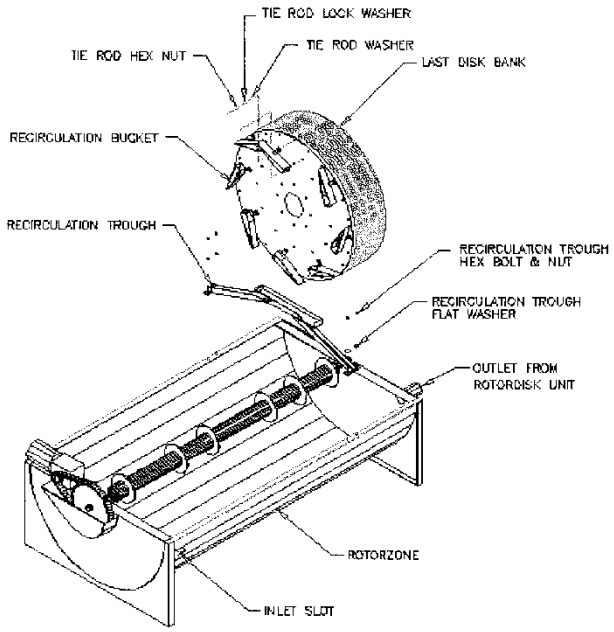
6. Mount small sprocket/coupling hubs on reducer output shaft (whichever is applicable).

7. Install Reducer-Motor Assembly in place. The reducer comes completely filled with synthetic lubricant. Ensure that the breather plug (mounted on top of one of the reducer oil intake ports) is installed on the reducer, after it is mounted on the ROTORDISK®. It is recommended that the motor be mounted into the reducer prior to assembly into the ROTORDISK® tank. Allow for some play in the reducer mounting bolt tightness so the chain tightness can be adjusted later.

8. Connect sprockets with chain. Check the axial alignment of the sprockets while tightening the chain. Tighten the previously loosened reducer mounting bolts after the sprockets are aligned and set in place. See installation, operation and maintenance instructions section of this manual regarding roller chain drives.

9. Connect two coupling hubs, grease, and fit coupling cover (if applicable). Before mounting, check bore on both hubs to match the shaft diameter. See installation, operation and maintenance instructions section of this manual regarding couplings.

10. Mount the stainless steel recycle trough on the ROTORDISK® tank with the bucket opening points to the proper rotation of the shaft.



NOTES:

1. Follow manufacturers instructions in the "Installation, Operation & Maintenance Manuals" included by SEPROTECH SYSTEMS INCORPORATED for mounting bearings, couplings (if applicable), reducer, sprockets and chain (if applicable).

2. Make sure all setscrews on sprockets and coupling hubs; bolts on reducer and bearings, are all well tightened before machine goes into operation.

6.0 - ROUTINE MECHANICAL MAINTENANCE OF ROTORDISK® SEWAGE TREATMENT PLANTS

6.1 - MOTOR:

If motor is equipped with grease fittings and relief plugs, it should be re-lubricated using a low-pressure gun once a year with Shell Alvenia R2" grease (DO NOT OVER-LUBRICATE). There is no lubrication required for motors without grease fittings and relief plugs

6.2 - REDUCER:

Reduction gear on ROTORDISK® units is filled with synthetic long life lubricant. No inspection or maintenance outside of periodic visual inspection is normally required. If there are no evidence of oil leaks on the seals, the synthetic lubricant must be changed every five (5) years for ROTORDISK® units running 24 hours a day.

Reduction Gear on medium and large ROTORDISK® size units are filled with Shell Tivela 75 oil and does not require oil changes (permanent lubrication). Periodic visual inspection is required. Check oil level and top up to required level with same oil, if necessary.

6.3 - BEARINGS:

Lubricant will deteriorate in time and rate of deterioration is a function of the operating conditions encountered. Lubrication cycle can be determined by analysing the samples taken near the bearing. See bearing manufacturer's maintenance instructions.

6.4 - SPROCKETS AND CHAIN:

(Applicable to non-direct drive ROTORDISK® units)

Chain drive should be inspected every six- (6) months for following points:
- If Chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated.
- Inspect oil for contamination, such as chips, dirt or grit. Replace oil if necessary (Oil with viscosity of SAE30 at ambient temperature 40° to 100° F is recommended).
- Milky white colour of the oil is indicative of flooding. Replace oil and determine the cause of the flood.
-Check Chain tension and adjust if required.

6.5 - COUPLING:

(Applicable for direct drive ROTORDISK®)

Coupling should be checked for lubricant level. Lubricant is to be added if required. Re-lubrication with NLGI#2 or LTG Grease once a year is usually adequate.

7.0 - TROUBLE SHOOTING

7.1 - MECHANICAL HARDWARE

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy chain	1. Loose chain 2. Faulty lubrication 3. Misalignment 4. Worn Parts 5. Moving parts rubbing stationary parts	1. Tighten chain 2. Lubricate properly 3. Correct sprocket alignment 4. Replace worn chain 5. Align & tighten chain to clear oil bath
Rapid wear on chain	1. Faulty lubrication 2. Loose or misalign parts	1. Lubricate properly 2. Align & tighten entire drive
Chain climbing sprockets	1. Worn out chain and sprockets 2. Loose chain	1. Replace worn out parts 2. Tighten chain
Stiff chain	1. Misalignment 2. Worn out chain or sprockets 3. Faulty lubrication 4. Rust corrosion	1. Correct alignment 2. Replace worn out parts 3. Lubricate properly 4. Clean and lubricate
Noisy Bearing	Rollers or bearings damaged	Replace bearing cartridge
Bearing grease discoloured or mixed with water	Insufficient grease in the bearings	Purge bearing with grease and increase lubrication interval
Hot bearing	1. Improper lubrication 2. Rollers or bearing race damaged	1. Purge bearing with grease and decrease lubrication interval 2. Replace bearing cartridge
Reducer temperature rises above 200 degrees Fahrenheit.	Oil level too high or too low	Maintain proper oil level
Oil leakage from reducer	1. Oil seals need to be replaced 2. Ventilators/breather plugged causing pressure build-up inside the reducer. 3. Oil level too high	1. Replace oil seals 2. Clean Ventilators 3. Correct oil level
Noisy reducer	1. Bearing failure 2. Misalignment in worm gear inside 3. Coupling between motor and reducer worn out and misalign	1. Check bearings and replace if necessary 2. Align worm gear shafts. 3. Replace coupling between motor and reducer. Align coupling hub vertically
Noisy Motor	Bearing damage	Replace damaged bearings
Motor overheating	1. Reducer overheating 2. Cooling fins on motor are clogged 3. Overload 4. Rotor rubbing on stator 5. Over greasing or lubrication	1. Check reducer 2. Clean fins 3. Check for excess friction or imbalance 4. Replace bearings 5. Avoid packing grease too tightly
Motor won't start	1. Power trouble 2. Single phasing at station 3. Fuse blown	1. Check source of power supply 2. Do not try to make it go and "fry" motor. Check starter windings 3. Replace fuse
Knocking/rumbling on motor bearings	1. Bearing worn due to lack of lubrication or excessive mechanical overload 2. Bearings slack in housing	1. Replace bearing and put new grease of recommended grade. 2. Fir new end shields
Rotordisk® shaft doesn't turn	1. Power failure 2. Motor failure 3. Reducer failure 4. Chain drive failure	1. Check power supply 2. Check and replace motor and bearings. 3. Check teeth worn gears and bearings. Replace necessary parts 4. Replace chain

7.2 - ROTORDISK® PROCESS

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
1. Slime on media appears shaggy with a brown colour	PROPER OPERATION	NO PROBLEM. NORMAL CONDITION
2. Black slime growing on disks	Solids and/or BOD overloading	a. Pre-aerate RBC influent b. For severe organic overloads, increase recycle rate c. De-sludge unit d. Place another RBC unit in parallel
3. Rotten egg or other obnoxious odors	Solids or BOD overloading	See Problem 2, solutions a, b, c and d, above
4. Development of odors and white biomass over most of the media surface	1. Septic influent wastewater or high hydrogen sulfide or sulfate concentration	a. Determine the cause of the problem and correct it at source. For example, aerate equalization tank b. Pre-aerate influent wastewater c. Determine the cause of the problem, possibly with the addition of chlorine or hydrogen peroxide; potassium permanganate has also been used
	2. Overload first stage	a. Check dissolved oxygen levels to confirm overload problem b. Increase number of recycle buckets
5. White slime	1. Bacteria that feed on sulfur compounds. Also, industrial discharges containing sulfur compounds may cause an overload	▪ See Problem 2, solutions a and b above
	2. Grease on the disks	a. Remove grease at source b. Install grease traps
6. Sloughing or loss of slime (biomass)	1. Toxic or inhibitory substances in influent, including abrupt pH changes	a. Eliminate source of toxic or inhibitory substances b. Reduce peaks of toxic or inhibitory substances by carefully regulating inflow to plant c. Dilute influent using plant effluent or any other source of water d. See Problem 7.4
	2. Variation in flow or organic loading	a. During low flow or loading periods, pump from secondary clarifier or 4th stage RBC unit effluent to recycle water with food and dissolved oxygen through the RBC unit b. During high flow or loading conditions, attempt to throttle plant inflow during peak periods c. For severe organic under loads, add a cheap source of soluble carbon in the PST such as molasses

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
7. Decrease in process efficiency	1. Reduced wastewater temperature	a. Decrease air opening in RBC building b. Heat air inside RBC unit cover or building
	2. Unusual variations in flow or organic loading	▪ See Problem 6, cause 2, solutions a and b above
	3. Sustained flows or loads above design levels	▪ Install additional treatment units
	4. High or low pH values	▪ Adjust pH to near neutral
	5. Improper rotation of media	▪ Inspect chain tension and adjust
8. Accumulation of solids and clogging in the RBC system	Solids removal in pre-treatment steps is not adequate	a. Improve pre-treatment efficiencies b. Provide supplemental aeration to help prevent solids from settling c. De-sludge primary tank
9. Floating or rising sludge in the secondary clarifier	Removal of sludge from the clarifier is inadequate	a. Increase the duration of pumping sludge from the clarifier b. Remove sludge from the clarifier more often
10. Excess shaft weight or biomass thickness	1. Organic loading too high	▪ Decrease organic loading
	2. Stage loading too high	a. Increase number of recycle buckets
	3. Inorganic solids accumulation because of inadequate pre-treatment	▪ Check primary treatment and grit removal equipment for proper operation
	4. Accumulation of minerals	▪ Use chemical pre-treatment to eliminate minerals
	5. Digester supernatant adding excessive BOD or sulfides	▪ Modify supernatant pumping frequency
11. Shaft rotation non-uniform or "jerky"	1. Normal variations in balance	▪ Time rotation by quarters. A difference of less than 3 seconds in quarter rotation time is normal
	2. Uneven biomass weight due to power outage	a. If severe, shut unit down and wash down disks b. Turn off the unit temporarily and rotate manually to uniformly wet biomass growth before restarting c. Decrease or stop flow of wastewater to affected units d. Contact manufacturer for assistance

ROTORDISK® TROUBLESHOOTING GUIDE

Problem	Cause	Corrective Action
12. Effluent quality apparently below requirements	1. Organic loading too high	a. Add additional operating RBC's b. Identify cause of additional loading and eliminate at source c. Add supplemental air to RBC trough
	2. Sampling or testing procedures inaccurate	a. If nitrification is occurring, analyze for carbon BOD only by using nitrification inhibitor b. Check for contaminated dilution water, sampler lines, or improper sampling storage
	3. Inadequate secondary clarifier operation	a. Clean and de-sludge clarifier b. Modify sludge removal procedures to eliminate BOD kickback c. Install filters after clarifier d. Increase alum dose to enhance flocculation
	4. Anaerobic solids in the RBC tanks producing BOD kickback	▪ Flush or drain tanks
13. Snails or other nuisance organisms in RBC tanks	Nutritional and conducive environment for reproduction of hard-bodied shell snails ($\frac{1}{8}$" - $\frac{1}{2}$" in size)	a. Addition of controlled dosages of chlorine. Physical removal may be required with taking units out of service temporarily b. Contact manufacturer

Contact SEPROTECH SYSTEMS INCORPORATED for advice on how to resolve problems related to the process before making changes to the process or equipment.

Adapted from Water Pollution Control Federation "Manual of Practice OM-10", 1988.

8.0 - MAINTENANCE PROGRAM – Do's and Don'ts

8.1 - DO'S

1. Do use biodegradable soap if at all possible. The system will, however, handle a certain amount of normal soap. When laundering clothes, please follow manufacturer's instructions regarding quantity of detergent. Excessive use of detergent can cause odour in the system.

2. Do put large amounts of grease in a container and dump in garbage. The system will handle a certain amount of fat and grease. If a tile bed is used and if fats and grease get into it, they may plug the pores of the soil and seal up the bed. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

3. Have your system pumped out a minimum of once a year to remove sludge and scum to maintain top operating treatment in your system and filter bed.

4. For small systems equipped with a service hatch, keep the service hatch above the ground. Do not let run-off water enter system, as this will cause hydraulic overload.

5. If a tile bed is used, do keep traffic such as cars, snowmobiles, etc., away from the system bed areas as they will break pipes and seal the soil over the bed.

6. If a tile bed is used, do leave the raised filter in place without disturbing it. The filter is specifically designed to provide maximum dispersal of the water. Altering it by adding fill, covering it up or changing in any way may destroy its water dispersal characteristics and result in bed failure.

7. If a tile bed is used, do encourage a growth of ground cover over the filter bed as it helps disperse water by evaporation and transpiration.

8.2 - DON'Ts

1. Do not put non-biodegradable materials downs the drain, put them in the garbage, these include any plastics, rubber, disposable diapers, sanitary napkins, rubber goods, cigarettes, children's toys, cellophane, etc. They will plug the system, and a pump out will be needed.

2. Do not put harsh chemicals down the drain. They will kill the bacteria necessary for efficient treatment. These include acid or caustic cleaners, gasoline, oil, turpentine, photographic chemicals, etc. Disinfectant and chlorine bleaches should be kept to domestic uses.

3. Do not leave taps running or faulty toilets. The excess water may overload the system and, if used, tile field causing breakout and poor treatment.

4. If you do not have access to workers with appropriate training, do not attempt to fix the mechanical parts yourself. Your dealer is trained to repair your plant and work safely with electrical and mechanical components. Call him if you have a problem or concerns.

5. Do not connect any other electrical load to the fuse or breaker feeding the plant as it will cause damage to the controls.

6. Never put large amounts of grease (i.e. old grease from deep fryer) into the sewer lines.

YOUR CO-OPERATION WITH RESPECT TO THE ABOVE POINTS SHOULD ENSURE TROUBLE-FREE OPERATION OF YOUR TREATMENT PLANT AND WILL BE GREATLY APPRECIATED.

9.0 - INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR VARIOUS MECHANICAL PARTS OF THE ROTORDISK® AND OTHER EQUIPMENT SUPPLIED

9.1 - INSTALLATION & MAINTENANCE DETAILS FOR ROLLER CHAIN DRIVES

CHAIN TENSIONING:
The proper fit of a chain may be obtained by adjusting the sprocket centres. When a chain is correctly tensioned, the total mid-span movement (double amplitude) in the slack span should be 4-6% of the span length for normal drives.

Where there is no adjustment means, adjustment may be made by removing links to compensate for elongation due to wear (Drives with fixed centres). Proper lubrication and proper drive maintenance may minimize chain wear.

LUBRICATION:
Although many slow-speed drives operate successfully with little or no lubrication beyond the initial factory lubrication, proper lubrication will greatly extend the useful life of every chain drive.

A good grade of clean petroleum oil without additives, free from flowing at the prevailing temperatures should be used.

Chain drives should be protected from abrasive and corrosive conditions, and the oil supply kept free of contamination. Periodic oil change is desirable. The lubricant viscosity recommended for ambient temperature 40° - 100°F is SAE 30.

OIL BATH:
With bath lubrication, the lower strand of chain runs through a sump of oil in the drive housing. The oil level should reach the pitch line of the chain at its lowest point while operating. Only a short length of chain should run through oil.

INSTALLATION RECOMMENDATIONS:
Shafting, bearings and foundations should be supported rigidly to maintain the initial alignment. Roller chain should be free of grit and dirt. Wash the chain in kerosene when required. Re-lubricate!

Misalignment results in uneven loading across the width of the chain and may cause roller link-plate and sprocket tooth wear. Drive alignment involves two things:

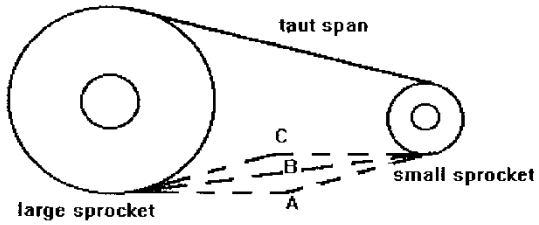
a) Parallel shaft alignment: Shafts should be parallel and level.
b) Axial sprocket alignment: Sprocket axial alignment can be checked with a straight edge, which will extend across the finished sides of the two sprockets.

Normally, it is good practice to align sprockets as close to the shaft bearings as possible.

Installing the Chain: Recheck all preceding adjustments for alignment and make sure all setscrews, bolts and nuts are tight. Fit chain around both sprockets and bring free ends together around one sprocket for connection.

Chain Tension: Check chain tension to be sure that the slack span has 4-6% mid-span movement in horizontal drives.

Recommended Possible Mid-Span Movement AC									
Drive	Tangent Length Between Sprockets								
Center-Line									
	5"	10"	15"	20"	30"	40"	60"	80"	100"
Horizontal to 45	.25"	.5"	.75"	1"	1.5"	2"	3"	4"	5"
Vertical to 45	.12"	.25"	.38"	.5"	.75"	1"	1.5"	2"	2.5"



AC = Total Possible Mid-Span Movement
Depth of Free Sag = .866 AB, approximately

MAINTENANCE RECOMMENDATIONS:

Regular maintenance schedules should be followed for all chain drives. Each drive should be inspected every six months. At each inspection period the following points should be checked:

a) Check Lubrication: If chain is covered with grit or chips, it should be cleaned in kerosene and re-lubricated before reinstalling. With bath lubrication, oil should be maintained at the proper level, as shown in lubrication instructions. Add oil if necessary. At each inspection, oil should be checked for contamination, such as chips, dirt or grit.

b) Check sprocket alignment: If the chain is properly aligned, no wear will show on the inner surfaces of the chain roller link-plates. If wear is apparent, this is evidence that sprockets are misalign and should be realigned as outlined in the installation instructions to prevent further chain and sprocket wear.

c) Check sprocket tooth wear: If sprocket shows evidence of wear high on the sprocket teeth, this is evidence of excessive wear in the chain and the chain should be replaced. If the sprocket teeth are severely worn, the sprocket should be replaced. Do not run new chain on worn sprockets.

d) Check chain tension: At each inspection period, the chain tension should be adjusted. If excessive slack has accumulated which cannot be removed by available shaft centre adjustment (i.e. by moving reducer away from large sprocket using chain tensioning bolts), two or more pitches of chain should be removed and chain reconnected.

9.2 - PROCEDURE FOR ASSEMBLING BEARINGS AND PILLOW BLOCKS

Shaft Preparation
Clean shaft and remove any burrs or sharp edges. Check the shaft diameter to given specifications.

Seal Installation
Place seal, which consists of: Double lip 'G' type seal

9.2.1 - MOUNTING OF BEARING ON SHAFT

Adapter Sleeve Mounting
Position adapter sleeve on the shaft to correct location with respect to required bearing centerline. A smear of lubricating oil (SAE 10 or 20) applied to the sleeve outside diameter surface results in easier bearing mounting and removal. (For pillow blocks mounted close to a pulley hub or similar obstruction, mount the adapter sleeve with threads inboard for easy removal. Remember to slide lock-nut, lock-washer and bearing onto the shaft before positioning the sleeve.)

NOTE: All bearings mounted on tapered sleeves have to be driven up the taper to the tolerances given in SKF tables, to ensure correct fits. Spherical roller bearings can be measured between the unloaded rollers and the outer ring sphere surface.

Un-mounted Clearance, Spherical Roller Bearings
Measure the un-mounted internal clearance in the bearing by inserting and sliding progressively larger feeler blades the full length of the roller between the most vertical unloaded rollers and the outer ring sphere. Never run the rollers over the feeler blade, as the wrong value will be obtained. Record the measurement of the largest size blade that will slide through. This is the un-mounted internal clearance.

Bearing
Mount the bearing hand tight on the adapter sleeve. Be sure the large end of the bore of the inner ring matches the taper of the adapter. To avoid damage to the bearing it is most important during this and subsequent operation that the shaft is blocked up so the bearing is unloaded. Do not apply lock-washer. Drive up procedure may damage it.

Bearing Drive Up, Spherical Roller Bearings
Lubricate the face and thread of the lock nut and apply to sleeve with chamfered face toward the bearing. Tighten the lock nut. Do not attempt to tighten the lock nut with a hammer and drift (use proper wrenches), the lock nut can be damaged and chips can enter the bearing. Further tighten the lock nut and measure the internal clearance until the internal clearance is less than the un-mounted clearance figure by the amount shown in the attached table (see last page). Finally, remove lock nut, position lock washer with outer tangs facing away from the bearing, and inner tang properly seated in the slot provided in the adapter. Replace lock nut and tighten until firmly seated.

9.2.2 - PREPARATION OF PILLOW BLOCK HOUSING

Check to be sure all pillow block parts are free of burrs and are completely clean. Internal surfaces should be removed. Apply a thin coat of grease to the bearing seat in the base. Fit the bearing and seal inserts into the pillow block base, being careful not to damage to O-rings. For assembling larger sizes where hoists must be used, it may be convenient to seat both bearings into their housing bases simultaneously.

FIXING RINGS

On each shaft one bearing is generally "Held" and other bearings are "Free", to permit shaft expansion. For "Held" bearing housings, use two fixing rings. Place one on each side of bearing.

CAPPING THE PILLOW BLOCK

Place the cap on the base so that the dowel pins in the base align with the holes in the cap, being careful not to damage the O-rings. Caps and bases are not manufactured for interchangeable assembly. They must be kept together. Install cap-bolts with lock washers and tighten securely.

GREASE LUBRICATED BLOCKS

Lubrication Notes

Grease Lubrication

If grease is used as a lubricant, it should be smeared between the rolling elements and worked in. The lower half of the housing should be packaged $^{1}/_{2}$ to $^{3}/_{4}$ full.

9.2.3 - PROCEDURE FOR APPLYING LUBRICANT TO BEARINGS AND PILLOW BLOCKS

Pack each bearing as completely full of the specified grease as possible by swiveling the outer ring open and rotating it as necessary to inject the grease. Then, swivel the outer ring closed being careful not to use force in the event a roller end catch the corner of the outer ring sphere.

B) Before assembling the pillow block cap to the base, and after completing bearing and base assembly, fill $^{1}/_{2}$ to $^{3}/_{4}$ of the pillow block base with the same lubricant that was used to pack the bearing.

9.2.3.1 - LUBRICATION PROCEDURE TO BE USED AT START-UP

A) All pillow block assemblies that have not been prepared for stage are ready for use, assuming the installation procedures have been correctly followed.

B) While shaft is rotating, lubricate each seal through the outside lubricant fittings until grease is seen emerging from the labyrinth areas. Make sure the outside of the lubricant fitting is clean before applying grease.

9.2.3.2 - RE LUBRICATION

Lubricants deteriorate in time, and the rate of deterioration is a function of the lubricant used at the operating conditions encountered. Determining the re-lubrication cycle depends on sampling the grease and analysis of the samples. Provisions must be made to adequately evaluate the contamination by solids. Samples for grease evaluation should be taken from near the bearing, and evaluation of the samples should dictate the re-lubrication cycle.

Remove caps once a-year and re-apply new grease.

Each seal assembly should be lubricated once a month, while the bearing is rotating, with the same grease that is used in the bearing.

9.3 - GREASE CLASSIFICATION

		Oil Viscosity Saybolt Second (approx. SSU)		
Class	Type of Base (1)	@ 100 F	@ 210 F	NLGI (2) Grade
A	Lithium or Equal	200 - 500	48 – 55	0
B	Lithium or Equal	400 - 600	58 – 68	1
C	Lithium or Equal	800 - 1,000	75 – 82	1
D	Lithium only	800 - 1,000	75 – 82	2

	Grease requirement from above			
Operating temperature of bearing (4)	Low (5)	Medium	High	Suggested Re-lube cycle
0 – 70	A or B			6 – 12 months
70 – 120	B or C			6 – 12 months
120 – 160	B or C	C or D (6)	D (7)	2 - 3 weeks
160 – 200	C	C or D (6)	D (7)	1 - 4 weeks

1) Calcium Complex Greases NOT recommended for spherical roller bearings.

2) National Lubricating Grease Institute Consistency Code.

3) Definition of speed categories:
Low: up to 1/4 of catalog speed limit for static oil lubrication.
Medium: 1/4 to 1/2 catalog speed limit for static oil lubrication.
High: 1/2 to full catalog speed limit for static oil lubrication.

4) Consult SKF Engineering if temperature is below 0° or above 200°F.

5) Extremely slow speed will require special consideration if loads are high.

* Under all conditions, application should be checked using the SKF lubricant film parameter found in the Engineer Data Catalog.

6) Use type "C" where load is heavy, 15,000 hours-rating life or less and/or speed are less than RPM.

7) Consult SKF Engineering - Grease lube not normally recommended under this combination of operating conditions.

8) Dry clean applications only. For moderate conditions of dirt and/or moisture, use cycle of 1 to 2 months. For extreme conditions of dirt and/or moisture, use cycle of 1 week. Vertical applications normally require shorter than normal re-lube cycle.

9) Never mix greases with unlike bases.

10) Remove old grease at least once a year.

10 - LIMITED WARRANTY

SEPROTECH SYSTEMS INCORPORATED warrants the parts in each treatment plant to be free from defects in material and workmanship; for a period of 15 months from shipment or 12 months from start-up, whichever occurs first, in the treatment of domestic wastewater. Sole obligation under this warranty is as follows:

SEPROTECH SYSTEMS INCORPORATED shall fulfil this warranty by repairing or exchanging any component part, F.O.B. our factory, that in SEPROTECH SYSTEMS' judgement, shows evidence of defects, provided said component part has been paid for and is returned through an authorized dealer, transportation prepaid. The warranty must also specify the nature of the defect to the manufacturer. New placed parts are under warranty for one year.

The warranty does not cover treatment plants that have been flooded, by external means, or that have been disassembled by unauthorized persons, improperly installed, subjected to external damage or damage due to altered or improper wiring or overload protection.

This warranty applies only to the treatment plant and does not include any other electrical wiring, plumbing, drainage, or disposal system. SEPROTECH SYSTEMS INCORPORATED is not responsible for any delay or damages caused by defective components or material, or for loss incurred because of interruption of service, or for any other special or consequential damages or incidental expenses arising from the manufacture, sale, or use of this plant.

SEPROTECH SYSTEMS INCORPORATED reserves the right to revise, change, or modify the construction and design of the treatment plant for domestic wastewater or any component part or parts thereof without incurring any obligation to make such changes for modifications in previously sold equipment. SEPROTECH SYSTEMS INCORPORATED also reserves the right, in making replacements of component parts under this warranty, to furnish a component part, which, in its judgement is equivalent to the Company part replaced.

Under no circumstance will SEPROTECH SYSTEMS INCORPORATED, be responsible to the warrantee for any other direct or consequential damages. Including but not limited to; lost profits, lost income, labour charges, delays in production, and/or idle production, which damages are caused by a defect in material and/or workmanship in its parts.

This warranty is expressly in lieu of any other expressed or implied warranty, excluding any warranty of merchantability or fitness, and of any other obligation on the part of SEPROTECH SYSTEMS INCORPORATED.

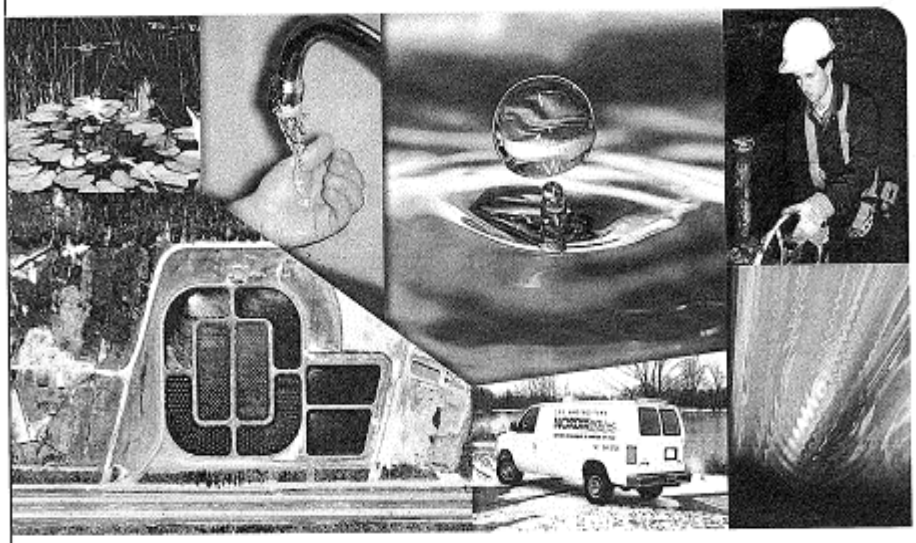
Appendix B: NORDIKeau Technical Support Manual

ORIGINAL

AEM

Agnico-Eagle Mines

TECHNICAL SUPPORT
SECTION 2



NORDIKeau INC.

EXPERTS TECHNIQUES EN GESTION DE L'EAU

HEAD OFFICE
603, Base-de-Roc Blvd
Joliette (Québec) J6E 5P3
Tel: (450) 756-6227
Fax: (450) 756-8313
nordikeau@bellnet.ca
www.nordikeau.com

50255 / JUNE 2010

ORIGINAL

AEM

Agnico-Eagle Mines

TECHNICAL SUPPORT
SECTION 2

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

HEAD OFFICE
603, Base-de-Roc Blvd
Joliette (Québec) J6E 5P3
Tel: (450) 756-6227
Fax: (450) 756-8313
nordikeau@bellnet.ca
www.nordikeau.com

50255 / JUNE 2010

AGNICO EAGLE

TECHNICAL SUPPORT
SECTION 2

Written by :

Yves Payette
Yves Payette, T.A.E. Sr

Approved by :

Frédéric Rubin-Delanchy
Frédéric Rubin-Delanchy, assistant general manager

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU
603, Base-de-Roc Blvd
Joliette (Quebec) J6E 5P3

June 30th, 2010
(N/Réf. : 50255)

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

TABLE OF CONTENTS

1. INTRODUCTION 1

2. PROCESS DESCRIPTION & DESIGN CHARACTERISTICS 2

2.1 Process description 2
2.2 Design characteristics 3
2.3 Effluent characteristics and performance guarantee 5

3. DESCRIPTION AND OPERATION OF THE SEWAGE TREATMENT 6

3.1 Basic description of the sewage treatment plant 6
3.2 Operation procedure 9
3.2.1 Lifting station n° 1 9
3.2.2 Lifting station n° 2 9
3.2.3 Equalization tank 10
3.2.4 Rotating biological contactors (RBC) 13
3.2.5 U.V. Disinfection system 24
3.2.6 Lifting station n° 3 33

4. PROCESS CONTROL 34

4.1 Summary 34
4.2 Sampling procedures 35
4.3 Sampling points location 36
4.4 Analysis results interpretation 37
4.4.1 Independent laboratory analysis results 37
4.4.2 On site analysis results 40
4.5 Other process interpretations 42
4.5.1 Observing the media 42
4.5.2 Smell 44
4.5.3 Observing the clarifiers and final effluent 44
4.5.4 Determination of the sludge blanket 45
4.6 Process parameters 45
4.6.1 Percent Removal Calculations 45
4.6.2 Organic loading 46
4.7 Process troubleshooting guide 47

5. TROUBLESHOOTING GUIDES 55

5.1 MOTOR AND GEARBOX – BIODISK L333 55
5.2 TROJAN UV 3000 – BIODISK L333 55
5.3 PYROTENAX INDUSTRIAL HEAT TRACING – BIODISK LJ-100 55
5.4 SEVERN TRENT ULTRADYNAMIC UV SYSTEM – BIODISK LJ-100 55
5.5 GREY LINE FLOWMETER DFM 4.0 - EQT 55
5.6 YSI ENVIRONMENTAL – YSI 550A DISSOLVED OXYGEN METER 55
5.7 HACH – SENSION 6 DISSOLVED OXYGEN METER 55

6. RECORD KEEPING 56

APPENDIX

Appendix A MOTOR AND GEARBOX – BIODISK L333
Appendix B TROJAN UV 3000 – BIODISK L333
Appendix C PYROTENAX INDUSTRIAL HEAT TRACING – BIODISK LJ-100
Appendix D SEVERN TRENT ULTRADYNAMIC UV SYSTEM – BIODISK LJ-100
Appendix E GREY LINE FLOWMETER DFM 4.0 - EQT
Appendix F YSI ENVIRONMENTAL – YSI 550A DISSOLVED OXYGEN METER
Appendix G HACH – SENSION 6 DISSOLVED OXYGEN METER

1. INTRODUCTION

The operations manual is a practical guide for the operation and maintenance of the wastewater treatment system, Rotating Biological Contactors type, installed on the Meadowbank mine site to treat domestic effluents from the Main Camp and Nova Camp.

This manual is intended both to the operator and technical supervisor. It aims to collect and condense specific data of works in place. Whenever possible, information available on previous works has also been collected and grouped together to present the most coherent overall.

Typically the operations manual contains the main works components, and described its function, its characteristics and its operation. The equipments mechanical maintenance is briefly discussed, most often in reference with documents provided by the supplier. Finally, it also includes a method and tools to follow and document the works' functioning, including information that must appear in the Daily Operation Logbook.

The operations manual has been prepared assuming that the staff assigned to the building installations has a basic knowledge in wastewater treatment and possesses the necessary qualities and skills to plan and carry out all operating tasks, process control, and maintenance grouped in this manual.

The operator plays a key role and represents a factor in:

- The quality of treated water, in connection with the disposal requirements to be met, among others;
- the optimization of the operation that can significantly reduce costs (electricity, chemicals);
- the quality of equipment maintenance which, in turn, directly affects both short-term costs (repairs) and the medium and long term (parts or equipment replacement).

2. PROCESS DESCRIPTION & DESIGN CHARACTERISTICS

2.1 Process description

Rotating biological contactors (RBC) were originally developed in Europe and recently accepted by America and Asia. The process system is primarily a fixed-film biological reactor consisting of a synthetic medium mounted on a horizontal shaft and place in a contour-bottomed tank. The general concept of rotating biological contactors is to let wastewater flow through the tank, and to rotate the medium in the wastewater to be treated, alternatively exposing the medium (and the attached biological growth) to air and the wastewater. The slowly rotated media are 40% immersed in the wastewater for aerobic removal of organic waste by the biological film developing on the media. The lattice-structured medium, and to a lesser extent the disc structure, is fragile and should be protected from direct exposure to wind, sun, and weather fluctuation. Therefore, the media are usually enclosed in a superstructure or individual shaft covers.

Media rotation can be provided by either mechanical drives or air-motivated rotation. Rotation not only results in exposure of the film to the atmosphere as a means of aeration, but also provides rotational shear forces for stripping off the excess biomass on the medium. The stripped biological solids are maintained in suspension by the mechanical mixing action of the rotation medium or by supplemental diffused air, depending on the driving force of rotation. The air-driven system, in rotating the media by diffused air generated near the thank bottom, alleviates the development of undesirable anaerobic conditions, and also reduces the oxygen limitation, which often is the limiting factor in biological oxidation.

The most important factor affecting performance of the rotating biological contactors is the biological slime of those microorganisms that grow on a series of thin media, such as disc, mounted side by side on a shaft. When the process is first started, the microorganisms in the wastewater begin to stick to the medium surfaces and grow there until all the media are covered with a 1/16 to 1/8 in layer of biological slime. The attached biomass is similar to the biofilm in a trickling filter, except that the microorganisms are passed through the wastewater rather than the wastewater being passed over the microorganisms. As with all biological units, alkalinity, pH, nutrients, temperature, oxygen, biomass population balance, concentrations of pollutants, and so on, must be acceptable for efficient operation.

Most organisms cannot tolerate pH levels above 9.5 or below 4.0. In general, the optimum pH for biological growth lies between 6.5 and 7.8 for carbonaceous oxidation, between 8.2 and 8.6 for nitrification (12), and between 7.2 and 7.8 for denitrification. An alkalinity deficit can result from nitrification; thus a supplemental alkalinity source may be required. The inorganic nutrients normally present in domestic wastewater are sufficient to assure maximum biological growth, provided that all other environmental conditions are optimum. The nutrient needs should be checked when there is a significant industrial waste contribution. A suggested ratio of BOD_5:N:P is 100:5:1. Wastewater temperatures between 13 and 32 °C have no significant effect on process performance. The treatment efficiency, however, decreases with decreasing wastewater temperature below 13 °C. For year-round operation in warm climates, a simple sun roof is sufficient protection; whereas for year-round operation in cold climates, rotating biological contactor plants should be weatherproofed.

To achieve high treatment efficiency, the wastewater should be maintained under aerobic conditions throughout the entire treatment system for carbonaceous and nitrification. It is suggested that a minimum of 1 to 2 mg/L of dissolved residual oxygen be maintained in the tank to prevent oxygen deficiencies from limiting the substrate removal rate.

Each shaft of medium operates as completely mixed, fixed-film reactor, I which the biological growth rate and the excess biomass stripping rate are at dynamic equilibrium. As the treated wastewater and the stripped biomass pass from stage to stage, the wastewater undergoes a progressively increased degree of treatment by the specific biomass found in each stage, which in turn adapt to the changing wastewater. Microorganisms in the initial stages of a medium, which receive the highest concentration of organic wastes, are mainly ordinary bacteria responsible for carbonaceous oxidation. Higher life forms, such as nitrifying bacteria, protozoa, rotifers, and other predators, begin to appear in subsequent stages, where the concentration of organic substances gradually decreases form stage to stage.

2.2 Design characteristics

The sewage treatment plant (STP) has been designed to meet environmental requirements and site conditions.

The STP design includes two (2) parallel biodisks units and has been based on the following characteristics:

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

DESCRIPTION	L 333	LJ 100	Total
Number of unit	1	3	4
Average Daily Flow	105 m³/d	3 x 27,5 m³/d	188 m³/d
Peak Hour Flow	4 x design	4 x design	4 x design
Influent BOD_5			250 mg/L
Total Suspended Solids (TSS)			250 mg/L
Total Ammonia			35 mg/L
Outdoor temperature			-40 to +40 °C
Indoor temperature			10 to 25 °C
Operating			24 hr / 365 day
Process details			
Hydraulic loading	105 m³/d	3 x 22,62 m³/d	173 m³/d
Bio support media area	3390 m²	3 x 487 m²	4851 m²
Bio support media diameter	2,44 m	1,63 m	
Primary clarifier capacity	73,09 m³	3 x 6,82 m³	93,55 m³
Final clarifier capacity	24,72 m³	3 x 3,88 m³	36,36 m³
Biozone capacity	18,12 m³	3 x 3,43 m³	28,41 m³

2.3 Effluent characteristics and performance guarantee

The STP has been designed to meet the effluent characteristics shown in table 2.1 below.

Prior to the construction of the Tailing Storage Facility, the License shall direct the effluent from Stormwater Management Pound to the monitoring station ST-35, to the northwest arm of Second Portage Lake and not exceed the government quality limits shown in table 2.1.

TABLE 2.1 EFFLUENT CHARACTERISTICS AND PERFORMANCE GUARANTEE

PARAMETER	STP Design	Government effluent quality limits	
	Monthly average	Monthly average	Grab sample
BOD_5	15 mg/L	25 mg/L	50 mg/L
TSS	15 mg/L	25 mg/L	50 mg/L
Fecal Coliforms	200 / 100 mL	1000 / 100 mL	2000 / 100 mL
Temperature	10 °C		
pH		6,0 to 9,5	6,0 to 9,5

3. DESCRIPTION AND OPERATION OF THE SEWAGE TREATMENT

3.1 Basic description of the sewage treatment plant

The sewage treatment plant has been designed to treat domestic wastewaters coming from the Main Camp and Nova Camp. As shown in Figure 1, treatment works include the following components:

- **Lifting station n° 1**

  Pumping station n° 1 is adjacent to the Main Camp. It receives grey waters coming from the kitchens and the laundry. A screen basket is installed in front of the inlet pipe to hold the unrefined wastes. These waters are currently pumped downstream to the STP, directly in pumping station n° 3 (LS-3), which insures the pumping of all effluent (treated or not) toward the Tailing Storage Facility.

- **Lifting station n° 2**

  Pumping station no 2 (LS-2) is adjacent to the STP. It receives sanitary wastewaters (washbasins, toilets, showers) coming from dormitories of Main Camp and, still to confirm, Nova Camp. These waters are pumped in the Equalization Tank (EQT) to be processed.

- **Equalization tank**

  The equalization tank (EQT) allows lopping flow peaks of the day. Wastewaters accumulated in this tank are pumped in constant flow towards the rotating biological contactors (RBC). The EQT is currently equipped with four (4) pumps. Pumps P-1 and P-2 send wastewaters towards LJ-1 and LJ-2 RBC, while pumps n° 5 and n° 6 are pumping wastewaters toward RBC L333.

- **Rotating biological contactors (RBC)**

  The RBC secondary treatment system is a fixed culture treatment process. The biological contactor (Rotorzone) is made of several thin plastic disks assembled around a horizontal axis. Microorganisms responsible for the degradation are naturally fixed to the disks and form a biofilm of about 1 to 4 mm of thickness. Approximately 40% of the disks surface is immersed. The disks' rotary movement around the axis alternately exposes the biomass to the atmosphere and the wastewaters, allowing the aeration and wastewaters mixing. The shearing forces created by the rotary movement limit the biofilm's thickness and lead to a

detachment of the excess biomass, which is then separated from the effluent with the help of a secondary settling tank (*final clarifier*).

A primary treatment system composed of a settling tank (*Primary tank*) is located under the biological contactor to hold fibrous solids, greases, scum, and other unwanted waste subjected to hang on to the disks.

The treatment system is composed of four (4) biodisks:

- One (1) unit SEPROTECH L333 designed to treat a 105 m^3/d daily flow.
- Three (3) units LJ-100 (one is not started yet) designed to treat an 83 m^3/d daily flow (27, 5 m^3/d per unit).

- **UV disinfection**

The wastewaters disinfection by ultraviolet radiation is the last stage of treatment before the treated waters is discharged towards the Tailing Storage Facility. It consists of sending wastewaters through a reactor composed of mercury vapor lamps emitting UV radiations. The radiations have the characteristic to inactivate the microorganisms.

The treatment system is composed of three (3) UV lamps:

- One (1) unit TROJAN, UV3000 PTP model, installed at the exit of biodisk L333
- Two (2) units SEVERN TRENT, ULTRADYNAMICS model, currently installed at the outlet of biodisks LJ-1 and LJ-2. Currently, these units are not in service.

- **Lifting station n° 3**

Pumping station n° 3 is located inside the WTS. It currently receives the final effluent of the STP and untreated grey waters from Main Camp and Nova Camp. Two (2) submersible pumps assure the pumping of these waters towards the Tailing Storage Facility.

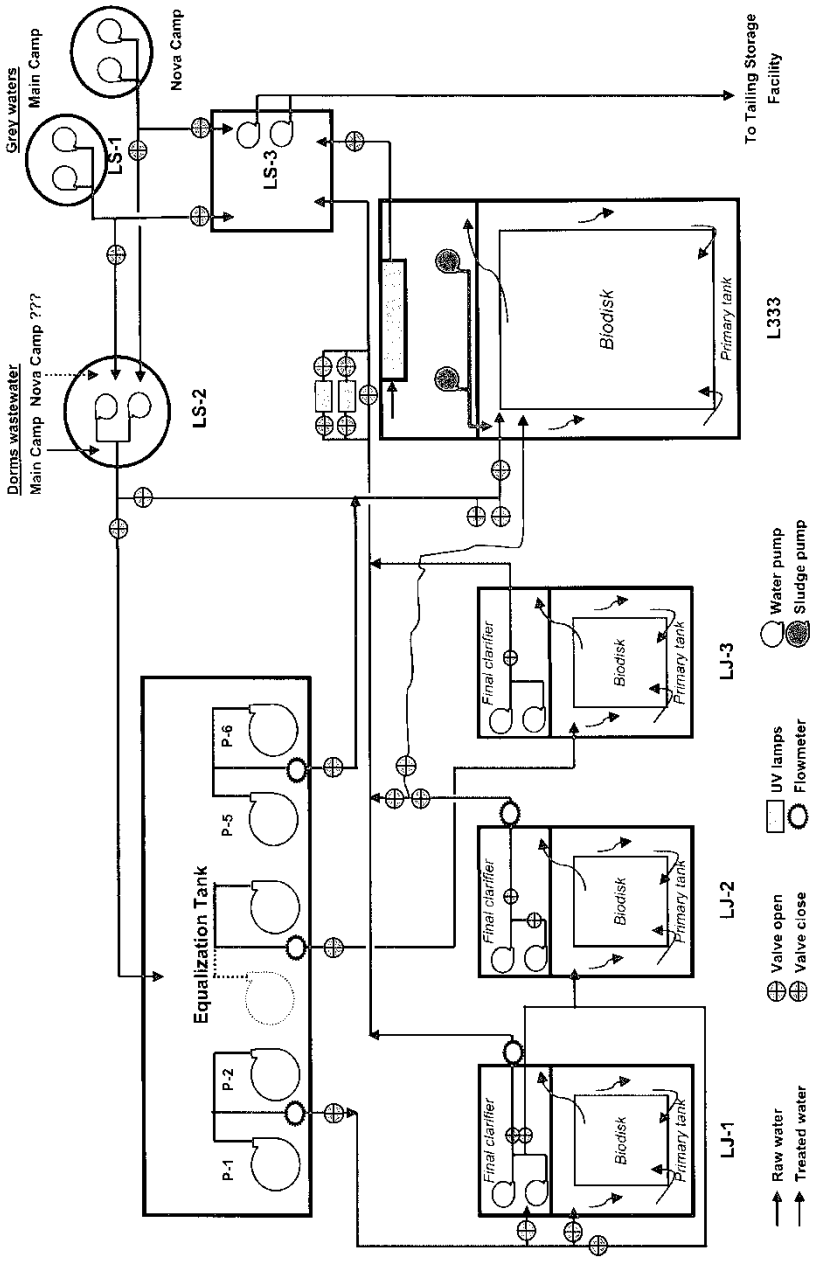


FIGURE 3.1: FLOWSHEET

3.2 Operation procedure

3.2.1 Lifting station n° 1

Pumping station n° 1 is adjacent to the Main Camp. It receives grey waters coming from the kitchens and the laundry. A screen basket is installed in front of the inlet pipe to hold the unrefined wastes. These waters are currently pumped downstream to the STP, directly in pumping station n° 3 (LS-3), which insures the pumping of all effluent (treated or not) toward the Tailing Storage Facility.

The lifting station is equipped with two (2) MYERS submersible pumps. There are level floats to control stop, and start cycles of pumps. Each pump has a check valve on their discharge pipe.

Starts and stops levels of the pumps are voluntarily set-up at close intervals to avoid prolonged operations, which could lead to an overflow of pumping station LS-3. It is also for this reason that the ball valve on the pumps' force main (just before LS-3) is maintained partially closed.

The cleaning operation of the screen basket, which requires the presence of two employees, is required approximately once a week.

No overflow pipe is present. In case of defaults of the pumping station, overflowing of the station and sewer system can occur.

3.2.2 Lifting station n° 2

Pumping station LS-2 receives wastewaters (washbasins, showers and toilets), of Main Camp dormitories and, still to confirm, Nova Camp. Pumping station n° 2 (LS-2) is adjacent to the STP. It receives sanitary wastewaters (washbasins, toilets, showers) coming from dormitories of Main Camp and, still to confirm, Nova Camp. These waters are pumped in the equalization tank (EQT).

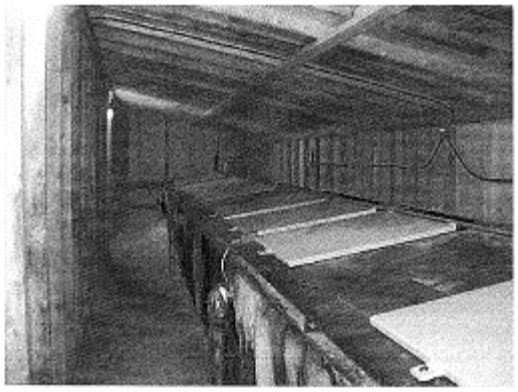
This station is equipped with two (2) MYERS submersible pumps that discharge the wastewater in the EQT. There are level floats to control stop, and start cycles of pumps. Each pump has a check valve on their discharge pipe.

3.2.3 Equalization tank

The equalization tank (EQT) allows lopping flow peaks of the day. Wastewaters accumulated in this tank are pumped in constant flow towards the rotating biological contactors (RBC). The EQT is currently (May 2010) equipped with four (4) pumps, but two (2) more pumps will be installed soon to feed the LJ-3 biodisk:

- Pumps P-1 and P-2 are pumping wastewaters towards LJ-1 and LJ-2;
- Pumps P-3 and P-4 (future) will pump wastewaters towards LJ-3;
- Pumps no. 5 and no. 6 are pumping wastewaters toward L333.

Each pair of pumps are equipped with a Doppler Flowmeter *GREYLINE*, model DFM 4.0. The sensor is fixed to the pipe with coupling material between the sensor face and the pipe. Sensor installation with excessive coupling compound can result in gaps or voids in the coupling and cause errors or signal loss. Insufficient coupling compound will create similar conditions. Over time, temporary coupling compounds (e.g. Petroleum Gel) may gradually sag away from the sensor resulting in reduced signal strength and, finally, complete loss of signal. Warm temperatures, moisture and vibration will accelerate this process. Dow Corning Silicone Compound # 4, as supplied with the DFM 4.0 (and available from Greyline Instruments) is recommended for semi-permanent installations. For more information, refer to the GREYLINE instruction manual.



The equalization tank (EQT) has the following dimensions, approximately: 14,3 m x 2,3m x 2,5 m, for a total volume of 80 m^3. The stabilization of the flow is done with the help of five (5) liquid level floats switches.

Four (4) 10 kW heating elements are installed at the bottom of the EQT to heat wastewater if required. The number of heating elements to put in service must be set to maintain a temperature between 20 and 25 °C. Temperature below 15 °C will probably cause a decrease in microbiological growth on biodisk media and reduce efficiency of the biological process. Temperature over 30 °C increases the nitrification reactions and the anaerobic fermentation which can lead to an important pH and alkalinity decrease and also can, under certain conditions, increase the formation of H_2S gas.

A control unit allow to adjust the running pumps cycles for pumps n° 1 and n° 2 (towards LJ-100), and for pumps n° 5 and n° 6 (towards L333).

The current position of the level floats and pumps on/off cycles' settings ensures an appropriate storage capacity of about 50 m^3.

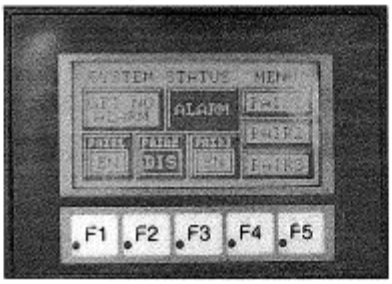
In automatic mode, the control sequence is currently the following:

Float 1 (low level):	low level alarm
Float 2 (stop):	stop pumping
Float 3 (start):	Pumps 1 and 2 (54 sec ON, 306 sec OFF) Pumps 5 and 6 (95 sec ON, 265 sec OFF)
Float 4 (high flow):	Pumps 1 and 2 (162 sec ON, 198 sec OFF) Pumps 5 and 6 (285 sec ON, 75 sec OFF)
Float 5 (high level):	High level alarm and simultaneous start of the four (4) pumps as long as the float stays in horizontal position.

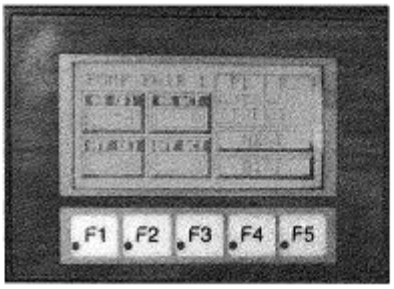
If the water level in the EQT remains low, it indicates that the current controls of the pumps operating time are too high and, consequently, the tank's equalization function is useless.

If the water level in the EQT remains very high, it indicates that the current controls of the pumps operating time are too low and, consequently, the tank's equalization can reach the level 4 «High Flow» which, obviously, would cause overflowing of station LS-3.

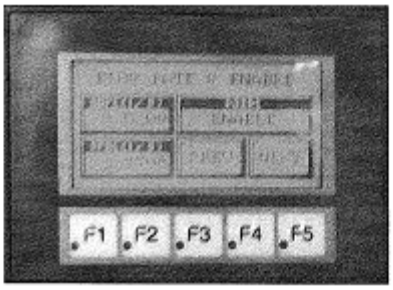
To change the ON/OFF setting cycles of each pair of pumps, you need to follow the step below. The example is for pumps 1 and 2.



Press on **PAIR 1**. A new screen (below) will appear.



Press on **NEXT**. A new screen (below) will appear



Press on **ADF1 (l/s).** Increase or decrease the value in the pop-menu to increase or decrease the running time of the pumps (in seconds) during the 360 seconds ON/OFF cycles.

The five (5) floats level switches must be inspected periodically (once a month). It is very important to keep the floats as clean as possible. Grease can potentially accumulate around the floats and impede operation.

In order to reduce deposits accumulation in the EQT, the level float n° 2 (stop pump) must be kept approximately at mid-level of the motor's pumps.

The depth of solids at the bottom of the EQT must be monitored once a month with the *RAVEN* slude interface detector.

It is possible to bypass the EQT for cleaning, maintenance, or repairs by closing valve V-__ and opening valve V-__. In this situation, Lifting Station n° 2 wastewaters will be all pumped in unit L333. A decreasing of the final effluent quality could be observed.

3.2.4 Rotating biological contactors (RBC)

The treatment system is composed of four (4) biodisks:

- One (1) SEPROTECH L333 UNIT
- Three (3) LJ-100 units

3.2.4.1 Operation summary

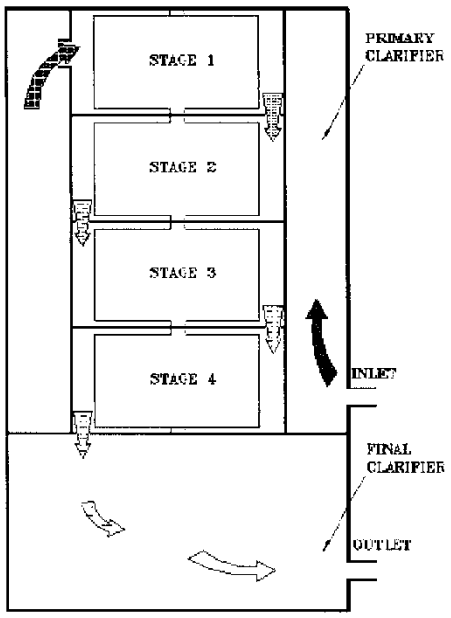
Rotating Biological Contactors (RBC) is a secondary treatment plant designed to remove organic material. It is composed of the primary settling tank (PST), the Biozone tank, and the final clarifier.

Raw sewage is pumped into the PST. Fats, oils and greases (FOG) will float to the top of the PST. The Biozone location concentrates the scum in the area along the side walls of the tank. Settling separates the heavy solids. The clarified water enters the Biozone tank section through the inlet slot located at the bottom of the non-drive end section of the Biozone.

This is the first section of four stages in the RBC aeration process. The normal color of the bacteria in the first stage is dark brown. This is the stage where most of the BOD reduction occurs. The succeeding stages are mounted on the same shaft. The fourth disk bank has recycle buckets that introduce both fresh dissolved oxygen into the PST and nitrifying bacteria present in the recycled water.

Partially treated water from the RBC now enters the final clarifier which allows gravity separation of spent biological growth. Spent biomass settles in this chamber. Sludge is

pumped to the primary clarifier and the supernatant (final effluent) is evacuated to the Lifting Station n° 3.



3.2.4.2 Biodisk LJ-100

A) Equipment characteristics

Supplier		:	Biodisk Corporation
Capacity (each unit)		:	27 500 L/d at a strength of 250 mg/L BOD Effluent BOD and TSS 20 mg/L
Drive motor and gear		:	Nord Gear Limited SK9043.1-80LH/4 Helical Bevel Gear Motor 208 volts, 1 ph, 60 Hz, 1 HP Rotation speed of the shaft is 4,8 rpm
Bearings	(fixed)	:	SKF SNL22518/3.3/16 TG
	(free)	:	SKF22518/3,3/16 THL Bearings are permanently lubricated

Effluent (2) and sludge (1) pumps	:	MYERS, Model ME50S-53 0,5 HP, 575 V, 3ph, 60 Hz
Flowmeter (LJ-1 and LJ-2 only)	:	ENDRESS & HAUSER, Promag 10W
Recorder (LJ-1, LJ-2 and LJ-3)	:	ENDRESS & HAUSER, Echograph RSG 30

B) Electrical controls

The detailed wiring diagram is provided on the inside of the panel and in the operation manual. All of the electrical power requirements pass through the panel. The panel has been designed for a 600/120v, 60 HZ.

The panel has a 200 watt forced air panel heater.

Breaker protection has been provided for all components.

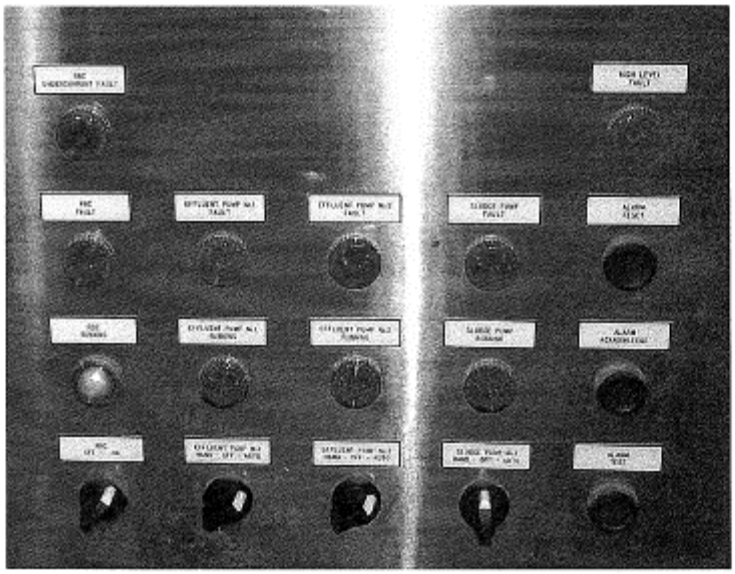
The panel lights will show which equipment is running. Pumps and heaters are normally left in the AUTO position and the RBC runs 24h/365d in the ON position.

Duplex alternating effluent pump controls are provided with HAND-OFF-AUTO switches and high water alarm. The floats in the final clarifier start and stop the pumps. The fourth and highest float allows two pumps to operate at the same time for high flows. This feature will also start the stand by pump when the primary pump failed. The third float is for a high water level alarm.

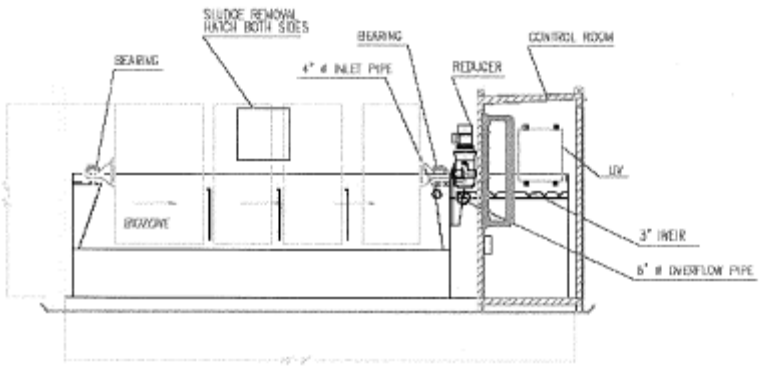
A flashing red light mounted on the top of the control panel is activated by the RBC drive motor when the motor amps are too high or too low, or high water and effluent pump malfunction. The control panel lights will indicate the component that triggered the alarm.

The tank is heat traced. One additional heat tracing contact has been provided.

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

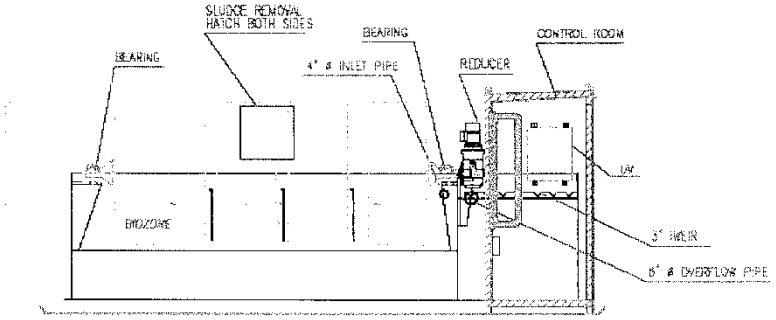


LJ-100 Electrical Panel

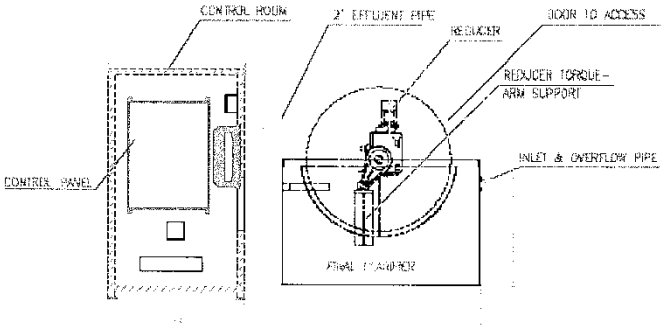


SECTION VIEW

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

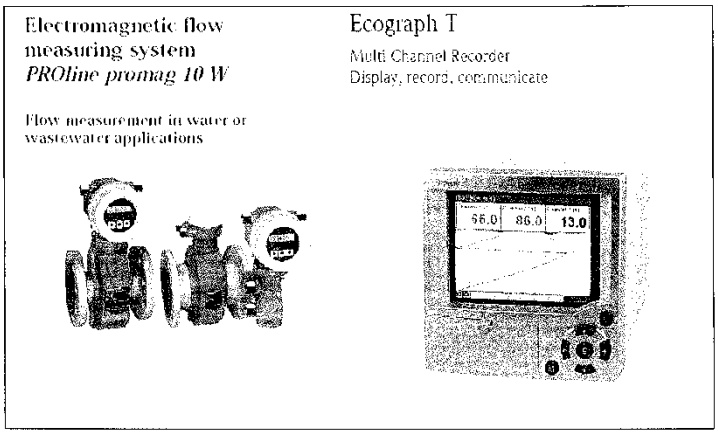


SECTION VIEW



END VIEW

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU



3.2.4.3 Rotordisk L333

A) Equipment characteristics

Supplier		:	Seprotech Systems inc.
Capacity (each unit)		:	105 000 L/d at a strength of 250 mg/L BOD Effluent BOD and TSS 20 mg/L
Drive motor and gear		:	Nord Gear Limited SK9062185TC Motor TEFC 185 TC Frame 575 volts, 3 ph, 60 Hz, 3 HP
Bearings	(2)	:	SKF SNH22524, 4 3/16 inches diameter
	(2)	:	SKF SNH 22526 4 7/16 inches diameter
Coupling	(1)	:	
Sludge pumps	(2)	:	MYERS, Model

B) Electrical controls

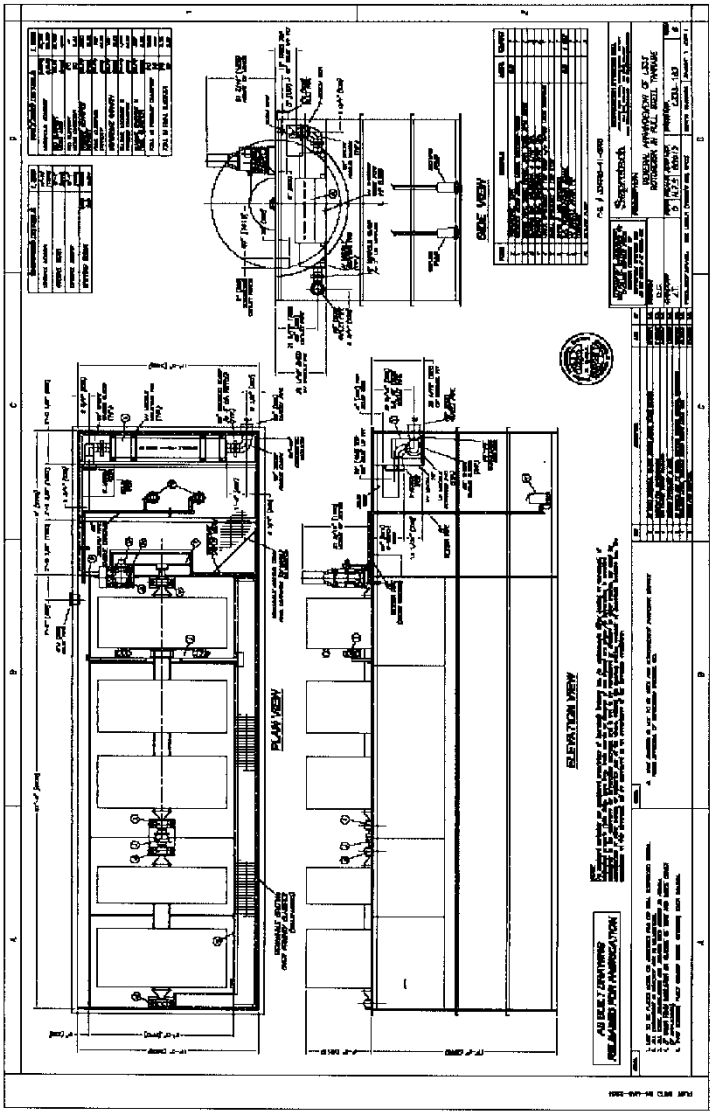
Refer to section 10 of the *« Seprotech L33 Installation, operation and maintenance manual »* for the detailed wiring diagram. All of the electrical power requirements pass through the panel. The panel has been designed for a 600/120v, 60 HZ.

Breaker protection has been provided for all components.

The panel lights will show which equipment is running. Pumps, heaters are normally left in the AUTO position and the RBC runs 24h/365d in the ON position.

Duplex alternating sludge pump controls are provided with HAND-OFF-AUTO switches. In automatic mode, pumps are controlled by an « ON-OFF » timer located inside the panel. Sludge pumps have been initially set to operate for 15 sec every 3 hours.

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU



C) What to check

✓ **Abnormal Noise (1 / day)**

The Biodisk does not have any noisy components. Check valves are the only noisy (clunk) component. The splash of the disk going through the water is as constant as the humming of the motor is. Noises should be at a low level and constant. There are three sources of noise to listen for: the drive, the bearings and the rotating assembly. The drive motor makes a constant humming. High speed noises are generally associated with motor bearings or reducer input bearings. Low speed noises are reducer output noises.

Bearing noises are often cyclical. The rotation speed of the shaft is 4.8 rpm. Bearing can also squeak continuously. This type of noise needs to be investigated.

The rotating assembly consists of the shaft and the disk banks. The disk banks are bolted to the shaft. Lock Tight is used on the disk collar bolts. Movement in the collar bolts will loosen the disk bank and allow it to move. This movement will be evident on every revolution and may be accompanied by a thud. If left unattended, the loose components will eventual break down. Tighten all components that have any movement.

✓ **Visual inspection (1 / day)**

An experienced operator can tell if the Biodisk is working properly by looking at the process. The amount of scum, biomass thickness, coverage, texture, colour, odour, final clarifier scum and time are visual indicators of process efficiency.

Scum will float in the primary clarifier. Scum formation is normal. Fats, oils and grease (FOG) are not beneficial to biological growth and needs to be removed from the wastewater flow before the RBC process. The removal happens in the primary clarifier of the Biodisk. When the scum blanket completely covers the primary tank and has a depth of about 8", the primary tank may need pumping.

The amount of **scum in the final clarifier is an indicator**. A small amount of scum is an indicator that nitrogen gas has being released. Nitrogen gas is liberated in anoxic environments when a carbon source and nitrates are present. This process is called denitrification. When more than 50% of the final clarifier is covered with scum, it is an indicator that the Biodisk may need to have the biosolids and scum removed.

Sludge storage time is directly related to the organic load per day. Lightly loaded systems have long term sludge storage. Scum, biomass thickness, coverage, texture, colour, odour and time are all indicators to tell the sludge's thickness. The removal of

biosolids needs to be addressed. A pump-out truck normally does the sludge removal. A particular point to emphasize is that the biological growth (biomass) on the disks should **not** be washed off.

The thickness and distribution of the biomass is an indicator of plant capacity. When the flow is close to or at design, the biomass will be 1/8" in the first stage and progressively less on the following stages. When the treatment is at capacity, biomass will be evident on the last stage. As the flow is reduced, the amount of biomass on the disks will be proportional to the loading. At 50% of design, the organic removal biomass will occupy 50% of the shaft's length. Light brown nitrification bacteria on the last stage are a good sign. Nitrification does not occur in the Biodisk until the BOD is less than 30 mg/L. If the last stage is without obvious biomass, it is a good indicator of complete nitrification.

Biomass colour is a process indicator to the operator. The biomass in the lead stages will be a medium brown colour. In the lag stages, the disks will be lighter brown when the system is lightly loaded and heavier colour shows when designed for nitrification. Colorless or no biomass is a sign of an under loaded system. The appearance of black and grey patches biomass is not good. Black and grey biomass is an indicator of organic overload and or excessive FOG. This will appear first on the lead stage. It may be time to have the system pumped out.

Often, black and grey spots are accompanied by gelatinous material. These unhealthy bacteria hang on the ends of the tie rods. This is also a sign of organic over load, FOG and excessive use of detergents or cleaners.

The **effluent** near the outlet at the backside of the final clarifier should be relatively clear, colourless and relatively free of suspended solids. Clarity can test rapidly by performing turbidity analysis.

The bearing, gear box and motor have been lubricated with long life synthetic lubricants. **Look for oil and grease leaks.**

✓ **Odour (1 / day)**

Odour is evident when dissolved oxygen (DO) levels are low in the RBC. Low DO in the first stage is an indicator of organic overload. If the problem causing the black, grey and gelatinous biomass is not addressed, it will lead to increased odour and process breakdown. The indicators will appear on the first stage and eventually progress down the full shaft.

Odour under the RBC cover is normally not offensive. A healthy biomass smells like rich earth or loam. In some application, the RBC has been used as an odour eater. If the RBC is producing odour, it is an indicator of poor effluent, organic overload or excessive FOG.

✓ **Water sampling and on site analysis (1 / day)**

Dissolved Oxygen (D.O), pH, and temperature analysis must be performed in the first and last stage of the Biodisk.

The same analysis must be performed on the effluent of the final clarifier. Alkalinity analysis must also be performed, if required.

For more information regarding procedures and interpretations analysis, please refer to Section 4 Control Process.

✓ **Monitoring the flow rate (1 / day)**

The plant is equipped with three Doppler (3) flowmeters located on the force main of the EQT pumps. There is also two (2) magnetic flowmeters install on the force main of the effluent pumps of LJ-1 and LJ-2 units.

These instruments are equipped with a counter that allows tracking of the total volume (m^3) and pumps flowrate (m^3/h).

✓ **Determination of accumulated sludge blanket (periodically)**

The sludge blanket in the PST and in the final clarifier must be measure periodically with the « Sludge Interface Detector ». The sludge accumulation must be compare to the maximum storage capacities listed on the "Details" section of the general arrangement drawing for the Biodisk model in question.

Sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone. Once an average sludge height has been determined, multiply it by the surface area of the clarifier in question to determine the existing volume of stored sludge. Compare to maximum design capacity listed on the general arrangement drawing. If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

Sludge accumulations in PST should be removed once they reach indicated maximum storage levels, because failure to do so could result in lowered treatment efficiency, and possibly cause serious damage to the structure of the Rotating Assembly and drive unit. If sludge is allowed to accumulate past storage heights, flow through the primary clarifier will begin to disturb the sludge blanket, and thus carry loads of solids and dissolved organic matter into the Rotorzone, which are not anticipated in the design of the unit.

✓ **Sludge removal (periodically)**

L333

A pump-out truck (same type that pumps out septic tanks) normally does the sludge removal. For the L333 primary settling tank, it is preferable to connect the suction hose directly to the three (3) PVC pipes connected to the bottom of the tanks and withdraw the sludge only, while taking as little of the supernatant as possible.

Once the primary sludge is withdrawn from the primary settlement tank, the supernatant of the secondary clarifier can be transferred to the primary settlement tank, to expose the secondary sludge. The suction hose should be placed down at a multiple number of points of the final clarifier (particularly in the corners) to help ensure complete removal of accumulated sludge deposits. Floating surface scum should also be removed.

LJ-100

Before withdrawing the sludge of the LJ-100 primary settling tank, it is recommended to transfer the supernatant at the inlet of other LJ-100 units before connecting the suction hose directly to the bottom of the tanks and withdraw the sludge only.

The same operation is recommended for the LJ-100 final clarifier.

3.2.5 U.V. Disinfection system

3.2.5.1 Summary

Another step in the STP process is to disinfect the wastewater. This ensures that any harmful bacteria are destroyed before wastewater is released from the plant. The most common method for disinfecting treated wastewater for small treatment plants is to use ultraviolet (UV) disinfection. UV disinfection relies on the high energy contained in UV light to destroy the ability of bacteria and other microorganisms to reproduce, thereby,

effectively killing them. In wastewater treatment, UV lamps are typically installed in a shallow contact channel, so as the wastewater passes through the channel, UV light is shone through the water. The UV lamps are submerged in the wastewater. When submerged UV lamps are used, they must be encased in quartz tubes to prevent excessive cooling and protected from breakage by a metal grid.

UV disinfection has been proven to be very effective in destroying bacteria in drinking water and some wastewaters. However, because the UV light must reach the bacteria in wastewater in order to be effective, wastewater must be relatively clear and free of turbidity (have few suspended solid particles that give the wastewater a cloudy appearance). In turbid or very cloudy wastewater, the suspended solid particles will reflect and scatter much of the UV light, shielding some bacteria in the wastewater from the light and leaving them unharmed. This will result in inadequate disinfection. For this reason, UV light should not be used as the sole disinfectant on wastewaters with high suspended solids concentrations. It should also be noted that, unlike chlorination, UV disinfection provides no residual disinfection of wastewater. Since wastewater can easily be contaminated again, it should not be stored for a significant length of time before its release back into receiving waters from the treatment facility.

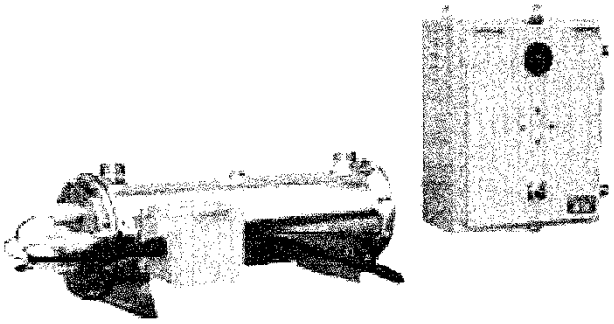
The UV disinfection system must not exceed the following effluent quality limits:

- Fecal Coliforms : 1000 CFU / 100 mL (monthly average)
  2000 CFU / 100 mL (grab sample)

The treatment system is composed of three (3) UV lamps:

- One (1) unit TROJAN, UV3000 PTP model, installed at the outlet of biodisk L333
- Two (2) units SEVERN TRENT, ULTRADYNAMICS model, currently installed at the outlet of LJ-1 and LJ-2 biodisks. Currently, these units are not in service.

3.2.5.2 Ultradynamics UV system



A) Equipment characteristics

Supplier	:	SEVERN TRENT SERVICES
Model – UV Intensity Monitor	:	8102-DM
Model – UV Reaction Chamber	:	8102-HO-60
Number of lamps	:	6
UV lamps rate	:	9000 hours or 1 year
Capacity	:	30 m³/h (clear wastewater, 65 % T)
Maximum operating pressure	:	150 psi
Power requirements	:	240 V, 1,3 kW, 5,6 amps
Maximum water temperature	:	38° C
Ambient temperature	:	2 to 43° C
Maximum start/stop cycles	:	4 per 24 hours
Minimum flowrate (to avoid heat)	:	0,7 m³/h (3 us gal/min)

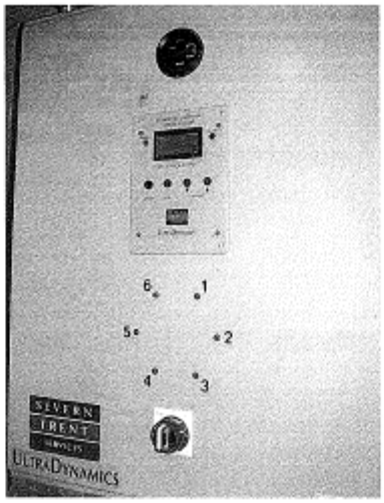
B) Equipment description

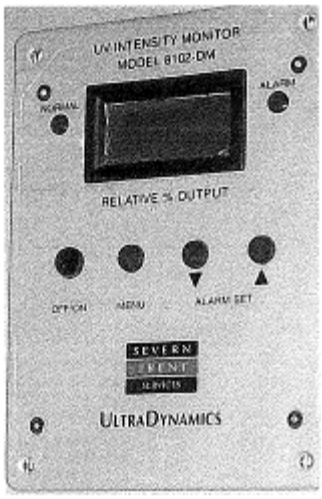
Ultraviolet disinfection performance is monitored with the UV Intensity Monitoring System. The Ultraviolet Intensity Monitoring System includes a monitor with digital display and indicator alarms mounted in a remote cabinet and a sensor assembly located at the lamp source.

Ultraviolet light intensity is monitored with a submersible UV Sensor designed for reliability in a water environment. The sensor transmits an electrical signal proportional to the UV intensity in the channel to the UV intensity monitor. The system is set to accurately indicate relative UV light intensity on a scale of 0 to 100%, with 100% representing the UV intensity in normal process effluent with clean quartz sleeves and new lamps in the UV system. Indicator lights and alarms on the UV intensity monitor keep the operator informed of UV system performance. The sensor is positioned in a UV reactor to measure the relative UV energy. Since the rate of quartz sleeve fouling and the water quality are consistent within the reactor, the readings from the UV intensity monitor are a good indication of performance.

UV Intensity Monitoring Systems measure relative UV intensity, not actual UV intensity. A reading of 100% represents the UV intensity registered with clean quartz sleeves, new lamps and normal water quality. Reductions in UV intensity are due to lamp aging, fouling of quartz sleeves, fouling of the diffuser on the sensor, and/or changes in water quality (suspended solids and percent transmission).

When cleaning the UV system quartz sleeve, it is also necessary to clean the UV sensor probe. Shut off water, relieve the system pressure and/or isolate (valve out) the UV chamber. Remove the monitor by unscrewing the white retaining nut and sliding the probe out of the sensor port. Deposits on the sensor probe are mostly caused by suspended and dissolved solids and minerals naturally occurring in the water. This coating can be easily removed by applying a small amount of lemon juice on a soft dry cloth and gently rubbing the sensor probe until clean, rinsing with hot water.





Ultraviolet lamps must be replaced every 10 to 12 months of continuous use, after every two (2) years of intermittent use, or when the monitor reads 60% of the new lamp output. **DO NOT WAIT** for the monitor to cut-off. Always stock spare lamps.

C) Operation and maintenance

Inspecting the Quartz Jackets:

As water passes through the UV unit, minerals, debris and other matter in the water will settle and deposit onto the quartz jackets. This will impair the ability of the UV rays to penetrate into the water. Therefore, it is necessary to determine a cleaning schedule for the quartz jackets, and the frequency will depend on the specific type of water used at your facility.

If the water has been processed through deionization, reverse osmosis, or distillation, the cleaning frequency can be set at once a year. If clear, fresh water is used, the probable cleaning frequency will be anywhere from once every thirty (30) days to once every six (6) months. You can determine the cleaning frequency by visually inspecting any quartz jacket to see if any debris or film has settled on the outside of the quartz jacket.

Severn Trent Services suggest to initially scheduling your first inspection after thirty (30) days of use and after the first month. If the quartz jacket is noticeably dirty, your cleaning frequency should be shortened; if the jacket is clean, the frequency can be lengthened.

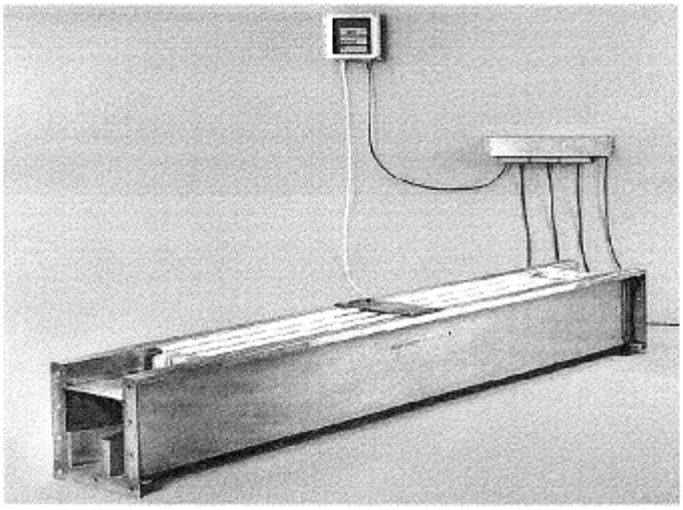
Cleaning the Quartz Jacket:

To clean the quartz jackets, first turn off the water, disconnect the electrical service and drain the UV chamber. Next, remove the UV lamps. Then loosen the compression nut and carefully remove the quartz jackets. The quartz jackets may be washed with a mild soap and hot water and rinsed clean with hot water. Should this be insufficient to clean the quartz jackets, use a mild abrasive cleaning agent. Be careful when cleaning the quartz jacket. It is fragile. Should a quartz jacket be damaged, it must be replaced.

Other Periodic Maintenance :

- ✓ Operate the quartz jacket wiper system regularly on manual models (push/pull stroke). You cannot overclean the quartz jacket(s).
- ✓ The exterior surfaces of the UV unit should be kept clean as part of routine maintenance. Use a soft cloth and water or any commercial stainless steel cleaner.
- ✓ Inspect for overhead piping leaks and correct as necessary to protect UV equipment.
- ✓ Measure the performance of the UV unit at sufficient intervals to ensure the effluent meets your requirements.

3.2.5.3 Trojan UV system



A) Equipment characteristics

Supplier	:	TROJAN TECHNOLOGIES
Model	:	UV3000 PTP
Model – UV Reaction Chamber	:	8102-HO-60
Number of lamps	:	
Number of module	:	
UV lamps rate	:	8 760 hours (1 year)
Capacity	:	
Power requirements	:	
Maximum water temperature	:	
Ambient temperature	:	
Maximum start/stop cycles	:	
Minimum flowrate (to avoid heat)	:	

B) Equipment description

The Trojan UV3000TMPTP is made of several components (some of which are optional):

- UV Module
- UV Lamps
- Quartz Sleeves, Springs, Spacers
- Lamp Holder Seal Assembly
- Effluent Channel
- Transition Boxes
- Power Distribution Receptacle
- Monitoring System UV Sensor
- Level Control Weir
- UV Module rack

UV Module

The UV module is the basic unit of the flowthrough UV bank. A bank is made up of UV modules placed in parallel within a single channel.

UV Lamps

Trojan supplied __ inch long UV lamps. The UV output after one year of use is approximately 80% of the output after the 100 - hour burn-in period. It should also be noted that frequent cycling shortens the life of the lamps.

Quartz Sleeves, Springs, Spacers

The quartz sleeves are made of Type 214 clear fused quartz circular tubing. They are rated 89% for UV transmittance and are not subject to solarisation. The sleeves protect the lamps from breakage and in conjunction with the spacer rings, they provide insulation. This assures minimum lamp temperature variations, which could affect the lamps performance.

Lamp Holder Seal Assembly

The open end of the lamp sleeve is sealed with a type 316 stainless steel sleeve nut which threads onto a sleeve cup and compresses the sleeve o-ring. The knurled surface of the sleeve nut allows a positive handgrip for tightening; it does not require any tools for removal. The lamp is held in place with a moulded lamp holder, which incorporates a triple seal. The lamp holder seals against the inside of the quartz sleeve to act as a second seal in series with the external o-ring seals.

Another seal on the lamp holder isolates and seals the lamp from the module frame and all other lamps in the module. If a quartz sleeve fracture happens, the seals of the lamp holder prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

Effluent Channel (Type K)

The effluent channel is typically made of 14 Type 304 stainless steel gauges, and comes complete with drain, UV module support rack and downstream serpentine weir.

Transition Boxes (optional)

Transition boxes are conceived to provide transition between the UV channel and flanged inlet and outlet pipes. The inlet transition box helps to ensure a plug flow condition that is conducive to more efficient disinfections.

Power Distribution Receptacle

The PDR consists of duplex ground fault interrupter receptacle that can be mounted in a location which allows convenient hook-up of UV Modules. The PDR is provided with a weatherproof cover. However, direct water sprays should be avoided.

Monitoring System UV Sensor

The submersible UV Sensor measures the UV intensity within each bank of UV lamp modules. The UV Sensor is mounted on a representative UV lamp module. The UV Sensor is calibrated in the factory and should not be altered, or its calibration changed. The monitoring system offers the main following features:

- A UV Sensor that continuously monitors the UV intensity produced in each bank of UV lamp modules.
- A 3 character display that indicates UV intensity in milliwatt per square centimeter (mW/cm2). This display will flash when the intensity drops below the Low UV Intensity Alarm setpoint.
- A 5 character display that indicates elapsed time in hours. The Elapsed Time display will flash when lamps will need to be changed in a near future.

Level Control Weir (optional)

A water level control weir controls the effluent level within the UV channel.

UV Module Rack

The UV Module Rack is a stainless steel support frame, which supports each bank of UV modules.

D) Operation and maintenance

To ensure maximum performance, it is essential that the quartz sleeves containing the UV lamps are kept clean. If coating is to building up on the sleeves, the amount of UV light transmitted to water is reduced. The cleaning interval for the UV modules depends on the effluent quality. Often, a hosing off of foreign matter clinging to the unit may be all that is required. Over a period of time, however, a coating will build up on the quartz sleeves and it will be necessary to clean them thoroughly.

Always clean quartz sleeves when intensity falls below 2,8 mW/cm2. Clean the UV Sensor at the same time.

CAUTION : ***Wear cotton gloves when handling quartz sleeves and lamps.***

The Trojan UV3000TMPTP sleeves' cleaning method is to manually hand wipe the quartz sleeves using a Trojan approved cleaning agent. The cleaning agent is applied using a cleaning cloth or sprayed on the quartz sleeves, then wiped off. See the Trojan Instruction Manual for the complete maintenance procedure.

The crest of the Level Control Weir and the channel must be clean periodically.

Lamps must be typically replaced every 8760 hours of operation (1 year), although the actual time varies according to the following factors: effluent temperature, power levels of lamps, and frequency of switching lamps ON and OFF. To ensure lamps are replaces at the proper time, it is best to replace all lamps in a scheduled operation, and to maintain a record of lamp replacement dates and elapsed timing on all lamps.

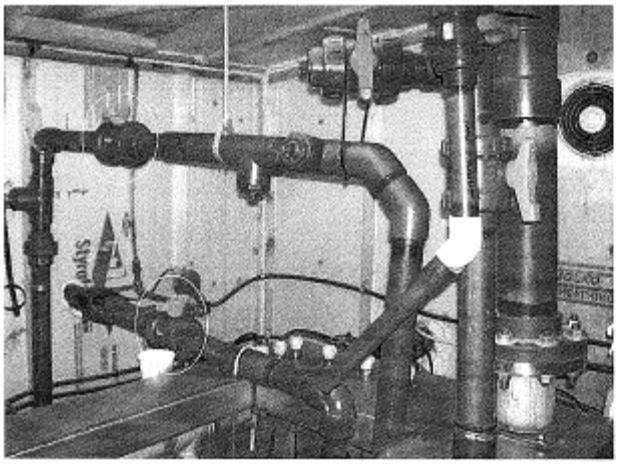
3.2.6 Lifting station n° 3

Pumping station LS-3 received the final effluent of the STP and grey waters (untreated) of Main Camp and Nova Camp wastewaters.

This station is equipped with two (2) MYERS submersible pumps and forces back waters towards the Tailing Storage Facility. Pumps control is ensured by four (4) level switch floats. Both pumps run simultaneously when the water level in the station reaches the level switch n° 3. Timers for the pumps' running time figured on the control panel.

The dimensions of the wet well are very limited (1,20 m x 0,9 m x 0,9 m), as well as the pumping flowrate capacity of the station. **No overflow pipe is present.** Overflowing can

thus occur, particularly when pumps upstream are manually started for more than a few minutes. For that reason, the ball valves installed on both grey waters 2 inches inlet pipes must be maintained partially closed (see photo below). Furthermore, Nova Camp's grey waters are pumped during the night, a low flow period.



4. PROCESS CONTROL

4.1 Summary

Operation of the RBC system is more than "just turning it on and letting run itself". The operator has a number of options even in plants with limited flexibility if he is willing to use his ingenuity.

Certain visual indicators, such as the appearance of different biomass colors, presence of odours and amounts of solids in the effluent of clarifiers and RBC overflow points, give and indication of how the process is working. These have been described in the lesson; however, they have to be related to the individual plant before they have true significance to the operator. They are valuable and should not be overlooked or discounted.

Additionally, certain lab tests are also described to tell whether the first stage is overloaded, whether nitrification might be expected in later stages, whether nitrification is occurring and reducing pH, how much DO is present, etc. Test results should be used to

make process control decisions, not simply to satisfy some regulatory requirement. Use of this information has been described.

Maintenance must be performed routinely and preventive steps taken to keep the process healthy. Lubrification of bearings, maintenance of other moving parts such as shafts, belts, chains, and media are all part of standard operation duties. The importance of this has been mentioned above.

Finally, the RBC units are depending on the correct functioning of the other processes. When all the parts of the process reviewed as tools needed to produce the final products, namely disposable solids and acceptable effluent, the operator can be proud of his job.

4.2 Sampling procedures

The analytical results of a sample are only as accurate as the quality of the sample taken. If your technique for collecting the samples is poor, then no matter how accurate your lab procedures are, the results will be poor. Buy sampling according to set procedures, you reduce the chance of error and increase the accuracy of your samples results.

Wastewater sampling is generally performed by one of two methods:

- grab sampling
- composite sampling

Grab sampling is just what it sounds like; all of the test material is collected at one time. As such, a grab sample reflects performance only at the point in time when the sample was collected, and only if the sample was properly collected.

Composite sampling consists of a collection of numerous individual discrete samples taken at regular intervals over a period of time, usually 24 hours. The material being sampled is collected in a common container over the sampling period. The analysis of this material, collected over a period of time, will therefore represent the average performance of a wastewater treatment plant during the collection period.

Numerous industry references list various parameters for wastewater testing and whether samples should be collected using grab sampling or composite sampling methods. For example, grab sampling allows the analysis of specific types of unstable parameters such as pH, dissolved oxygen, chlorine residual, and temperature.

However, the most widely used indicators of treatment plant performance, including BOD_5 (biochemical oxygen demand), TSS (total suspended solids) normally require the use of a 24 hours composite sampling techniques because routine variations in the volume and

strength characteristics of incoming wastewater create fluctuations in the quality of treatment plant effluent. Therefore, an effluent grab sample taken at one specific time throughout the daily flow pattern will not be representative of the system performance over the entire day.

In the absence of an automatic composite sampler on Meadowbank site, all the water samples collected to control and monitor the process are taken using grab samples.

Once a sample is taken, the constituents of the sample should be maintained in the same condition as when collected. When it is not possible to analyze collected samples immediately, samples should be preserved properly. Biological activity such as microbial respiration, chemical activity such as precipitation or pH change, and physical activity such as aeration or high temperature must be kept to a minimum. Methods of preservation include cooling, pH control, and chemical addition. Freezing is usually not recommended. The length of time that a constituent in wastewater will remain stable is related to the character of the constituent and the preservation method used.

4.3 Sampling points location

In order to make appropriate adjustments to the treatment plant, the operator should be able to take representative water sample at the following location of the STP as shown on Table 4.1.

Table 4.1 Sampling points location

Sampling point	Location	Test to perform		Comments
		On site by operator (each day)	Independant laboratory (each week)	
STP Influent		pH temperature	BOD5 COD TSS NH3-NH4 P tot	
Biodisks (First stage)		pH Temperature D.O. Media observation		
Biodisks (Last stage)		pH Temperature D.O. Media observation		
STP Effluent		pH Temperature D.O. Turbidity	BOD5 COD TSS NH3-NH4 P tot NO2-NO3 Fecal coliform	

4.4 Analysis results interpretation

There are a number of parameters and analyses that should be tested and tracked, beyond those required by the Government. This chapter is intended to introduce the reader to laboratory tests interpretation.

4.4.1 Independent laboratory analysis results

Biochemical Oxygen Demand (BOD) is the rate at which micro-organisms use the dissolved oxygen in the wastewater while stabilizing or breaking down decomposable organic matter. In decomposition, the organic matter serves as food for the bacteria.

The BOD is an index of the amount of oxygen that will be consumed by the decomposition of the organic matter in a wastewater.

The analysis consists of measuring the initial dissolved oxygen concentration in a water sample, and measuring the final dissolved oxygen after incubation for five (5) days (BOD_5) at 20 °C.

The STP has been designed to reduce total BOD of the effluent to approximately 15 mg/L.

The organic loading apply on a RBC must generally not exceed 5 g BOD / m² of Bio support media / day.

An increase of BOD on the effluent treated water is a sign of deterioration of the treatment process.

Chemical Oxygen Demand (COD) is a measure of the water capacity to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. Chemical Oxygen Demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific temperature conditions and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid (H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay.

Generally, COD is preferred to BOD in process control applications because results are more reproducible and are available in just a few hours rather than five (5) days.

The COD test is not a direct substitute for the BOD test; however, a ratio usually can be correlated between the two (2) tests. This requires COD versus BOD testing over a specified period of time.

On typical domestic wastewater, a ratio COD/BOD between 2 and 3 is usual. On treated effluent a ratio COD/BOD between 4 and 6 is usual.

Total Suspended Solids (TSS) are the particles which are either suspended in solution or slowly settled to the bottom. Wastewater treatment plants are designed to remove TSS from wastewater.

TSS of a water sample is determined by pouring a carefully measured volume of water through a pre-weighed filter of a specified pore size, then weighing the filter again after drying to remove all water. The gain in weight is a dry weight measure of the particulates

present in the water sample expressed in units derived or calculated from the volume of water filtered (typically milligrams per litre or mg/L).

Although turbidity purpose is to measure approximately the same water quality property as TSS, the latter is more useful because it provides an actual weight of the particulate material present in the sample. In water quality monitoring situations, a series of more labor intensive TSS measurements will be paired with relatively quick and easy turbidity measurements to develop a site-specific correlation.

The STP has been designed to reduce TSS of the effluent to approximately 15 mg/L.

An increase of TSS on the effluent treated water is probably a sign of insufficient sludge extraction in the biodisks's final clarifier.

Ammonia nitrogen (NH_3 and NH_4^+) is a form of nitrogen, which is a nutrient necessary for both plant and animal life. The Nitrogen Cycle is the natural conversion of nitrogen from one form to another through various biological processes. Wastewater treatment plants are generally designed to remove NH_3 from wastewater.

Large concentrations of ammonia create a large oxygen demand due to the conversion of ammonia to nitrate (NO_3) by nitrifying bacteria. Approximately 4.3 mg O_2 are consumed for every mg of ammonia-nitrogen oxidised to nitrate-nitrogen.

Nitrification is possible if sufficient detention time is created. There are two (2) bacterial species involved. *Nitrosomonas sp.* bacteria which oxidize ammonia to nitrite, while Nitrobacter bacteria convert nitrite to nitrate, with both species utilising the energy released by the reactions.

Between 7 to 8 mg of alkalinity in the form of HCO_3^- are consumed per mg of ammonia-nitrogen oxidised. This is quite a substantial amount of alkalinity and it will over a period of time dramatically change the character of the water during the treatment process, affecting pH stability. Nitrification process is the main reason of the pH water drop during the RBC treatment process.

The increase of nitrites (NO_2) and nitrates (NO_3) during the treatment process, and the decrease of ammonia nitrogen (NH_3 and NH_4^+) and pH is also an indication of the rate of nitrification during the treatment process.

Even if the STP system has been designed for ammonia/nitrate removal, there is no Government effluent quality limits for these parameters.

Controlling **phosphorus** discharged from municipal wastewater treatment plants is a key factor in preventing eutrophication of surface waters. The overall total phosphorus

removal obtained in a conventional biological wastewater treatment like the Meadowbank STP is generally very low, less than 20%.

4.4.2 On site analysis results

Temperature is an important factor for the treatment process. Settling properties are more effective at higher temperatures whereas colder conditions reduce the biological activity and organic removal efficiency decreases at wastewater temperatures below 15 °C.

Water will hold more dissolved oxygen at colder temperatures as compared to warmer temperatures. Water in the winter can hold almost twice as much Dissolved Oxygen (DO) as in the summer.

Biological activity and nitrification process decreases, however, as temperature decreases.

Covers on RBC provide protection against drop of water temperature and protect equipment and media from freezing during winter.

The term **pH** is a measure of the acidity or alkalinity of a liquid. The pH scale ranges from 0 to 14, with the acceptable range for wastewater typically being 6.0 to 8.5.

The microbiological organisms begin to become stressed at higher and lower pH which in turn results in lower treatment efficiencies.

Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in the air. The measurement of turbidity is a key test of water quality.

A property of the particles —they will scatter a light beam focused on them — is considered a more meaningful measure of turbidity in water. Turbidity measured this way uses an instrument called a nephelometer with the detector setup to the side of the light beam. More light reaches the detector if there are lots of small particles scattering the source beam than if there are few. The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units (**NTU**). To some extent, how much light reflects for a given amount of particulates depends on properties of the particles like their shape, color, and reflectivity.

For this reason (and that heavier particles settle quickly and do not contribute to a turbidity reading), a correlation between turbidity and total suspended solids (TSS) is somewhat unique for each location or situation.

Dissolved Oxygen (DO)

In an aerobic RBC system, a biofilm is allowed to form on the medium, which is partly submerged in the wastewater and partly exposed to the air. The rotation alternately exposes this biofilm to atmospheric oxygen and wastewater. Oxygen transfers from the air to the RBC unit in three (3) ways: by oxygen absorption of the liquid film over the biofilm surface when the biofilm is in the air; by direct oxygen transfer to the air-water interface; and by direct oxygen absorption by the microorganisms during the air exposures.

Usually, as a consequence of an active respiration in the initial stages, the oxygen concentration reaches minimal levels, increasing along the reactor where substrate concentration is low.

During operation oxygen levels must be properly controlled and, to prevent from becoming a limiting factor, initial stages should have at least 1 mg/L of D.O.

Oxygen demand is the amount of DO required by bacteria and microorganisms to oxidize the influent organic waste. It is directly proportional to the organic strength of the influent waste. Therefore, oxygen requirements are dependent on BOD loading as well as the degree of treatment.

Alkalinity

Alkalinity is an indication of the acid neutralizing wastewater capacity. It is a measure of wastewater's resistance to changes in pH. The major components of alkalinity are carbonate (CO_3) and bicarbonate (HCO_3) species.

BOD removal causes a slight decrease in alkalinity. Ammonia (NH_3) removal, also known as nitrification, causes a significant decrease in alkalinity. During nitrification, NH_3 is converted to NO_3. Theoretically, 7.14 mg of alkalinity is consumed during the oxidation of 1 mg of NH_3.

When DO is not available, nitrate (NO_3) is used as an oxygen source. NO_3 removal, also known as denitrification, causes a slight increase in alkalinity. NO_3 is converted to N2 gas. Theoretically, 3.57 mg of alkalinity is created during the reduction of 1.0 mg of NO3.

When DO and NO_3 are not available, sulfate (SO_4) is used as an oxygen source. Organic nitrogen is used as a food source, which causes a significant increase in alkalinity. This leads to the generation of ammonia (NH_3).

4.5 Other process interpretations

4.5.1 Observing the media

Rotating biological contactors use bacteria and other living organisms growing on the media to treat waste. Because of this, you can use your senses of sight and smell to identify problems. The slime growth or biomass should have a brown to gray color, no algae present, a shaggy appearance with a fairly uniform coverage, and very few or no bare spots. The odour should not be offensive, and certainly there should be no sulfide (rotten egg) smells.

During operation, observations of the RBC movement, slime color and appearance are helpful in determining system performance; that is, they can indicate process conditions. If the unit is covered, observations are usually limited to that portion of the media that can be viewed through the access door.

A gray, shaggy appearing biological slime is indicative of a system designed strictly for BOD removal. A brown, thinner, less shaggy biological slime is indicative of a nitrifying system.

The Rotorzone is subdivided into four (4) sections, with disk banks in each. The wastewater first enters the Rotorzone in the section marked "1" in the sketch (furthest away from the inlet to the plant). The flow then proceeds through sections 2, 3, and 4 before entering the final settling tank.

The accumulation of biological growth will be greatest in section 1, and gradually decrease through subsequent sections. Generally, the growth will be thick, and often filamentous ("stringy"), in section 1, becoming thinner and more compact through sections 2-4.

The colour of the growth will typically be dark brown to black in Section 1. Some grey growth may also be noticed, depending on the relative load and type of wastewater being treated. Growth in sections 2-4 will typically vary from medium brown to a light brown or tan growth in section 4.

Black appearance

If the appearance becomes black and odours, which are not normal to occur, then this could be an indication of solids or BOD overloading. These conditions would probably be accompanied by low DO in the plant effluent. Compare previous influent suspended solids and BOD values with current test results to determine if there is an increase. To solve this problem, place another rotating biological contactor unit in service, if possible,

or try to pre-aerate the influent to the RBC unit. Also review the operation of the primary clarifiers and sludge digesters to be sure they are not the source of the overload.

White appearance

A white appearance on the disc surface also might be present during high loading conditions. This might be due to a type of bacteria which feeds itself on sulfur compounds. The overloading could result from industrial discharges containing sulfur compounds upon which certain sulfur loving bacteria thrive and produce a white slime biomass. Corrective action consists of placing another RBC unit in service or trying to pre-aerate the influent to the unit. During periods of severe organic or sulfur overloading, remove the bulkhead or baffle between stages one and two.

Another cause of overloading may be sludge deposits that have been accumulating in the bottom of the bays. To remove these deposits, drain the bays, wash the sludge deposits out and return the unit to service. Be sure the orifices in the baffles between the bays are clear.

Sloughing

Sloughing is the term used to refer to the process in which excess microbrial growth separates from the media and is washed to the secondary clarifiers with the treated wastewater. The excess slime will settle out in the secondary clarifiers and be removed from the system. Natural biological sloughing will occur from any fixed film reactor. It is a normal consequence of media growth.

If severe sloughing or low growth of biomass occurs after the start-up period and process difficulty arises, the causes may be due to the influent wastewater containing toxic or inhibitory substances that kill the organisms in the biomass or restrict their ability to treat wastes. To solve this problem, steps must be taken to eliminate the toxic substance even though this may be very difficult and costly. Biological processes will never operate properly as long as they attempt to treat toxic wastes. Until the toxic substance can be located and eliminated, loading peaks should be dampened (reduced) and a diluted uniform concentration of the toxic substance allowed reaching the media in order to minimize harm to the biological culture.

Another problem which could cause low biomass growth is an unusual variation in flow and/or organic loading. In small communities, one cause may be high flow during the day and near zero flow at night. During the day, the biomass is receiving food and oxygen and starts growing; then the night flow drops to near zero, available food is reduced and nearly stops. The biomass starts sloughing off again due to lack of food. Considering the presence of the Equalization tank, this problem should not occur.

4.5.2 Smell

In a well-functioning unit with the appropriate feed of wastewater, there will be an earthy, humus-like ("musty") smell inside the Biodisks. A substantial sour, "sewage" smell may be an indication of sub-optimal conditions in the treatment process.

When undesirable septic conditions appear, a classic "rotten egg" odour is noticeable. It results from the bacterial breakdown of organic matter in the absence of oxygen (anaerobic digestion). Remember that Hydrogen sulfide is a toxic gas.

4.5.3 Observing the clarifiers and final effluent

Clarification in the secondary clarifier is another major factor that affects performance. For example, shallow clarifier, as installed in Meadowbank, normally have difficulty containing the typically low density sludges. Low density sludge blanket are also easily disturbed by hydraulic (flow) fluctuations, and such disturbances can cause the loss of sludge particles (TSS) in the final effluent.

Rising sludge ('pop-ups') are particles or chunks of sludge floating to the surface of the clarifier. The sludge can be carried over the effluent weir, which results in elevated effluent TSS levels. The sludge is carried to the surface by bubbles of gas formed in the sludge blanket at the bottom of the clarifier or from sludge hung up on the walls of the clarifier. The gas may be either nitrogen or hydrogen sulfide gas (H_2S) formed from the biological decomposition of the sludge.

Some differences of the gas can be used to determine if the sludge is denitrifying or going septic at the bottom of the tank. Pop-ups caused by nitrogen are usually light brown to brown in color, and have no odour when broken up by a hose or cleaning brush. When pop-ups are caused by septic conditions, a classic "rotten egg" odour is noticeable when the sludge is hosed down or otherwise broken up, due to release of the hydrogen sulfide gas. The pop-ups are usually dark brown to black.

If sludge extraction frequency is too low, sludge can accumulate and be washed into the effluent or the sludge may remain in the clarifier but have no DO, causing the higher microorganisms to die or the bacteria to denitrify or go anaerobic and cause gas bubbles and rising sludge.

The effluent near the outlet at the backside of the final clarifier should be relatively clear and colourless and relatively free of suspended matter. The turbidity measurement of the final effluent is a quick and easy method of checking the operation and performance of the RBC process. An increasing effluent turbidity indicates an unfavourable trend in process operation which should be promptly investigated and corrected.

Turbidity in the final effluent is chiefly due to biological floc that has carried out over in the clarifier effluent. Monitoring the sludge blanket in the clarifier is the most direct method available for determining when sludge extraction must be done.

4.5.4 Determination of the sludge blanket

The sludge levels accumulation can be directly measure with the Sludge Interface Detector supplied on site. The Raven SID-10200 utilizes the infrared light dispersion technology sensor probe to accurately determines the sludge blanket solid/liquid interface depth in primary tanks and clarifiers.

Sludge levels should be measured at several locations in each settlement tank to ensure a reasonably accurate calculation of accumulated volumes. This is required since sludge accumulation levels are not uniform; being highest at the inlet ends of both clarifiers, and, below the slot at the bottom of the first section of the Rotorzone.

If the accumulated levels equal or exceed design values, it is time to remove the sludge from the unit.

4.6 Process parameters

4.6.1 Percent Removal Calculations

BOD, TSS, and NH_3 are all pollutants, which are present in large concentrations in the influent wastewater coming into a treatment plant. Through the treatment process, the concentrations of BOD, TSS and NH_3 are reduced.

The Percent Removal Calculation is used to determine the percentage of the incoming concentration of a particular pollutant (BOD, TSS or NH_3) that was removed through the treatment process. It is calculated as follows:

$$\text{Percent Removal (\%)} = \frac{(\text{Influent Concentration, mg/L}) - (\text{Effluent Concentration, mg/L})}{(\text{Influent Concentration, mg/L})} \times 100$$

Example

Influent BOD = 250 mg/L
Effluent BOD = 15 mg/L

$$\text{Percent Removal (\%)} = \frac{(\text{Influent Concentration, mg/L}) - (\text{Effluent Concentration, mg/L})}{(\text{Influent Concentration, mg/L})} \times 100$$

$$\text{Percent Removal (\%)} = \frac{(250\ \text{mg/L}) - (15\ \text{mg/L})}{250\ \text{mg/L}} \times 100$$

Percent Removal (%) = 94%

4.6.2 Organic loading

Organic loading is defined as the grams of Biochemical Oxygen Demand (BOD) introduced into the RBC basin per square meter of media surface area per day. The design of the media optimizes its available surface with the use of ridges and void spaces. Consequently, the media surface can not be accurately calculated by an operator and is provided by the manufacturer. See table in section 2.2.

Typical organic loading of a RBC is 4 to 6 grams BOD/day/m².

Increased organic loadings lead to increased biological slime thickness where dissolved oxygen becomes depleted. With higher organic loadings sulfur reducing filamentous bacteria (*Beggiatoa*) become abundant due to DO deficient conditions. This phenomenon is indicated by a white/gray colored biomass

Organic Load is calculated as follows:

$$\text{Organic Load (g BOD/day/m}^2\text{)} = \frac{\text{(BOD, mg/L) x (Flow, m}^3\text{/d)}}{\text{(Area, ft2)}}$$

Example 1

Calculate the organic loading on L333 Biodisks if the operation data are the following:

- Media Surface Area of L333 = 3390 m² (see table on Section 2.2)
- Influent Flow = 55 m³/d (flowmeter on P5 and P6 pumps of the EQT)
- Influent BOD = 240 mg/L (last result from independant laboratory)

$$\text{Organic Load} = \frac{\text{(240 mg/L) x (55 m}^3\text{/d)}}{\text{(3390 m}^2\text{)}}$$

$$\text{Organic Load} = \text{3,9 g BOD/day/m}^2$$

Example 2

Calculate the organic loading on the four (4) Biodisks if the operation data are the following:

- Media Surface Area of L333 = 3390 m² (see table on Section 2.2)
- Media Surface Area of each LJ-100 = 487 m² (see table on Section 2.2)
- Influent Flow = 78 m³/d (flowmeter on P5 and P6 pumps of the EQT)
- Influent BOD = 280 mg/L (last result from independent laboratory)

$$\text{Organic Load} = \frac{\text{(280 mg/L) x (78 m}^3\text{/d)}}{\text{(4851m}^2\text{)}}$$

$$\text{Organic Load} = \text{4,5 g BOD/day/m}^2$$

4.7 Process troubleshooting guide

This section of the manual presents troubleshooting procedures for solving common operating problems experienced in the Rotating Biological Contactors (RBC) process.

With each problem or observation, a list is included for the probable causes, checks to determine the cause, and the suggested corrective measures. You, the operator, must determine and select one or more of the corrective measures that will restore the process to its full efficiency with the least adverse effect on the final effluent quality.

There are different problems presented that frequently occur in operating the RBC process. In all of the guides presented, the probable cause given for the observation should be looked at concurrently because many times one problem may have several causes.

Table 7.3 – Troubleshooting Guide — Rotating Biological Contactors

(Adapted from *PERFORMANCE EVALUATION AND TROUBLESHOOTING AT MUNICIPAL WASTEWATER TREATMENT FACILITIES*, Office of Water Program Operations, US EPA, Washington, DC.)

INDICATOR/OBSERVATION	PROBABLE CAUSE	CHECK OR MONITOR	SOLUTION
1. Decreased treatment efficiency.	1a. Organic overload.	1a. Check peak organic loads — BOD, SS, DO, pH, temperature.	1a. 1. Improve pretreatment of plant. 2. Place another RBC in service if available. 3. Remove bulkhead between stages 1 and 2 for larger first stage. 4. Recycle effluent as a possible short-term solution.
	1b. Hydraulic overload.	1b. Check peak hydraulic loads — if less than twice the daily average, should not be the cause.	1b. 1. Flow equalization; eliminate source of excessive flow. 2. Balance flows between reactors. 3. Store peak flows in collection system, monitor possible overflows of collection system.
	1c. pH too high or too low.	1c. Desired range is 6.5 - 8.5 for secondary treatment; 8 - 8.5 for nitrification.	1c. 1. Eliminate source of undesirable pH or add acid or base to adjust pH. When nitrifying, maintain alkalinity at 7 times the influent NH_3 concentration. 2. Sodium bicarbonate can be used to increase both pH and alkalinity.
	1d. Low wastewater temperatures.	1d. Temperatures less than 55°F will reduce efficiency.	1d. 1. Cover RBC to contain heat of wastewater. 2. Heat influent to unit or building.
2. Excessive sloughing of biomass from discs.	2a. Toxic materials in influent.	2a. Determine material and its source.	2a. 1. Eliminate toxic material if possible — if not, use flow equalization to reduce variations in concentration so biomass can acclimate. 2. Recycle effluent for dilution.
	2b. Excessive pH variations.	2b. pH below 5 or above 10 can cause sloughing.	2b. Eliminate source of pH variations or maintain control of influent pH.
	2c. Unusual variation in flow and/or organic loading.	2c. Influent flow rate(s) and organic strength.	2c. Eliminate/reduce variations by throttling peak conditions and recycling from the secondary clarifier or RBC effluent during low flows. 2d. Monitor industrial contributors for flow variations.
3. Development of white biomass over most of disc area.	3a. Septic influent or high H_2S concentrations.	3a. Influent odor.	3a. Pre-aerate wastewater or add sodium nitrate or hydrogen peroxide or place another RBC unit in service. Prechlorination of influent will also control sulfur-loving bacteria.
	3b. First stage is overloaded organically.	3b. Organic loading on first stage.	3b. 1. Improve pretreatment of plant. 2. Place another RBC in service, if available. 3. Adjust baffles between first and second stages to increase total surface area in first stage.
4. Solids accumulating in reactors.	4a. Inadequate pretreatment.	4a. Determine if solids are grit or organic.	4a. Remove solids from reactors and provide improved grit removal or primary settling.

Reprinted, with permission, from *Operation of Wastewater Treatment Plants*, Vol. 3, 4th ed., Office of Water Programs, California State University, Sacramento Foundation

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BILLOWING SOLIDS

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
1. Localized clouds of homogenous sludge solids rising in certain areas of the clarifier. Mixed liquor in settleability test settles fairly well with a clear supernatant.	A. Equipment malfunction.	1. Refer to Troubleshooting Guide No. 1, Observations 1-A, 2-A, and 2-B. 2. Check the following equipment for abnormal operation. a. Calibration of flow meters. b. Plugged or partially plugged RAS or WAS pumps and transfer lines. c. Sludge collection mechanisms, such as broken or worn out flights, chains, sprockets, squeegees, plugged sludge withdrawal tubes. 3. Check sludge removal rate and sludge blanket depth in clarifier.	2) Repair or replace abnormal operating equipment. 3) Adjust RAS rates and sludge collector mechanism speed to maintain sludge blanket depth at 1 to 3 feet from clarifier floor.	pg II-77 pg II-29

I-10

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BILLOWING SOLIDS (continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
	B. Air or gas entrapment in sludge floc or denitrification occurring.	1. Perform sludge settleability test and gently stir sludge when settling to see if bubbles are released.	1) If the process is not nitrifying, refer to Probable Cause A above, and Troubleshooting Guide No. 7, Observation 2.	pg II-90
		2. If bubbles are released, check nitrate mg/l in secondary effluent to see if the process is nitrifying.	2) If the process is nitrifying, refer to Troubleshooting Guide No. 5, Probable Cause A.	
	C. Temperature currents.	1. Perform temperature and D.O. profiles in clarifier.	1) If temperatures exceed 1 to 2 degrees between top and bottom of clarifier, use an additional aeration tank and clarifier if possible.	pg II-81
		2. Check inlet and outlet baffling for proper solids distribution in clarifier.	2) Modify or install additional baffling in clarifiers.	pg II-81
			3) Refer to Probable Cause A-1, and A-2 above.	
	D. Solids washout due to hydraulic overloading.	1. Check hydraulic detention time in aeration tank and clarifier, and surface overflow rate in clarifier.	1) If hydraulic loadings exceed design capability, use additional aeration tanks and clarifiers if possible.	pg II-78
			2) Reduce RAS rate to maintain high sludge blanket depth in clarifier.	pg II-29
			3) If possible, change process operation to sludge retention or contact stabilization mode.	pg III-15
			4) Refer to Probable Causes B-1, B-2, and C-2 above.	

I-11

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 3 — SOLIDS WASHOUT/BULLOWING SOLIDS (continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
2. Localized clouds of fluffy homogenous sludge rising in certain areas of the clarifier. Mixed liquor in settleability test settles slowly, leaving stragglers in supernatant.	A. Overloaded aeration tank (low MLSS) resulting in a young, low density sludge.	1. Check and monitor trend changes which occur in the following: a. Decrease in MLVSS, mg/l. b. Decrease in MCRT, Gould Sludge Age. c. Increase in F/M ratio. d. Lower air SCFM rate to maintain D.O. level.	1) Decrease WAS rates by not more than 10% per day to bring process back to optimum parameters.	pg II-87 & II-36

I-12

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 5 — SLUDGE CLUMPING

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
1. Sludge clumps (from size of a golf ball to as large as a basketball) rising to and dispersing on clarifier surface. Bubbles noticed on clarifier surface. Mixed liquor in settleability test settles fairly well, however a portion of and /or all of the settled sludge rises to the surface within four hours after test is started.	A. Denitrification in clarifier.	1. Check for increase in secondary effluent nitrate level. 2. Check loading parameters. 3. Check D.O. and temperature levels in the aeration tank. 4. Check RAS rates and sludge blanket depth in clarifier.	1) Increase WAS rate by not more than 10% per day to reduce or eliminate level of nitrification. If nitrification is required, reduce to allowable minimum. 2) Maintain WAS rates to keep process within proper MCRT, Gould Sludge Age, and F/M ratio. 3) Maintain D.O. at minimum level (1.0 mg/l). Be sure adequate mixing is provided in the aeration tank. 4) Adjust RAS rate to maintain sludge blanket depth of 1 to 3 feet in clarifier.	pg II-90 & II-36 pg II-35 pg II-24 pg II-29
	B. Septicity occurring in clarifier.	1. Refer to Troubleshooting Guide No. 1, Observation No. 2. 2. See 3 and 4 above.		

I-16

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 8 — CLOUDY SECONDARY EFFLUENT

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
1. Secondary effluent from clarifier is cloudy and contains suspended matter. Mixed liquor in settleability test settles poorly, leaving a cloudy supernatant.	A. MLSS in aeration tank low due to process start-up.	1. Refer to Troubleshooting Guide No. 2, Observation No. 1.		
	B. Increase in organic loading.	1. Perform microscopic examination on mixed liquor and return sludge. Check for presence of protozoa.	1) If no protozoa are present, possible shock organic loading has occurred.	pg II-93 & IV-18
		2. Check organic loading on process.	2) Reduce WAS rate by not more than 10% per day to bring process back to proper loading parameters and increase RAS rates to maintain 1 to 3 foot sludge blanket in clarifier.	pg II-42 & II-36
		3. Check D.O. level in aeration tank.	3) Adjust air SCFM rate to maintain D.O. level within 1.0 to 3.0 mg/l.	pg II-24
	C. Toxic shock loading.	1. Perform microscopic examination on mixed liquor and return sludge. Check for presence of inactive protozoa.	1) If protozoa are inactive, possibility of recent toxic load on process.	pg II-93
			2) Refer to Troubleshooting Guide No. 2, Observation No. 1-C.	

I-17

ACTIVATED SLUDGE PROCESS
SECONDARY CLARIFIER

TROUBLESHOOTING GUIDE NO. 6 — CLOUDY SECONDARY EFFLUENT (continued)

OBSERVATION	PROBABLE CAUSE	NECESSARY CHECK	REMEDIES	REFERENCES
	D. Overaeration causing mixed liquor floc to shear.	1. Perform microscopic examination on mixed liquor. Check for dispersed or fragmented floc and presence of active protozoa.	1) Refer to Troubleshooting Guide No. 1, Observation No. 1-A.	pg IV-18
	E. Improper D.O. levels maintained in aeration tank.	1. Refer to Troubleshooting Guide No. 1, Observation No. 2.		

I-18

NORDIKeau INC.
EXPERTS TECHNIQUES EN GESTION DE L'EAU

5. TROUBLESHOOTING GUIDES

This section presents a summary of Troubleshooting Guides gathered in the available Operation and Maintenance Manuals.

The Troubleshooting Guide in this section only applies to trouble, probable cause, and corrective solution that can occur on mechanical equipment. The problems and solutions related to the process are in Section 4.

For more information, refer to Operation and Maintenance Manual before working on equipment.

5.1 MOTOR AND GEARBOX – BIODISK L333

See appendix A

5.2 TROJAN UV 3000 – BIODISK L333

See appendix B

5.3 PYROTENAX INDUSTRIAL HEAT TRACING – BIODISK LJ-100

See appendix C

5.4 SEVERN TRENT ULTRADYNAMIC UV SYSTEM – BIODISK LJ-100

See appendix D

5.5 GREY LINE FLOWMETER DFM 4.0 - EQT

See appendix E

5.6 YSI ENVIRONMENTAL – YSI 550A DISSOLVED OXYGEN METER

See appendix F

5.7 HACH – SENSION 6 DISSOLVED OXYGEN METER

See appendix G

6. RECORD KEEPING

The operators of the Sewage Treatment Plant (STP) are important players behind any effluent treatment successful story. In successful organizations, the operators are typically tasked with specific responsibilities that include daily chores such as general daily inspection of the STP to ensure that there is no effluent pipe leakages or equipment breakdown, preventive maintenance and performance monitoring, sampling, record keeping, etc. These activities need to be conducted in a coordinated manner to ensure proper functioning of all the STP components.

Monitoring, recording, and reporting of the STP performance are required to demonstrate that the treatment system is functioning correctly and the effluent standards are being complied with.

A successful effluent treatment depends on all components of the STP being operational and in optimal condition. Problems with any system components will affect the overall efficiency of the STP, resulting in poor effluent quality. To ensure a successful treatment and regulatory compliance, each of the treatment processes (unit processes and unit operations) needs close monitoring on a regular basis.

It is recommended to maintain the performance monitoring data and corrective actions taken record to address problems encountered in the STP daily operation. The tables recommended to use are shown in the next pages. The record should be kept in a log or in a file and should be available on demand.

SECTION 7 TROUBLESHOOTING

7.1 Error Codes

Error codes inform the user of an out-of-range value or meter problem. *Table 6* outlines the operator assistance codes available in the meter series.

Table 6

Error Code	Error Type	Possible Remedy
E-1	Data error in the non-volatile memory.	Turn off the meter, then turn it on again.
E-3	Failure to correctly store a reading.	Call Service. Meter cannot store data in at least one location, but is otherwise functional.
E-9	Failure to correctly retrieve a reading that was stored earlier.	Call Service.
E-10	Sample temperature is out of range (0 to 50 °C).	

Note: *To display the electric current coming from the dissolved oxygen electrode, press the* **READ** *and* **CONC** *% keys simultaneously.*

Appendix A

MOTOR AND GEARBOX – BIODISK L333

7.0 - TROUBLE SHOOTING

7.1 - MECHANICAL HARDWARE

TROUBLE	PROBABLE CAUSE	CORRECTIVE ACTION
Noisy chain	1. Loose chain 2. Faulty lubrication 3. Misalignment 4. Worn Parts 5. Moving parts rubbing stationary parts	1. Tighten chain 2. Lubricate properly 3. Correct sprocket alignment 4. Replace worn chain 5. Align & tighten chain to clear oil bath
Rapid wear on chain	1. Faulty lubrication 2. Loose or misalign parts	1. Lubricate properly 2. Align & tighten entire drive
Chain climbing sprockets	1. Worn out chain and sprockets 2. Loose chain	1. Replace worn out parts 2. Tighten chain
Stiff chain	1. Misalignment 2. Worn out chain or sprockets 3. Faulty lubrication 4. Rust corrosion	1. Correct alignment 2. Replace worn out parts 3. Lubricate properly 4. Clean and lubricate
Noisy Bearing	Rollers or bearings damaged	Replace bearing cartridge
Bearing grease discoloured or mixed with water	Insufficient grease in the bearings	Purge bearing with grease and increase lubrication interval
Hot bearing	1. Improper lubrication 2. Rollers or bearing race damaged	1. Purge bearing with grease and decrease lubrication interval 2. Replace bearing cartridge
Reducer temperature rises above 200 degrees Fahrenheit.	Oil level too high or too low	Maintain proper oil level
Oil leakage from reducer	1. Oil seals need to be replaced 2. Ventilators/breather plugged causing pressure build-up inside the reducer. 3. Oil level too high	1. Replace oil seals 2. Clean Ventilators 3. Correct oil level
Noisy reducer	1. Bearing failure 2. Misalignment in worm gear inside 3. Coupling between motor and reducer worn out and misalign	1. Check bearings and replace if necessary 2. Align worm gear shafts. 3. Replace coupling between motor and reducer. Align coupling hub vertically
Noisy Motor	Bearing damage	Replace damaged bearings
Motor overheating	1. Reducer overheating 2. Cooling fins on motor are clogged 3. Overload 4. Rotor rubbing on stator 5. Over greasing or lubrication	1. Check reducer 2. Clean fins 3. Check for excess friction or imbalance 4. Replace bearings 5. Avoid packing grease too tightly
Motor won't start	1. Power trouble 2. Single phasing at station 3. Fuse blown	1. Check source of power supply 2. Do not try to make it go and "fry" motor. Check starter windings 3. Replace fuse
Knocking/rumbling on motor bearings	1. Bearing worn due to lack of lubrication or excessive mechanical overload 2. Bearings slack in housing	1. Replace bearing and put new grease of recommended grade. 2. Fir new end shields
Rotordisk® shaft doesn't turn	1. Power failure 2. Motor failure 3. Reducer failure 4. Chain drive failure	1. Check power supply 2. Check and replace motor and bearings. 3. Check teeth worn gears and bearings. Replace necessary parts 4. Replace chain

Motor Trouble Shooting Chart

Problem	Likely Causes	What To Do
Motor fails to start upon initial installation.	Motor miswired.	Verify motor is wired correctly.
	Motor damaged and rotor is striking stator.	May be able to reassemble; otherwise, motor should be replaced.
	Fan guard bent and contacting fan.	Replace fan guard.
Excessive humming	High voltage.	Check input line connections
Motor had been running, then fails to start.	Fuse or circuit breaker tripped.	Replace fuse or reset breaker.
	Stator is shorted or went to ground. Motor will make a humming noise and the circuit breaker or fuse will trip.	Contact NORD for assistance
	Motor overloaded or load jammed.	Inspect to see that the load is free. Verify amp draw of motor versus nameplate rating.
Motor runs but dies down.	Voltage drop.	If voltage is less than 10% of the motor's rating contact power company or check if some other equipment is taking power away from the motor.
	Load increased.	Verify the load has not changed. Verify equipment hasn't got tighter. If fan application verify the airflow hasn't changed.
	Bad bearings.	Noisy or rough feeling bearings should be replaced.
	Voltage too low.	Make sure that the voltage is within 10% of the motor's nameplate rating. If not, contact power company or check if some other equipment is taking power away from the motor.
Motor runs in the wrong rotation.	Incorrect wiring.	Disconnect from power source and interchange any two of the three line leads from the three-phase motor.
Vibration	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Resonance.	Tune system or contact NORD for assistance.
Motor overload protector continually trips.	Load too high.	Verify that the load is not jammed. If motor is a replacement, verify that the rating is the same as the old motor. If previous motor was a special design, a stock motor may not be able to duplicate the performance. Remove the load from the motor and inspect the amp draw of the motor unloaded. It should be less than the full load rating stamped on the nameplate.
	Ambient temperature too high.	Verify that the motor is getting enough air for proper cooling. Most motors are designed to run in an ambient temperature of less than 40° C. (Note: A properly operating motor may be hot to the touch.)
	Winding shorted or grounded.	Inspect stator for defects, or loose, cut wires that may cause it to go to ground.

NORD Gear Corporation
National Customer Service Toll Free 888-314-6673
www.nord.com

NORD Gear Limited
Toll Free in Canada 800-668-4378

WEST
1121 Railroad Street
Building 101
Corona, CA 92882
Phone 909-279-2600
Fax 888-408-6673

MIDWEST
PO Box 367
800 Nord Drive
Waunakee, WI 53597
Phone 608-849-7300
Fax 800-373-6673

SOUTH
100 Forsyth Hall Dr.
Building 100B
Charlotte, NC 28273
Phone 704-529-1255
Fax 888-259-6673

CANADA
41 West Drive
Brampton, Ontario L6T 4A1
Phone 905-796-3606
Fax 905-796-8130

TROUBLE SHOOTING

PROBLEM WITH THE REDUCER		POSSIBLE CAUSES	SUGGESTED REMEDY
Runs Hot	Overloading	Load exceeds the capacity of the reducer	Check rated capacity of reducer, replace with unit of sufficient capacity or reduce load
	Improper lubrication	Insufficient lubrication	Check lubricant level and adjust up to recommended levels
		Excessive lubrication	Check lubricant level and adjust down to recommended levels
		Wrong lubrication	Flush out and refill with correct lubricant as recommended
Runs Noisy	Loose foundation bolts	Weak mounting structure	Inspect mounting of reducer. Tighten loose bolts and/ or reinforce mounting and structure
		Loose hold down bolts	Tighten bolts
	Worn RV Disc	Overloading unit may result in damage to disc	Disassemble and replace disc. Recheck rated capacity of reducer.
	Failure of Bearings	May be due to lack of lubricant	Replace bearing. Clean and flush reducer and fill with recommended lubricant.
		Overload	Check rated capacity of reducer.
	Insufficient Lubricant	Level of lubricant in the reducer not properly maintained.	Check lubricant level and adjust to factory recommended level.
Output Shaft Does Not Turn	Internal parts are broken	Overloading of reducer can cause damage.	Replace broken parts. Check rated capacity of reducer.
		Key missing or sheared off on input shaft.	Replace key.
		Coupling loose or disconnected.	Properly align reducer and coupling. Tighten coupling.
Oil Leakage	Worn Seals	Caused by dirt or grit entering seal.	Replace seals. Autovent may be clogged. Replace or clean.
		Overfilled reducer.	Check lubricant level and adjust to recommended level.
		Autovent clogged.	Clean or replace, being sure to prevent any dirt from falling into the reducer.
		Improper mounting position, such as wall or ceiling mount of horizontal reducer.	Check mounting position. Name tag & verify with mounting chart in manual.

NORD Gear Corporation
National Customer Service Toll Free 888-314-6673
www.nord.com

NORD Gear Limited
Toll Free in Canada 800-668-4378

WEST
1121 Railroad Street
Building 101
Corona, CA 92882
Phone 909-279-2600
Fax 888-408-6673

MIDWEST
PO Box 367
800 Nord Drive
Waunakee, WI 53597
Phone 608-849-7300
Fax 800-373-6673

SOUTH
100 Forsyth Hall Dr.
Building 100B
Charlotte, NC 28273
Phone 704-529-1255
Fax 888-259-6673

CANADA
41 West Drive
Brampton, Ontario L6T 4A1
Phone 905-796-3606
Fax 905-796-8130

Appendix B

TROJAN UV 3000 – BIODISK L333

13.1 Basic System Troubleshooting

UV module (UVM) troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. One UV lamp status LED is off	Corresponding lamp is off	Lamp failure	Replace lamp
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
	Corresponding lamp is on	Module Board (MCB)	Replace module board
2. Two UV lamp status LEDs are off (lamps 1&2 or lamps 3&4)	Corresponding lamps are off	Lamp failure	Replace lamps
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
		Ballast failure	Replace ballast
	Both LEDs are off in a two-lamp module	No power to the module	Inspect module power cable – is it plugged-in or damaged? Reset ground fault of PDR or reset PDR supply breaker
	Corresponding lamps are on	Module Board (MCB)	Replace module board
3. All UV lamp status LEDs are off	All lamps are off	Lamp failure	Replace lamps
		Lamp holder / wiring	Inspect lamp holder and wiring and replace as necessary
		Water intrusion	Inspect and replace lamp, sleeve and o-ring as necessary
		Ballast failure	Replace ballast
	All lamps are on	Module Board (MCB)	Replace module board
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE AT 1-800-666-9459			

Power Distribution Receptacle (PDR) Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. Ground Fault (GFI) trips	GFI trips for a specific module only	Cracked sleeve causing water intrusion	Replace sleeve
		Faulty o-ring causing water intrusion	Replace o-ring
		End-cap assembly causing water intrusion	Inspect and repair or replace end-cap assembly
		Faulty or cut wiring	Inspect and repair or replace faulty wiring
	GFI trips for any module	Faulty wiring at GFI	Inspect and repair or replace wiring as necessary
		Faulty GFI receptacle	Replace GFI receptacle
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE AT 1-800-666-9459			

Monitoring System Troubleshooting

Condition	***Symptom***	***Possible Cause***	***Solution***
1. Elapsed Time display flashing		Elapsed time displays 9500-10,000, 19,500-20,000… hours	Replace lamps. Display will stop flashing after 10,000, 20,000… hours
2. UV intensity display is flashing and displaying 0.0mW/cm^2		Sensor cable is not connected to monitoring system	Reconnect UV sensor to monitoring system
		Fouled sleeve and/or sensor	Clean sleeve and sensor as required
		Loose or no connection at TB5 terminal in monitoring system enclosure	Tighten or reconnect wiring at terminal
3. UV intensity display is flashing and displaying value less than alarm set point (1.6 mW/cm^2)		Fouled sleeve and/or sensor	Clean sleeve and sensor as required
IF YOU HAVE CHECKED ALL POSSIBLE CAUSES, PLEASE CALL TROJAN TECHNOLOGIES FOR TECHNICAL ASSISTANCE AT 1-800-666-9459			

Appendix C

PYROTENAX INDUSTRIAL HEAT TRACING
BIODISK LJ-100

10 Troubleshooting Guide

Symptom	Probable Causes	Corrective Action
Insulation resistance less than expected	1. Rainy or high humidity. 2. Nicks or cuts in heating cable sheath, with moisture present. 3. Kinked or crushed heating cable. 4. Arcing created by damage to the heating cable. 5. Physical damage to heating cable is causing a direct short. 6. Presence of moisture in terminations or connections. 7. Damaged termination.	(1) Dry tails and face of seal. (2, 3, 4) Visually inspect cable for damage, especially at elbows, flanges, and around valves. If damaged, repair or replace heating cable. Inspect power connection box for moisture or signs or tracking. Dry out connections and retest. (5) Check for visual indications of damage around the valves, pump, and any area where there may have been maintenance work. Look for crushed or damaged insulation along the pipe. Replace damaged sections of heating cable. (6) Dry out cold lead and/or connections and replace termination if necessary. (7) Replace termination

Symptom	Probable Causes	Corrective Action
Circuit breaker trips	1. Circuit breaker undersized. 2. Defective circuit breaker. 3. Short circuit in electrical connections. 4. Excessive moisture in connection boxes. 5. Nicks or cuts in heating cable sheath, moisture present. 6. Kinked or crushed heating cable. 7. Ground-fault protection device (GFPD) is undersized (5mA used instead of 30mA) or miswired.	(1) Recalculate circuit load current. Resize breaker as required. (2) Repair or replace breaker. (3, 4) Eliminate short circuit. Thoroughly dry connections. Install conduit drains as required. (5, 6) Repair damaged section or replace heating cable. (7) Replace undersized GFPD with 30mA GFPD. Check the GFPD wiring instructions.

Note: *If the corrective actions above do not resolve the problem, verify that the installation is as per design.*

38

39

10 Troubleshooting Guide

Symptom	Probable Causes	Corrective Action
Power output appears correct but pipe temperature is below design maintain temperature.	1. Wet or missing insulation.	(1) Remove wet insulation and replace with dry insulation and secure it with proper weather-proofing.
	2. Insufficient heating cable on valves, flanges, supports, pumps, and other heat sinks.	(2) Confirm compliance with system design. (If valve, flange, and pipe support types and quantities have changed, additional heating cable may be required.)
	3. Temperature controller set incorrectly.	(3) Reset temperature controller.
	4. Improper thermal design used.	(4) Contact your Tyco Thermal Controls representative to confirm the design and modify as recommended.
	5. Temperature sensor in wrong location.	(5) Confirm that sensor is in the correct location.
	6. Low fluid temperature entering pipe.	(6) Verify temperature of fluid entering pipe.

Symptom	Probable Causes	Corrective Action
Power output is zero or incorrect	1. No input voltage.	(1) Repair electrical supply lines and equipment.
	2. Temperature controller wired in the normally open (N.O) position.	(2) Confirm wiring using the normally closed (N.C.) terminals so that contacts close with falling temperature.
	3. Broken or damaged heating element, hot-cold joint, end cap, or broken tail.	(3) Repair or replace heating cable.
	4. Wrong cable used.	(4) Verify installation as per design and replace cable if necessary.
	5. Improper voltage used.	(5) Verify voltage and connect to proper voltage if necessary.

Note: *If the corrective actions above do not resolve the problem, verify that the installation is as per design.*

Appendix D

SEVERN TRENT ULTRADYNAMIC UV SYSTEM – BIODISK LJ-100

6 TROUBLESHOOTING CHART

Trouble	Probable Cause	Corrective Action
1. Low UV Output	a. Dirty quartz jacket b.Old or broken quartz jacket c.Old Uv lamps d.Water or condensation inside quartz jacket	a.Remove and clean quartz jacket b.Replace quartz jacket c.Replace UV Lamps d.Remove jacket and dry internal quartz
2.Low voltage output	a.Bad regulator	a.Replace regulator
3.Lamp out	a.Bad lamp b.Bad ballast	a.Replace lamp b.Replace ballast
4.Low UV transmission	a.dirty, cloudy or high mineral count	a.Install pre-filter or de-mineralizer
5.Sensor inoperative	a.Dirty sensor lens	a.Remove and clean lens
6.Sensor malfunctioning	a.Water or condensation inside sensor b.Sensor calbe not connected	a.Remove and dry inside sensor b.Verify that the sensor cable is connected to the monitor
7.Monitor not operating	a.Sensor cable not connected b.Monitor switch in the OFF position c.No power to monitor d.Incorrect power supply to monitor.	a.Verify that the sensor cable is connected to the monitor b.Verify that the monitor switch is in the ON position c.Verify power to monitor. d.Verify power supply voltage to monitor, either 120 Vac or 240 Vac.

Design improvements may be made without notice.
Represented by:

SEVERN TRENT SERVICES

Severn Trent Services
3000 Advance Lane Colmar, PA 18915
Tel: 215-997-4000 • Fax: 215-997-4062
Web: www.severntrentservices.com
E-mail: marketing@severntrentservices.com

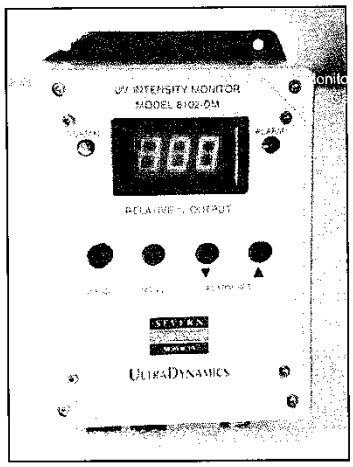
Copyright 2008 Severn Trent Services

Maintenance:
(Reference Figure 1 & 3)
Listed in the below table are possible causes for a reduced reading of UV intensity.

Indication	Cause	Corrective Action
Gradual loss of UV intensity over several weeks or months	Fouled quartz sleeve	Follow UV System instruction manual for quartz sleeve cleaning procedure
Gradual loss of UV intensity over a 1 year period	Lamp degradation	Replace UV lamp - lamps last for 1 year Refer to UV system instruction manual
Total loss of UV intensity Check lamp status alarm	Lamp failure	Replace UV lamp Refer to UV system instruction manual
Gradual or total loss of intensity after the above have been ruled out	Change in water quality	Increase in suspended or dissolved solids may require installation of pre-filter

When cleaning the UV system quartz sleeve it is also necessary to clean the UV sensor probe. Shut off water, relieve the system pressure and/or isolate (valve out) the UV chamber. Remove the monitor by unscrewing the white retaining nut and sliding the probe out of the sensor port.

Deposits on the sensor probe are mostly caused by suspended and dissolved solids and minerals naturally occurring in the water. This coating can be easily removed by applying a small amount of lemon juice to a soft dry cloth and gently rubbing the sensor probe until clean, rinsing with hot water.



Detailed Menu Level Description

L01 Press the menu key once. L01 will be displayed. Press the menu key again. The preset alarm level will be displayed. Use the up and down keys to select the new alarm level. Press the menu key return to return to the Relative % Output display. The new alarm level will be set. If the up or down keys are not activated for longer then two seconds, the unit will default to the Relative % Output display.

L02 This function is not used on the Series 8102–DM /P. Changing this value will have no affect on the unit's operation.

L03 Press the menu key once. Press the up key twice to display L03. Press the menu key once. The absolute detector current will be displayed in milliamperes. Press the menu key again to return to the Relative % Output display.

L04 Press the menu key once. Press the up key three times to display L04. Press the menu key once. The absolute detector voltage will be displayed in Volts. Press the menu key again to return to the Relative % Output display

L05 Consult Factory, not for customer use.

Appendix E

GREYLINE FLOWMETER DFM 4.0 EQT

FIELD TROUBLESHOOTING

Possible Causes:	*Corrective Action:*
METER READING LOWER THAN EXPECTED	
Calibration Error	• Review UNITS/MODE menu and Pipe ID
Lower flow rate than expected	• Investigate pump/valves. Compare velocity with alternate instrument
Signal not penetrating far enough into the flow stream	• Relocate sensor closer to elbows or flow disturbances
Improper mounting of sensor	• Reinstall Sensor with careful application of Coupling Compound
Pipe is not full	• Remount Sensor on vertical pipe
METER READING WHEN THERE IS NO FLOW	
Vibration on pipe	• Install in another location
Local electrical noise	• Ensure all Flowmeter wiring is in METAL conduit and sensor shield is properly grounded. • Ensure correct power input Ground connection (<1 ohm resistance). • Ensure 4-20mA Shield connected to Instrument Ground stud.
Cross talk between two or more DFM 4.0 flowmeters on same pipe	• Turn OFF one flowmeter or relocate the second flowmeter at a greater distance.
Variable Speed Drive interference	• Follow Drive manufacturers wiring and Grounding instructions • Relocate Flowmeter electronics, Sensor and wiring away from VSD
Valve leak or Reverse flow	• Test Valve. Relocate Sensor farther from valve • Use Backflow Rejection
Sensor connections incorrect	• Refer to Connections diagram

Possible Causes:	*Corrective Action:*
METER READING ERRATIC	
Sensor mounted too close to valve, pump or elbow	• Change sensor placement. Recommended 6-10 diameters from elbows, and 30 diameters from pumps, controlling valves, orifice plates, nozzles or open pipe discharge
NO FLOW INDICATION	
Not enough suspended particles or gases in the fluid	• Relocate sensor in more turbulent pipe section. Mount sensor at 12 o'clock position on horizontal pipe
Coupling compound washed out, or sensor loose on pipe	• Remount sensor • Use Dow Corning Silicone #4
`Slave` selected in `SPECIAL FUNCTIONS` menu with no Synchronization input from Master.	• Select `Master` in `SPECIAL FUNCTIONS` menu.
Power interruption. No flow.	• Check fuse/breaker. Confirm flow
METER READING TOO HIGH	
Calibration error	• Review UNITS/MODE menu and Pipe ID
Vibration or noise on the pipeline	• Install in another location.
Pipe is not full	• Remount Sensor on vertical pipe
Nearby velocity increasing device (pump, valve, orifice plate)	• Relocate sensor >30 pipe diameters from velocity increasing device
Local electrical noise	• Ensure all Flowmeter wiring is in METAL conduit and sensor cable shield is connected to Ground stud
Variable Speed Drive interference	• Follow Drive manufacturers wiring and Grounding instructions • Relocate Flowmeter electronics, Sensor and wiring away from VSD

Possible Causes:	*Corrective Action:*
METER READING DOES NOT TRACK FLOW	
Sensor and GND wires reversed or not properly connected	• Check Sensor connections
Improper AC power input Ground	• Use direct connection with 12 AWG wire to nearest Ground pole (<1 ohm resistance).

Appendix F

YSI ENVIRONMENTAL – YSI 550A DISSOLVED OXYGEN METER

TROUBLESHOOTING

NOTE: An error displayed briefly during the first few seconds after turning the instrument on does NOT indicate a problem.

SYMPTOM	POSSIBLE SOLUTION
1. Instrument will not turn on, LCD displays "LO BAT", or Main display flashes "OFF"	A. Low battery voltage, replace batteries B. Batteries installed incorrectly, check battery polarity C. Return system for service
2. Instrument will not calibrate.	A. Replace membrane and electrolyte B. Clean probe electrodes C. Return system for service
3. Instrument "locks up".	A. Remove batteries, wait 15 seconds for reset, replace batteries B. Replace batteries C. Return system for service
4. Instrument readings are inaccurate.	A. Verify calibration altitude and salinity settings are correct and recalibrate. B. Probe may not have been in 100% water saturated air during calibration procedure. Moisten sponge in calibration chamber and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
5. Main display reads "Over" or "Undr".	A. Sample O_2 concentration is more than 60 mg/L or 500%, or less than –0.02 mg/L or -0.3%. B. Verify calibration altitude and salinity settings are correct and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
6. Main display reads "Over" or "Undr" during calibration.	A. Replace membrane and electrolyte. Recalibrate. B. Clean probe electrodes. C. Return system for service.
7. Secondary display reads "Ovr" or "Undr".	A. Sample temperature is less than -5° C (23°F) or more than +45°C (122°F). Increase or decrease the sample temperature to bring within the allowable range. B. Return system for service.

Appendix C: STP Sample Sheets

MEADOWBANK STP - MONTHLY REPORT

Month: **February 2010** **Average flow:**

PARAMETER	INFLUENT	EFFLUENT	EFFICIENCY	COMMENTS
Independant laboratory				
BOD (mg/L)				
COD (mg/L)				
TSS				
TKN				
NH3-NH4				
NO2-NO3				
P tot				
Fecal Coliform				
On site				
pH				
Alkalinity				
D.O.				
Turbidity				
Temperature		22		

Sludge extractions (m^3)	Primary tanks	Final Clarifier	Comments
LJ-1			
LJ-2			
LJ-3			
L-333			
Total			

MEADOWBANK STP - WEEKLY ANALYSIS

Month: _____

DATE:						Average
STP - INFLUENT						
BOD_5 (mg O_2/L)						
COD (mg O_2/L)						
TSS (mg/L)						
TKN (mg N/L)						
NH_3-NH_4 (mg N/L)						
P tot (mg/L-P)						
STP - FINAL EFFLUENT						
BOD_5 (mg O_2/L)						
COD (mg O_2/L)						
TSS (mg/L)						
TKN (mg N/L)						
NH_3-NH_4 (mg N/L)						
NO_2-NO_3 (mg N/L)						
P tot (mg/L-P)						
Fecal Coliform (UFC/100 mL)						

Comments :

MEADOWBANK MINE - SEWAGE TREATMENT PLANT

Month: _____ **201** ____

Date	Time	Operator	Concentration of gaz at L-333				COMMENTS
			CO Level (ppm)	O_2 Level (%)	Comb/Ex	H_2S (ppm)	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							

MEADOWBANK MINE - SEWAGE TREATMENT PLANT

Month: _____ **201** ____

Date	Time	Operator	LJ -1				LJ -2				L 333				FINAL EFFLUENT				Grey Water LS-3	
			D.O		pH	Temp	D.O		pH	Temp	D.O	pH	Temp		D.O	pH	Temp.	Colour	pH	Temp
			In (mg/L)	Out (mg/L)	Out	Out (° C)	In (mg/L)	Out (mg/L)	Out	Out (° C)	Out (mg/L)	Out	Out (° C)		(mg/L)		(° C)			(° C)
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				
21																				
22																				
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				
31																				

Appendix D: Site Services Protocols and Procedures

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

PROCEDURE NUMBER:			MBK-SIT-0025
People concerned	**Site Services**	**Prepared by**	Services Department
		Approved by	Alain Hamel Services General Superintendent
Issuing date :	2012-04-11		
This procedure corresponds to the required minimum standard. Each and every one also has to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.			

Objective:

To

Concerned departments:

Site services

Required employee preparation:

- Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

✓

Impacts			
Health & Safety	Process/Quality	Costs	Environment

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

Procedure	Risks/ Impacts
The screen in the top left corner of the panel is what is used for controlling the pumps	
1. Start at the screen "SYSTEM STATUS MENU"	Prevent incident and /or accident; health issues
2. If the screen is not at "SYSTEM STATUS MENU" press "DISP" (DISPLAY)	Prevent incident and /or accident; health issues
3. If the "DISP" is not showing but a "PREV" is, press the "PREV" until you come to "DISP"	
4. Press the "DISP" key and that will take you to the "SYSTEM STATUS MENU"	
5. For pumps 1 & 2 which currently feed LJ #1 press PAIR 1 , "ON & OFF SCREEN"	
6. For pumps 3 & 4 which currently feed LJ #3 press PAIR 2 , "ON & OFF SCREEN"	
7. For pumps 5 & 6 which currently feed L333 press PAIR 3 , "ON & OFF SCREEN"	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

8. After pressing the pair of pumps you want to change press NEXT (middle right)	
9. You will see the "PUMP PAIR " screen	
10. Press Next	
11. You will now be at the "FLOW RATE & ENABLE " screen	
12. Press ADFI(l/s) (top left corner)	
13. Curser will be flashing on the last number on right	
14. Using the BS (Back space key) press until you are at the number you would like to change	
15. i.e. +0.4500 on the screen presently	
16. Each time you press the BS key you will remove a number from the left	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

17. Pressing BS 4 times will bring you to +0	
18. If you want to change it to +0.5150 , press the 5 , then the 1 , and the 5, not necessary to press 0	
19. After you have done this press "ENT" (bottom left)	
20. The ADF(Average Daily Flow) on the pump has now been changed	
21. To get back to the main menu	
22. Press "PREV"(bottom middle)	
23. Then press "DISP"	
24. You are now back to the main menu	
25. The above instructions are for pairs #1 & #3	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

26. **Pair # 2 is a little different**	
27. **You will notice that in pairs #1 & #3 the number you have programmed into the" ADFl (l/s)" screen of the "FLOW RATE & ENABLE" screen is the same as in the "PUMP PAIR " screen**	
28. **Pump #2 will have a lower number in the "FLOW RATE & ENABLE" screen than in the "PUMP PAIR" screen *(It is just the way it has been programmed)***	
29. **i.e. in order to get 45 seconds on the "PUMP PAIR " screen you have to enter +0.2800 in the ADFl(l/s) screen of the "FLOW RATE & ENABLE" screen**	
30. **The ADFl(l/s) number is approx. 63% of the seconds (not including the decimal point)**	
31. **You will just need to play with it a bit to get the number you want**	
32. **Important:** If you happen to press "ENABLE" in the "FLOW RATE & ENABLE" screen by mistake and it is now at "DISABLE" just press the "DISABLE" and it will go back to "ENABLE"	
33. **When you are at the first menu ("SYSTEM STATUS MENU") ensure that the pairs 1 , 2 & 3 all have an "EN" displayed if all pumps are being used**	
34. If not , go to the pair that has a "DIS" on it , press that pair	

Changing the length of time the pumps will pump from the EQ tank into the Bio-Disks

35. Press "NEXT" to get to the "FLOW RATE & ENABLE" screen	
36. Press on "DISABLE" to change it back to "ENABLE"	
37. Press "PREV"	
38. Press DISP"	
39. You should be back at the Main Menu	

Personal Hygiene at STP

Personal Hygiene Protocol to follow when working at the Sewage Treatment Plant and Lift Stations

Daily Inspection and readings

Lab coat

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Testing - every second day

Lab coat

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Cleaning Lift Station #3

Tyvek suit

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Cleaning/Changing U.V. lamps - Little Johns/L333

Tyvek suit

Boot covers

Nitrile gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Personal Hygiene Protocol to follow when working at the Sewage Treatment Plant and Lift Stations

Sludge measurement

Tyvek suit

Boot covers

Nitrile gloves inside rubber gloves

Safety glasses

- Shower not required
- Thorough washing and disinfection of hands before leaving decontamination unit

Sludge removal

Tyvek suit

Boot covers

Nitrile gloves inside rubber gloves

Safety glasses with full face shield/full face respirator

- Shower required

Changing Pumps in influent lift stations/working on pipes - raw sewage (plumbers?)

Tyvek suit

Boot covers

Nitrile gloves inside rubber gloves

Safety glasses

- Shower required

Changing Pumps in effluent lift stations/working on pipes (plumbers?)

Tyvek suit

Boot covers

Nitrile gloves - rubber gloves if required

Safety glasses

- Shower required

SAMPLING AND TESTING

TARGET ANALYSIS RESULTS

	TARGET	ACCEPTABLE
pH	6.5 - 8.0	6.0 - 8.5
D.O. in	> 1.0 ppm	> .3 ppm
D.O. out	> 4.0 ppm	> 2.0 ppm
Temperature	20 - 25 C	15 - 30 C
Turbidity	< 20 NTU	< 40 NTU

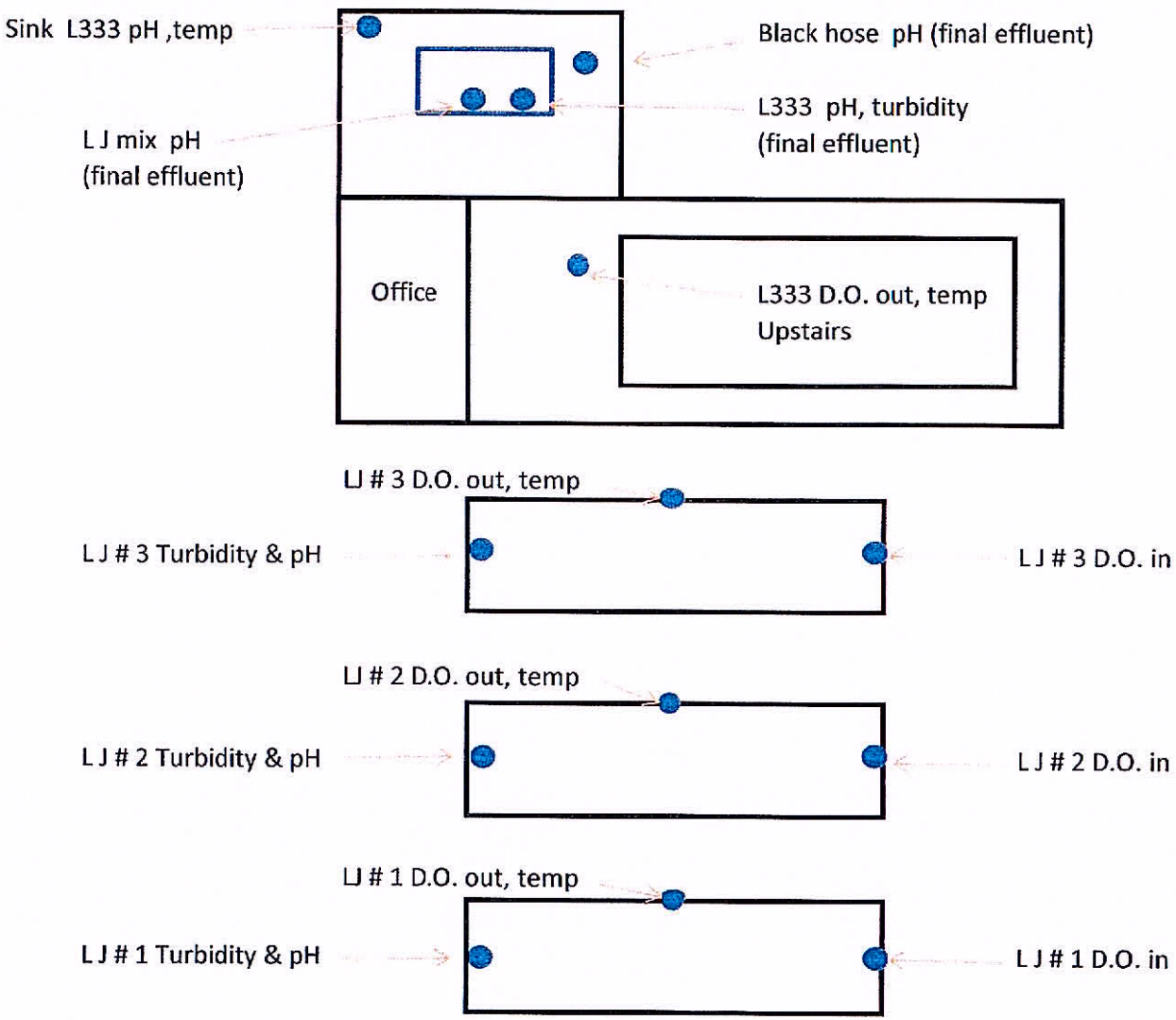
L J = Little Joh. S = Lift Station

STP SAMPLING POINTS

Location	Sampling Points	Frequency	Parameters	pH for Environment
Lift station #3 room	STP IN (Sink close to LS #3)	Every second day	pH temperature	Every Monday or whenever requested by environment department
L J back door	L J # 1 & # 3 IN	Every second day	D.O.	
L J side door	L J # 1 & # 3 OUT	Every second day	D.O. temperature	
L J double doors	L J #1 & # 3 FINAL EFFLUENT (Sample line in LJ close to the flowmeter above the clarifier)	Every second day	pH turbidity	Every Monday or whenever requested by environment department
L333 upstairs	L333 OUT (D.O. is marked on sample point)	Every second day	D.O. temperature	
Lift station #3 room	L333 FINAL EFFLUENT (3/8 " sample line above LS #3)	Every second day	pH turbidity	Every Monday or whenever requested by environment department
Lift station #3 room	L J MIX FINAL EFFLUENT (1" sample line above LS #3)		pH	Every Monday or whenever requested by environment department
Lift station #3 room	FINAL EFFLUENT (black hose from pipe beside flowmeter at LS #3)		pH	Every Monday or whenever requested by environment department

Note: Mondays pH tests done for the Environment Dept must be given to them that day

Sample points at the STP



L J = Little John L333 = Big Bertha

Calibration of pH meter

PROCEDURE NUMBER:			MBK-SIT-0023
People concerned	**Site Services**	**Prepared by**	Services Department
		Approved by	Alain Hamel Services General Superintendent
Issuing date :	2012-04-11		

This procedure corresponds to the required minimum standard. Each and every one also has to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.

Objective:

To

Concerned departments:	Required equipment
Site services	

Impacts			
Health & Safety	Process/Quality	Costs	Environment

Calibration of pH meter

Procedure	Risks/ Impacts
For better accuracy, frequent calibration of the instrument is recommended	Prevent incident and /or accident; health issues
Calibrate once a week and record on calibration report	Prevent incident and /or accident; health issues
1. From the normal measuring mode, **press and hold** the MODE button until OFF and until the secondary LCD is replaced by CAL	
2. Release the button. The LCD enters the calibration mode displaying "pH 7.01 USE"	
3. After 1 second the meter activates the automatic buffer recognition feature	
4. For a two point calibration, place the electrode in pH 7.01 buffer solution. After the first calibration point has been accepted, the "pH 4.01 USE" message appears	
5. If no valid buffer is recognized, then the "WRNG" message is shown. It may be time to change the buffer solutions	
6. If a valid buffer (4.01) is detected, then the meter completes the calibration procedure	

Calibration of pH meter

7. When the buffer is accepted, the LCD shows the accepted value with the "OK 2" message and then the meter returns to the normal measuring procedure mode	
8. ***THE ELECTRODE MUST STAY WET DURING STORAGE. ENSURE THAT THERE IS ALWAYS WATER IN THE STORAGE CAPSULE***	
9. ***Taking pH Measurements***	
10. **Submerge** the electrode **in the solution** to be tested while **stirring it gently**	
11. The **measurement** should be **taken when** the stability symbol **(clock)** on the top left of LCD **disappears**	

Testing at the STP

PROCEDURE NUMBER:		MBK-SIT-0022	
People concerned	**Site Services**	**Prepared by**	Services Department
		Approved by	Alain Hamel Services General Superintendent
Issuing date :	2012-04-11		
This procedure corresponds to the required minimum standard. Each and every one also has to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.			

Objective:

To

Concerned departments:

Site services

Required employee preparation:

- Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

Required equipment

- ✓ PPE : Safety glasses , hard hat, nitrile gloves, gas detector

Impacts			
Health & Safety	Process/Quality	Costs	Environment

Testing at the STP

Procedure	Risks/ Impacts
1. Turn on the D.O and calibrate before testing	Prevent incident and /or accident; health issues
2. Turn on the pH meter and calibrate if necessary(once a week)	Prevent incident and /or accident; health issues
3. Turn on the turbidity meter and calibrate if necessary(once a month)	
4. Check the chart on the wall for schedule and locations of sampling points	
5. Procedures for each sampling point are posted at each location	
6. Record all test results and enter into computer	

Procedures For Little John's

Procedures for Changing U.V. Lamps and

Changing/Cleaning Tubes in Little John U.V. Lamp Units

Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

✓ **Warning : Do not look at the U.V. lamps when they are on**

There are 2 sealed U.V. lamp units , both have 6 U.V. lamps inside each unit

✓ **PPE: Tyvek suit, boot covers, nitrile gloves, safety glasses, hard hat, locks for locking out electrical panel**

1) Check for gases with gas detector before entering the U.V. lamp area
2) Shut off and lock out one of the U.V. lamps units
3) Using a step ladder close the valves on both sides of the unit being cleaned
4) Place a pail under the drain hose and open the valve
5) Crack the outlet valve a bit to allow the unit to drain
6) Once the unit has been drained remove the sensor
7) The sensor is located on the side of each unit and is threaded in
8) With the 50% Lime Away solution spray bottle clean the sensor by spraying it and then wiping it down with a soft paper towel/kleenex
9) Take another dry paper towel/kleenex and wipe the sensor dry
10) Take the water hose and spray water into the sensor hole and let it drain to remove some of the dirt inside the unit
11) Thread sensor unit back into chamber
12) Close the valve on the drain hose
13) Remove the wiring harness from the U.V. lamps
14) Remove the U.V. lamps being very careful not to break them
15) Some end caps may need to be removed to get the lamps out(very tight spot)
16) These will need to be disposed of as HAZMAT
17) Remove the threaded end caps from the unit if removing the tubes
18) If the tubes are not being taken out the end caps do not need to be removed
19) If the tubes are being cleaned or replaced remove them as well by pulling them out
20) Be careful not to lose the o rings and stainless steel washers
21) Clean the tubes with Lime away if they are going to be cleaned
22) Install cleaned or new tubes

23) Install the U.V. lamps being careful not to get them dirty
24) Thread the end caps back into place
25) Put the wiring back on the lamps taking note that the wires are numbered to match with the unit
26) Unlock the Unit
27) Turn the unit back on for approximately 2 minutes
28) Open up the inlet and outlet valves
29) Wait for a few minutes to ensure that the lamps are working properly by checking the reading on the monitor.
30) The unit will now need to be calibrated
31) See the manual for calibrating
32) After calibrating the unit % will be at 100
33) The % will fluctuate at times as the effluent flows and particles of dirt get on the sensor
34) Enter the date the U.V lamps/tubes were changed in the back of the daily log book

Procedures for Cleaning Little John U.V. Lamp Sensor (downstairs)

Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

✓ **Warning : Do not look at the U.V. lamps when they are on**

There are 2 sealed U.V. lamp units , both have 6 U.V. lamps inside each unit

✓ **PPE: Tyvek suit, boot covers, nitrile gloves, safety glasses, hard hat, locks for locking out electrical panel**

1) Check for gases with gas detector before entering the U.V. lamp area
2) Shut off and lock out the U.V. lamp unit that is being cleaned
3) Using a step ladder close the valves on both sides of the unit being cleaned
4) Place a pail under the drain hose and open the valve
5) Crack the outlet valve a bit to allow the unit to drain
6) Once the unit has been drained remove the sensor
7) The sensor is located on the side of each unit and is threaded in
8) With the 50% Lime Away solution spray bottle clean the sensor by spraying it and then wiping it down with a soft paper towel/kleenex
9) Take another dry paper towel/kleenex and wipe the sensor dry
10) Take the water hose and spray water into the sensor hole and let it drain to remove some of the dirt inside the unit
11) Thread sensor unit back into chamber
12) Close the valve on the drain hose
13) Unlock the Unit
14) Turn the unit back on for approximately 2 minutes
15) Open up the inlet and outlet valves
16) Wait for a few minutes to ensure that the lamps are working properly by checking the reading on the monitor.
17) When all is working well the number should be around 100% after a cleaning
18) The % will fluctuate at times as the effluent flows and particles of dirt get on the sensor
19) Record the date the sensor was cleaned in the daily log book

Procedures for dumping sewage into and removing solids/sludge from lift station #2 at the STP

Workers are required to have Hepatitis A & B and Tetanus shots before doing any work that will bring them in contact with contaminants i.e. sludge, effluent, influent,sewage etc.

All sewage from bathroom facilities around the Meadowbank site including the Exploration and Emulsion plants must be dumped into lift station #2 at the Sewage Treatment Plant.

All other liquids including the liquids from the grease traps should be off loaded at the tailings pond.

Twice a week, Wednesdays and Sundays 1 load of solids should be removed from lift station #2 and unloaded at the tailings pond.

If other jobs or poor weather come up and the solids cannot be done during these days removing solids can be done on other days.

There is a sheet at the STP just inside the door of the decontamination unit which is to be filled out by the vacuum truck operator.

The operator will fill in the date, initials of driver of vacuum truck, size of sewage load in or size of solids load out. This size of the load will be entered in the appropriate column , example *¾ S or 75% S.*
(S for small truck, B for big truck)

Also on this sheet under comments enter why the solids were not able to be done if it happens example, " *blizzard , truck broke* down, *too busy*" or any other information the driver may need to enter example *"broken paddle needs to be repaired"*

Occasionally the STP operator will also ask for the sludge to be removed from the bottom of lift station #2 but this will come as a formal request.

Measuring Sludge in the Little Johns

	PROCEDURE NUMBER:		**MBK-SIT-0004**
People concerned	**Site Services**	**Prepared by**	Site Services
		Approved by	Roger Sauvé Services General Supervisor
Issuing date :	2012-04-11		

This procedure corresponds to the required minimum standard. Each and everyone also have to comply with the rules and regulations of the Nunavut Government in terms of health and safety at work.

Objective:

Sludge is required to be measured every 2 weeks in the primary and clarifier tanks(final stage)

Concerned departments:

Site services

Required employee preparation:

- Every person is required to have Hepatitis A & B and Tetanus shots before doing any work at the STP that will bring them in contact with contaminants i.e. sewage, sludge, effluent, influent, etc.

Required equipment

- Gas detector , safety glasses ,hard hat, Tyvek suit and boot covers, nitrile/rubber gloves, locks for locking out bio-disk

Impacts				Location	
Health & Safety	Process/Quality	Costs	Environment	Control Room	Field

Measuring Sludge in the Little Johns

Procedure	Risks/ Impacts
1. Ensure proper PPE is worn	Prevent incident and /or accident; health issues
2. Two (2) people to be present when measuring sludge	
3. Shut off and lock out the bio-disk	
4. Keep gas tester on person or close at hand	
5. Little Johns primary tank measurement : side door/opening on the left side when facing the Little Johns from the big double doors – 1 measurement	
6. Turn the sludge meter on	
7. Turn the alarm on the sludge meter	
8. Slowly drop the sensor into the effluent allowing in to go to the bottom	

Measuring Sludge in the Little Johns

9. The alarm will sound as it starts to hit the sludge	
10. Take note of the depth of the tank by reading the numbers on the cord (measured in 6" intervals)	
11. Slowly lift the sensor/cord until the alarm goes off	
12. Record the difference on the cord from when the alarm is on at the bottom to when the alarm goes off	
13. This difference is the depth of the sludge	
14. Follow the same procedures in the Little Johns clarifier tank	
15. Little Johns clarifier tank measurement : open double doors and take measurements on both sides of the tank	
16. Once the sludge measurements have been taken and recorded, the bio-disk can be unlocked and restarted	
17. Clean up tools and put things away where they belong	

MEADOWBANK GOLD PROJECT

Spill Contingency Plan

Meadowbank Mine Site

All Weather Access Road (AWAR)

Baker Lake Facilities

In Accordance with Water License 2AM-MEA1525

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 6
September 2015

EXECUTIVE SUMMARY

This document presents the Spill Contingency Plan for Agnico Eagle Mines Limited (AEM) Meadowbank Mine Site, All Weather Access Road (AWAR) and Baker Lake Facilities, which is a requirement of the Meadowbank Gold Project Type A Water License No. 2AM-MEA15255 issued on July 23, 2015. The Spill Contingency Plan (SCP) designates lines of authority, responsibility, establishes proper reporting and details plans of action in the event of a spill. This plan applies to the operational phase of the mine and is applicable to all AEM employees and any contractors associated with the project located at latitude 65°01'52"N longitude 96°04'22"W approximately 70 km north of Baker Lake in Nunavut including the Baker Lake Marshalling Facilities located at latitude 64°18'36"N and longitude 95°58'04"W and the AWAR.

IMPLEMENTATION SCHEDULE

As required by Water License 2AM-MEA1525, Part B, Item 14, the implementation schedule for this Plan is effective immediately (September 2015) subject to any modification proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

AEM - Environmental Superintendent

AEM – General Mine Manager

AEM – Engineering Superintendent

AEM – Health and Safety Superintendent

AEM – Geology Superintendent

AEM – Mill Superintendent

AEM – Maintenance Superintendent

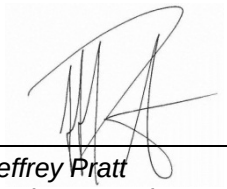
AEM – Mine Superintendent

AEM – Energy & Infrastructure Superintendent

AEM – General Services Superintendent

DOCUMENT CONTROL

Version	Date (YMD)	Section	Page	Revision
1	08/08/08			Comprehensive plan for Meadowbank Mine Site, Exploration Camp and Baker Lake Facilities
2	11/12/04			Update of Contacts, Spill management materials, include AWAR map and Spill KIT Location Map
3	12/07/25			Update of the hazardous materials stored on site
4	2013/11			Comprehensive revision and update with info for Baker Lake Jet-A Tank
5	2014/11	Appendices I & J		Include the prohibition of adding neutralizing chemicals to drainages or near or within water bodies
6	2015/09	3 5.1.3 5.6 Appendix L Appendix M	?	Change definition of a major spill and minor spill Add point that procedure MBK-ENV-0016 will be followed for reporting spills Addition of section on event monitoring. Dyno Nobel Emergency Response Plan added in appendix J MBK-ENV-0016 Spill Response Procedure Added

Prepared By: 

Jeffrey Pratt
Environmental Coordinator

Approved By:

Kevin Buck
Environmental Superintendent

Table of Contents

EXECUTIVE SUMMARY ii
IMPLEMENTATION SCHEDULE iii
DISTRIBUTION LIST iii
DOCUMENT CONTROL iv
SECTION 1 • INTRODUCTION 1-1
1.1 PURPOSE AND SCOPE OF THE SPILL CONTINGENCY PLAN 1-1
SECTION 2 • PROJECT DESCRIPTION 2-1
2.1 PREVENTION AND INSPECTIONS 2-1
SECTION 3 • DEFINITIONS 3-1
3.1 WHAT IS A SPILL? 3-1
3.2 MATERIALS AND REPORTABLE (to regulatory Authorities) SPILLS ON SITE 3-1
SECTION 4 • RESPONSE ORGANIZATION 4-1
4.1 FIRST RESPONDER 4-3
4.2 SUPERVISOR 4-3
4.3 INCIDENT COMMANDER 4-3
4.4 EMERGENCY RESPONSE TEAM 4-4
4.5 EMERGENCY RESPONSE TEAM COORDINATOR 4-4
4.6 ENIVRONMENTAL SUPERINTENDENT OR DESIGNATE 4-4
4.7 GENERAL MINE MANAGER ON DUTY 4-5
4.8 HEALTH AND SAFETY SUPERINTENDENT OR DESIGNATE 4-5
4.9 ON-SITE HEALTH CARE PROVIDERS 4-5
4.10 SPILL RESPONSE TEAM CONTACT INFORMATION 4-5
SECTION 5 • ACTION PLAN 5-1
5.1 INITIAL ACTION 5-1
5.1.1 Respond Quickly 5-1
5.1.2 Ensure safety 5-2
5.1.3 Report Spill 5-2
5.2 SPILLS ON LAND 5-2
5.3 SPILLS ON WATER 5-3
5.4 SPILLS ON SNOW AND ICE 5-3
5.5 DISPOSAL OF SPILLED MATERIAL 5-4
5.6 EVENT MONITORING 5-4
5.6.1 Portage Rock Storage Facility Seepage ..... **Error! Bookmark not defined.**
5.6.2 Assay Road Seepage ..... **Error! Bookmark not defined.**

SECTION 6 • HAZARDOUS MATERIALS STORED ON SITE 6-1
SECTION 7 • POTENTIAL SPILL ANALYSIS 7-1
SECTION 8 • RESPONSE EQUIPMENT 8-1
8.1 GENERAL EQUIPMENT 8-1
SECTION 9 • TRAINING & EMERGENCY SPILL/EXERCISE 9-1
9.1 TRAINING 9-1
9.1.1 On-site Personnel 9-1
SECTION 10 • LIST OF ACRONYMS 10-1

LIST OF TABLES

Table 1 - Spill quantities that must be reported to the NT-NU 24-HOUR SPILL REPORT LINE 3-1
Table 2 - Internal Contacts 4-6
Table 3 - Contractor Contacts 4-7
Table 4 - External Contacts 4-7
Table 5 - External Spill Response Contractor Phone Numbers ..... **Error! Bookmark not defined.**
Table 6 - Materials stored at site during operations 6-1

LIST OF FIGURES

Figure 1 : Layout Meadowbank Mine Site 2-3
Figure 2 : Layout Vault 2-4
Figure 3 : Baker Lake Diesel Fuel Tank Farm 2-5
Figure 4 : Baker Lake Jet-A Fuel Tank Farm 2-6
Figure 5 : Major spill/incident reporting procedure 4-2
Figure 6 : Spill Response Equipment Location 8-4
Figure 7 : Map of AWAPR Including Locations of Environmental Emergency Sea cans 8-5

LIST OF APPENDICES

Appendix A: Environmental Department weekly inspection template

Appendix B: Shipboard Oil Pollution Emergency Plan

Appendix C: Shipping company certificate of entry and acceptance boats
Communication protocol
Safety management system for entry into confined water
Safety management system for monthly safety meeting

Appendix D: NWT/NU Spill Report Form

Appendix E: General Response Procedures for Spilled Chemical Substances Explosives
E.1 Ammonium Nitrate
E.2 Ammonium Nitrate Fuel Oil (ANFO)

Appendix F: General Response Procedures for Spilled Chemical Substances
F.1 Compressed Gases

Appendix G: General Response Procedures for Spilled Chemical Substances
G.1 Flammable and Combustible Liquids

Appendix H: General Response Procedures for Spilled Chemical Substances
H.1 Oxidizing Substances - Liquids
H.2 Oxidizing Substances - Solids

Appendix I: General Response Procedures for Spilled Chemical Substances
I.1 Poisonous and Toxic Substances (Sodium Cyanide)

Appendix J: General Response Procedures for Spilled Chemical Substances: Corrosive Substances
J.1 Acids, Liquids
J.2 Acids, Solids
J.3 Bases/Alkali, Liquids
J.4 Bases/Alkali, Solids

Appendix K: Agnico Eagle Spill Response Training Records

Appendix L: Dyno Nobel Emergency Response Plan

Appendix M: MBK-ENV-0016 Spill Reporting Procedure

SECTION 1 • INTRODUCTION

1.1 PURPOSE AND SCOPE OF THE SPILL CONTINGENCY PLAN

The overall purpose of creating a spill contingency plan is to minimize the impacts of spills by the establishment of predetermined lines of response and plans of action. This plan has been designed to facilitate effective communication and the efficient clean-up of spills from potentially hazardous materials. These materials include:

- Hydrocarbon liquids such as diesel fuel, aviation fuel (Jet-A), gasoline, hydraulic oil;
- Soluble solids such as ammonium nitrate prill;
- Soluble liquids, such as glycols, acids, paints; and
- Corrosive liquids such as sulphuric acid and sodium cyanide.

More specifically the objectives of this Spill Contingency Plan (SCP) are to:

- Identify roles, responsibilities, and reporting procedures;
- Provide readily accessible emergency information to the cleanup crews, management, and government agencies;
- Comply with federal and territorial regulations and guidelines pertaining to the preparation of contingency plans and notification requirements;
- Promote the safe and effective recovery of spilled materials; and
- Minimize the environmental impacts of spills to water or land.

This plan has been prepared in accordance with the following reference documents:

- Indian and Northern Affairs Canada (INAC) 2007. *Guidelines for Spill Contingency Planning;*
- Government of Nunavut (GN), *Contingency Planning and Spill Reporting in Nunavut. A Guide to the New Regulations;*
- Government of Nunavut (GN) 2002, *Guideline General Management of Hazardous Wastes in Nunavut; and*
- Northwest Territories Resources Wildlife and Economic Development Environmental Protection Service. 1988. *Spill Contingency Planning and Reporting Regulations.*

SECTION 2 • PROJECT DESCRIPTION

The Meadowbank Gold Project, operated by Agnico Eagle Mines Limited, is located approximately 70 km north of the Hamlet of Baker Lake in Nunavut. The project is located on Inuit Owned surface lands (IOL BL-14) and has the following coordinates:

Latitude: 65°01'52"N
Longitude: 96°04'22"W
NTS map sheet 66H/1

Meadowbank Project components include marshalling facilities in Baker Lake, the 110 kilometer All Weather Private Access Road (AWPAR) from Baker Lake and the Meadowbank mine site (Figure 7). The Meadowbank mine site consists of the process plant, landfarm, sewage treatment plant, water intake, accommodation buildings, power plant, tank farm, warehouse, truck shop, emulsion plant, open pit (Figure 1) and Vault area (Figure 2). The Baker Lake Marshalling Area consists of a laydown transfer area to temporarily store materials prior to the delivery to the Meadowbank mine site. The Baker Lake fuel farm consists of six (6), ten (10) million liter tanks for diesel fuel, within secondary containment, (Figure 3) and twenty (20), 100,000L double walled tanks, within secondary containment, for aviation fuel (Figure 4). The fuel is delivered in bulk by sealift to the fuel farm. From there, fuel is hauled to the Meadowbank mine site by contractor tanker trucks on the AWPAR. Diesel fuel coming from the Baker Lake Tank Farm is stored at the Meadowbank site into a single 5.6 million liter tank, within secondary containment, and the aviation fuel into two (2) – 50,000L double walled tanks at the airstrip. From there, the diesel is redistributed into different storage tanks by an on-site tanker to mine site fuel tanks and Vault fuel storage tanks. Fuel storage locations have been designed to meet the CCME guidelines for Aboveground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.

Emergency spill response equipment (i.e. spill kits) is installed at each fuel storage location. Spill kits contain the appropriate type, size and quantity of equipment for the volume and type of product present at the storage location. Transport trucks, heavy equipment and light vehicles are all equipped with spill kits.

Construction at the mine site began with the issuance of the Type A Water License and other pertinent authorizations in July 2008 with operations commencing in January 2010.

2.1 PREVENTION AND INSPECTIONS

The first step in spill contingency planning is to take actions to prevent spills from occurring. Transport, transfer and storage of materials are performed by trained personnel using secondary containment, with well-maintained equipment and containers. Refueling stations in Baker Lake and at the mine site are equipped with a lined area to contain any minor leaks or spills while refueling. Transfer of fuel from tanks to tanker trucks are performed with the aid of fuel pumps. Good housekeeping practices are adopted especially in areas such as storage facilities, loading and unloading zones. Site orientations are conducted with all employees and spill prevention and response is discussed in detail. Regular worksite inspections are conducted to identify measures to minimize the risk of spills. All personnel are trained to be aware of the potential hazards associated with the fuel/chemicals with which they are assigned to work. In addition to work site inspections conducted by area specific employees, the Environmental Department conducts weekly inspections to audit facilities handling or storing hazardous materials (Appendix A).

AEM supports the following general principles for spill prevention:

- Provide up to date and accessible Material Safety Data Sheets (MSDS) for all hazardous materials;

- Regular inspections fuel/chemical storage areas for leaks (including flex connectors and plumbing) and platform shifting;
- Daily inspections of hazardous materials storage areas;
- Train workers in the use of safe work procedures for hazardous materials, and procedures to clean up spills;
- Encourage workers to take reasonable measures to prevent spills;
- Keep drums/containers sealed or closed;
- Place drums/containers within a suitable form of secondary or spill containment;
- Keep “overpack” or “salvage” drums nearby to contain leaking drums;
- Keep storage areas secure from unauthorized access;
- Segregate incompatible materials;
- Ensure chemical storage areas are adequately protected from weather and physical damage; and
- Provide adequate spill response materials at storage areas (details of spill response equipment are outlined in Section 8).

Figure 1 : Layout Meadowbank Mine Site

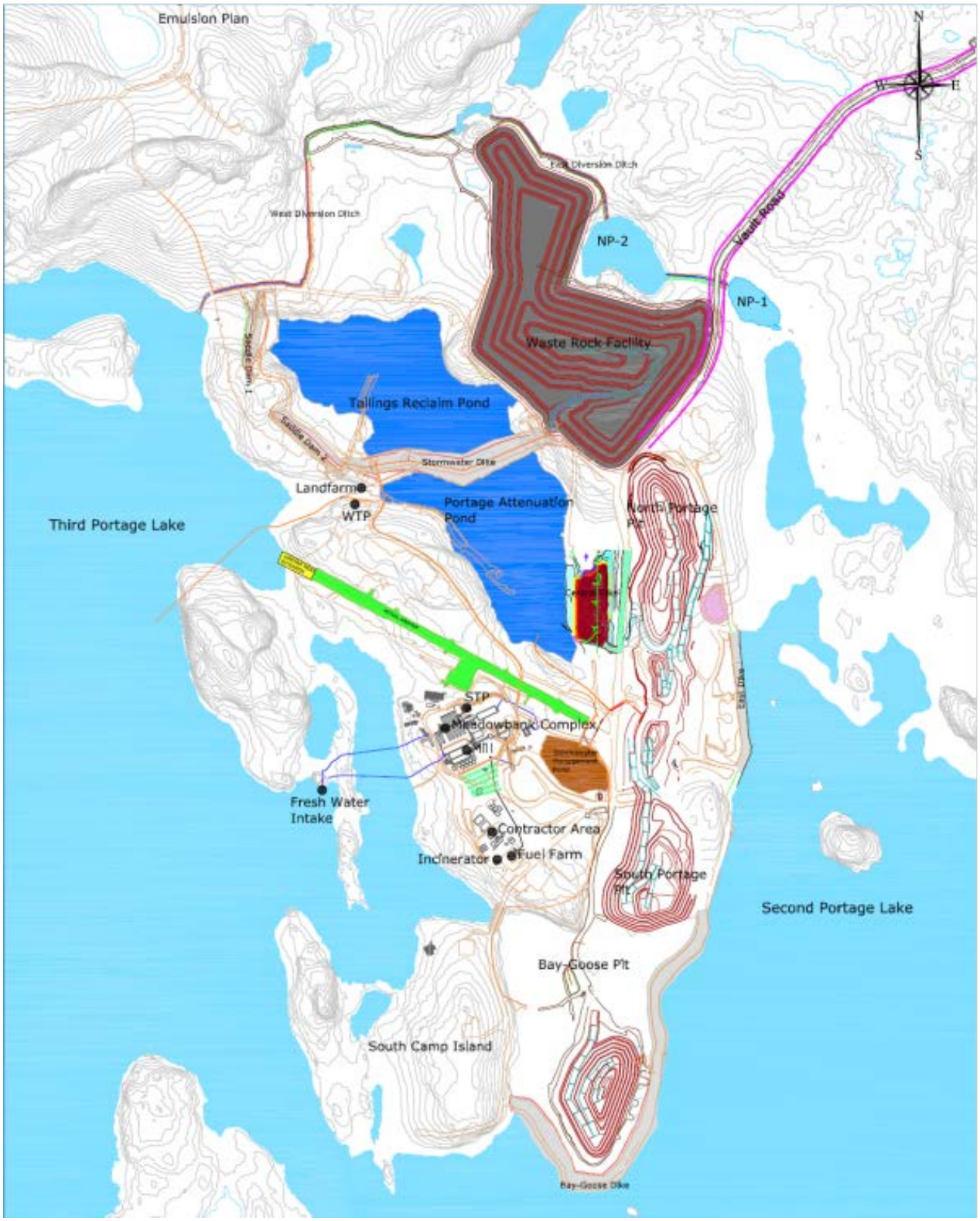


Figure 2 : Layout Vault

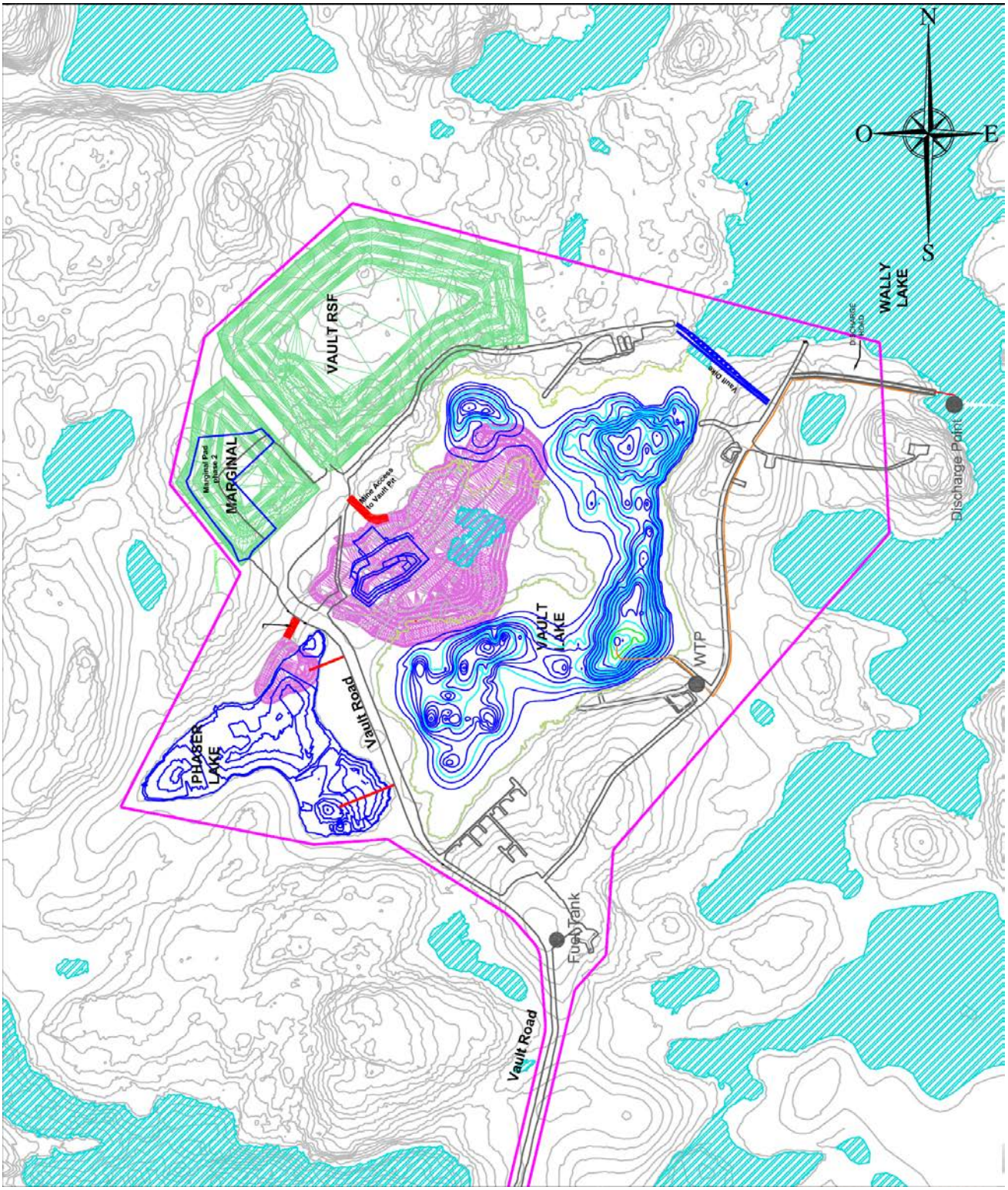
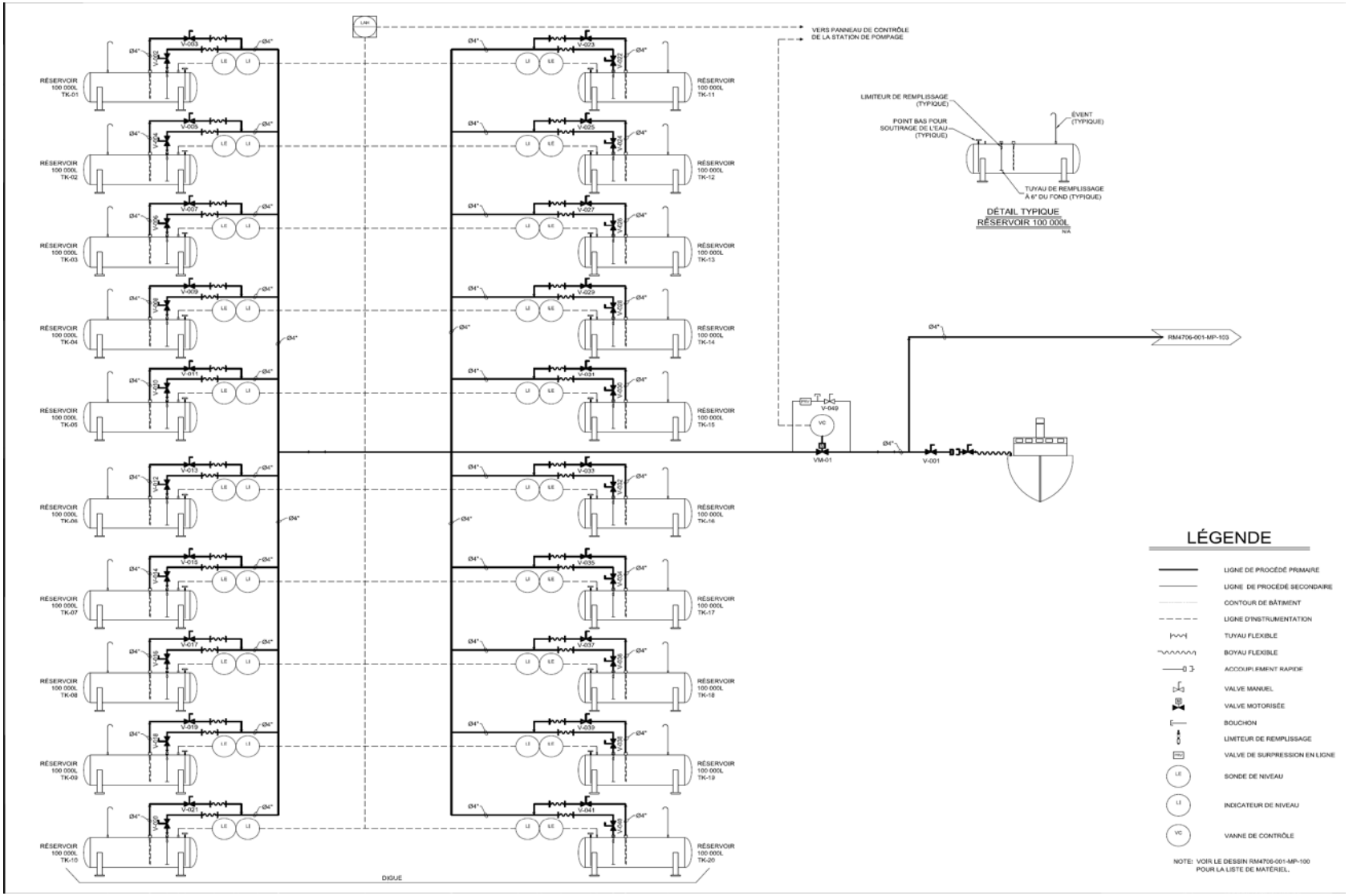


Figure 3 : Baker Lake Diesel Fuel Tank Farm

Figure 4 : Baker Lake Jet-A Fuel Tank Farm



SECTION 3 • DEFINITIONS

3.1 WHAT IS A SPILL?

For the purposes of this plan, a Major spill is defined as an accidental release of product into the environment that has the potential for adverse impacts to the receiving environment, AEM property or human health. This can include potential impacts to water, surface and groundwater, land, equipment, buildings,local communities, human health and the atmosphere.
A Minor spill is defined as any spill that does not involve a toxic, reactive, or explosive material in a situation that does not pose a significant risk to the environment, human health or AEM property. Minor spills are generally contained within AEM facilities.

3.2 MATERIALS AND REPORTABLE (TO REGULATORY AUTHORITIES) SPILLS ON SITE

As a precaution, if there is any doubt as to whether the quantity spilled meets the minimum thresholds for reporting to regulatory authorities listed in Table 1, the spill incident will be reported. Furthermore, AEM maintain a detailed log of all spills, reportable to authorities or non-reportable of all materials listed in Section 1.1. As part of AEM's overall environmental management system and in the spirit of a continuous improvement of environmental performance, procedures will be implemented to ensure **all** spills are reported to the Meadowbank Environmental Department.

To ensure compliance with Section 36(3) of the *Fisheries Act* and Section 35 of the *Migratory Bird Regulations* all spills of fuel or hazardous materials, regardless of quantity into a water body (including frozen), shall be reported immediately to the NT-NU 24-HOUR SPILL REPORT LINE (at 867.920.8130).

Table 1 - Spill quantities that must be reported to the NT-NU 24-HOUR SPILL REPORT LINE

Transportation Class	Type of Substance	Compulsory Reporting Amount
1	Explosives	Any amount
2.1	Compressed gas (flammable)	Any amount of gas from containers with a capacity exceeding 100 L
2.2	Compressed gas (non-corrosive, non- flammable)	Any amount from containers with a capacity exceeding 100 L
2.3	Compressed gas	Any amount
2.4	Compressed gas (corrosive)	Any amount
3.1, 3.2, 3.3	Flammable liquid	100 L
4.1	Flammable solid	25 kg
4.2	Spontaneously combustible solid	25 kg
4.3	Water reactant solids	25 kg
5.1	Oxidizing substances	50 L or 50 kg
5.2	Organic peroxides	1 L or 1 kg
6.1	Poisonous substances	5 L or 5 kg
7	Radioactive substances	Any amount
8	Corrosive substances	5 L or 5 kg
9.1 (in part)	Miscellaneous substances	50 L or 50 kg

9.2	Environmentally hazardous	1 L or 1 kg
9.3	Dangerous wastes	5L or 5 kg
9.1 (in part)	PCB mixtures of 5 ppm or more	0.5 L or 0.5 kg
None	Other contaminants	100 L or 100 kg
None	Seepage from TSF and WRSF	ANY

***Note**: L = litre; kg = kilogram; PCB = polychlorinated biphenyls; ppm = parts per million.*

SECTION 4 • RESPONSE ORGANIZATION

This section addresses the response organization and the responsibilities of each individual during response to an incident.

Figure 5 illustrates AEM's Spill Reporting Procedure in the event of a major spill and Sections 4.1- 4.9 list the major responsibilities of site staff that will be participating in the emergency response management.

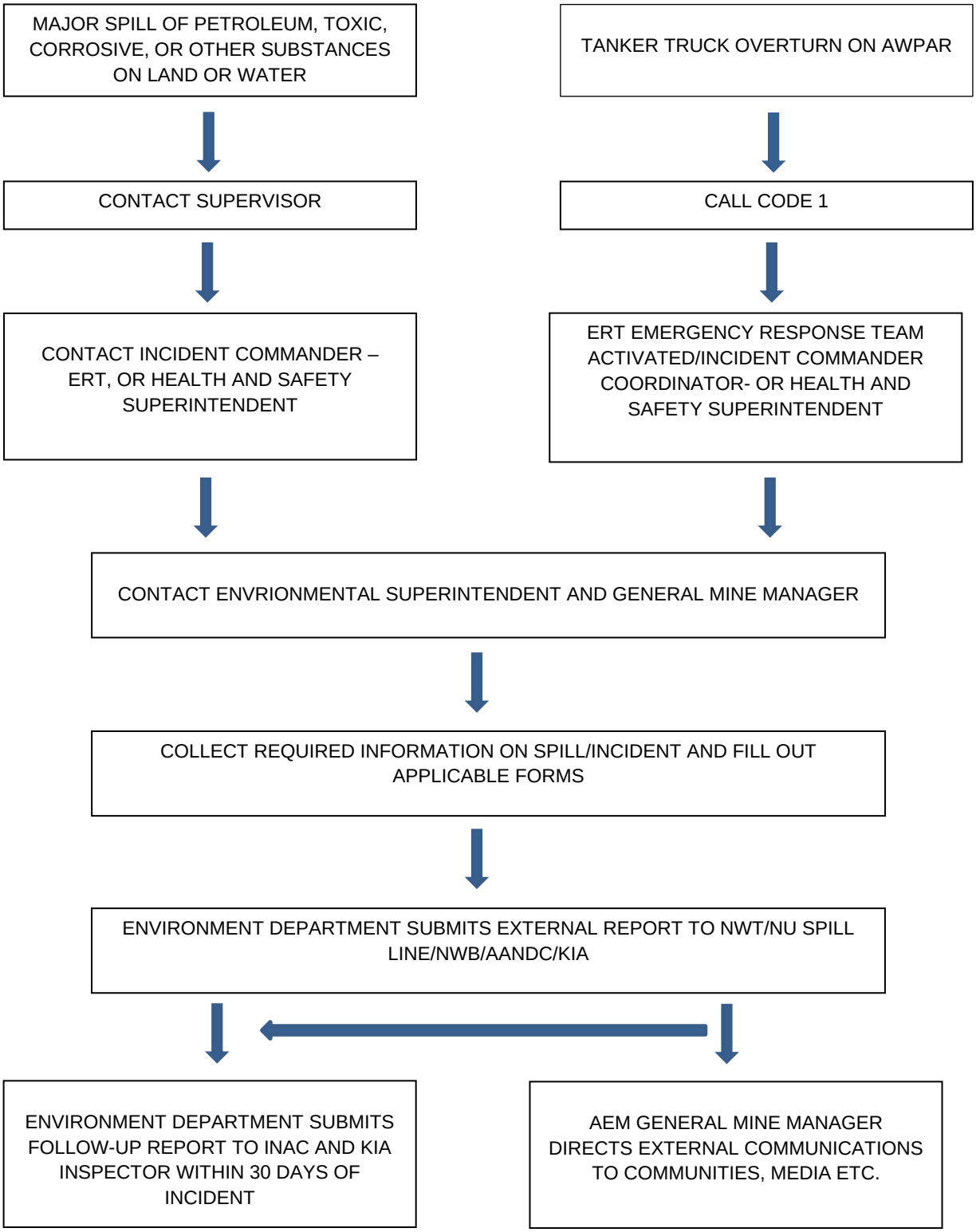
The first person (first responder) to notice, or come in contact with, any spill situation either initiates a Code 1 (for example in the case tanker truck overturn on AWPAR) or reports to his/her immediate supervisor (in the case of all other spills on land or water). The supervisor is responsible to report the incident to the designated Incident Commander for a major spill or to the environmental department for a minor spill. If a Code 1 is initiated, the Incident Commander will respond in conjunction with the ERT. Major responsibilities such as initial coordination, spill clean-up and mobilizing the ERT are part of the Incident Commander's duties.

The Incident Commander will contact the Environmental Superintendent and/or General Mine Manager or alternate, who in turn will inform the Senior Vice President, Environment and Sustainable Development. After all information has been collected, the Environmental Superintendent or alternate will submit a spill report and follow up spill report to the NWT/NU Spill Line, Nunavut Water Board, Kivalliq Inuit Association and Aboriginal Affairs and Northern Development Canada. Incidents that require media communications will be the responsibility of AEM General Mine Manager or alternate.

In the event of a major spill during a ship-to-ship transfer or due to unforeseen circumstances, the shipping company will be the sole proprietor for the spill. The containment and clean-up of inadvertent spills resulting from the tankers in transporting the fuel is the responsibility of the shipping company. In the unlikely event where a major fuel spill becomes unmanageable, the shipping company could call on external resources such as the Canadian Coast Guard for assistance. In these situations, AEM would provide whatever assistance it can to the shipping company[1]. Due to the lack of resources in which Agnico Eagle Mines (AEM) possess to counter act such a large scale marine spill, AEM's assistance would be limited to providing support to preserve the shore line environment. AEM would put its resources to the best use possible during such an event, and assist as much as possible with the resources at hand. The Shipboard Oil Pollution Emergency Plan (SOPEP) (Appendix B) is the responsibility of the shipping company; it covers the ship-to-ship transfer of fuel near Helicopter Island. Please refer to the *Oil Pollution Emergency Plan* for more details. In Appendix C you will find certificate of entry and acceptance boats of shipping company, communication protocol, safety management system for entry into confined water and monthly safety meeting forms.

[1] *The Emergency Response Team will not be equipped or trained to respond to spills offshore in the Marine environment. They will however be able to respond to spills in the near shore area.*

Figure 5 : Major spill/incident reporting procedure



4.1 FIRST RESPONDER

The person who has caused a spill or the first to observe the spill is the first responder. The responsibilities of the first responder are as follows:

- In case of a tanker truck overturn, initiate a Code 1. Remain on radio to provide guidance to the ERT;
- In case of spill to land or water, contact the supervisor to report the incident;
- Identify and contain the spill, IF SAFE TO DO SO; and
- Participate in spill response as a member of the clean-up crew.

4.2 SUPERVISOR

The responsibilities of the Supervisor are as follows:

- Initial assessment of the severity of the incident;
- Contacts the Incident Commander or Environmental Department;
- Gathers facts about the spill; and
- Participate in spill response as a member of the clean-up crew.

4.3 INCIDENT COMMANDER

Responsibilities of the Incident Commander are as follows:

- Assume complete authority over cleanup personnel and the spill scene, as well as assume responsibility for all mitigation efforts;
- Evaluate the initial situation and assess the magnitude of the problem;
- Activates the initial response plan;
- Alert and assemble key personnel in the response team, as deemed appropriate, to handle the situation;
- In consultation with the Environmental Superintendent or designate, develop the overall plan of action for containment and cleanup of the specific incident, as well as direct and implement the plan;
- Ensure assigned responsibilities are carried out and the activities of team members are coordinated;
- Assess the requirements for people, equipment, materials, and tools to contain the spill in light of what resources are immediately available; urgency will depend on the nature of the spill; and
- In consultation with the Environmental Superintendent or designate mobilize any additional resources that may be required and arrange for the transportation of necessary personnel and/or materials to the site.

4.4 EMERGENCY RESPONSE TEAM

AEM has an Emergency Response Team (ERT) that is trained and responsible for controlling the major spills as well as spills from tanker truck overturns along AWPAR, and assisting with medical and other emergencies that may occur at the camp. These team members attend regular training sessions.

4.5 EMERGENCY RESPONSE TEAM COORDINATOR

The responsibilities of the Emergency Response Team Coordinator (ERTC) are as follows:

- Mobilize all ERT personnel, equipment, personal protective equipment and supplies as required to the site of the spill;
- Assist Incident Commander in obtaining any additional resources not available on site;
- Ensure that appropriate PPE is worn properly;
- Assist in developing and implementing emergency response training programs and exercises; and
- Ensure that all spill response personnel receive adequate training to fulfill their responsibilities as part of the ERT.

4.6 ENIVRONMENTAL SUPERINTENDENT OR DESIGNATE

The Environmental Superintendent or designate is responsible for implementing and maintaining the SCP. In addition, the Environmental Superintendent's or designates responsibilities in the case of a spill are to:

- Liaise with the Incident Commander;
- Provide technical advice on the anticipated environmental impacts of the spill;
- Advise on the effectiveness of various containment, recoveries, and disposal options, and suggest the most appropriate approach;
- Prepare and submit any formal reports (see Appendix D for NWT/NU Spill Report Form) to regulators and AEM management detailing the occurrence of a spill;
- Contact the Senior Vice President Environment and Sustainable Development immediately for a major spill;
- Act as the spokesperson with regulatory and government agencies;
- If authorized by the General Mine Manager, act as a spokesperson with the public and media, as required;
- Implement a sampling protocol for the collection and analysis of samples to identify and monitor possible contaminant levels resulting from the spill;
- Ensure on-site resources for spill response and cleanup are available;
- Monitor the effectiveness of the cleanup operation and recommend further work, if necessary;

- Reviews incident occurrences and recommends preventative measures; and
- Assists in implementing training and simulation requirements for spill response personnel.

4.7 GENERAL MINE MANAGER ON DUTY

The General Mine Manager/designate is required to inform team members of the detailed nature of the operations to be performed in the event of a major spill during the operations phase. The responsibilities of the General Mine Manager/designate are as follows:

- Liaise with AEM personnel resources and keep them informed of cleanup activities; and
- Assist the Incident Commander and ERT as needed, particularly in obtaining any additional resources not available onsite for spill response and cleanup.

4.8 HEALTH AND SAFETY SUPERINTENDENT OR DESIGNATE

The following are the responsibilities of the Health and Safety Superintendent or designate in conjunction with the Training Department:

- Maintain emergency and health and safety records;
- Assist in conducting emergency spill response exercises;
- Track all emergency and health and safety training that on-site staff have received, and when retraining will be required;
- Notify the Incident Commander (related to ERT) when retraining is required;
- Ensure that employees are retrained in appropriate emergency response skills, Workplace Hazardous Materials Information System (WHMIS) training, Hazard Communication (HAZCOM), Occupational Health and Safety Administration (OHSA) training, first aid, and respirator fit-testing prior to expiry of existing training certification; and
- Consult with appropriate organizations regarding retraining requirements and schedules.

4.9 ON-SITE HEALTH CARE PROVIDERS

On-site medics are responsible for the following:

- Providing on-site first aid and other medical support; and
- Providing additional training for ERT members.

In addition to the health care providers on site, the Baker Lake Hamlet health professionals will be called first on the scene, if required.

4.10 SPILL RESPONSE TEAM CONTACT INFORMATION

Internal contact information is contained in Table 2 for all AEM personnel involved in spill recovery and subsequent reporting. Table 3 provides contact information for AEM contractors present at the mine site and

transportation contractors. Important external contacts such as regulatory agencies and health organizations are listed in Table 4. Table 5 provides contact information for external contractors should incident warrant assistance from outside sources.

Table 2 - Internal Contacts

Title	Name	Telephone No.
Sr. Vice President, Environment and Sustainable Development	Louise Grondin	416.847.8656 Cell: 819.724.2020
Vice President of Environment	Michel Julien	416-947-1212 ext. 3738 Cell: 514.244.5876
Corporate Director, Communications & Public Affairs	Dale Coffin	416.847.8669 Cell: 647.274.4154
Manager of Regulatory Affairs Nunavut	Stephane Robert	819.759.3700 ext. 5188 Cell: 819.763.0229
Manager of Nunavut Services Group	Jason Allaire	819.759.3555 ext. 6968 M: 819.355.2608
Meadowbank General Mine Manager	Bertin Paradis	819.759.3555 ext. 6725 Cell: 819.355.9348
H&S Superintendent or H&S Ass. Superintendent	Normand Ladouceur or Yves Levesque	819.759.3555 ext.6720 Cell: 819.860.6258 or 819.759.3555 ext.6720 Cell: 819.856.9051
Emergency Response Counselors	André Rouleau Or Philip Beaudoin	819.759.3555 ext.6809 Cell: 819.355.2191 or 819.759.3555 ext.6809 Cell: 450.847.4214

Environmental Superintendent	Kevin Buck	819.759.3555 ext.6838 Cell: 819.856.1956
Environmental Coordinator	Jeffrey Pratt or Erika Voyer	819.759.3555 ext.6728 or 819.759.3555 ext.6980
Environmental Department	Environmental Technicians	819.759.3555 ext.6747/6759
Incident Commander	Jeffrey Pratt/Erika Voyer Kevin Buck	867.793.4610 ext. 6728/6980 867.793.4610 ext. 6838
On-site Medics	On-site Nurses	819.759.3555 ext.6734 or 6751
Site Security	On-site Security	(867) 793-4610 ext. 6748

Table 3 - Contractor Contacts

Title	**Telephone No.**	**Contact in Emergency for:**
Nolinor Aviation Services	Protocol Agent 867.759.3700 ext. 8008	Flight services for additional crew, or additional supplies
First Air	(867) 669-6605	Flight services for additional crew, or additional supplies
Calm Air	(867) 793-2873	Flight services for additional crew, or additional supplies
Dyno Nobel Explosives Ltd.	(867) 793-4610 ext. 6804	Heavy Equipment, Man power, Emergency Blasting
Woodward Group of Companies (Shipping)	(709) 896-2421	Fuel Hauler
Baker Lake Contracting & Supplies	(867) 793-2831 Press #1	Man power, equipment, trades personnel i.e. pipefitter, plumber, electrical
Peter's Expediting	(867) 793-2703	Equipment, man power, Ground transportation services
Arctic Fuel Services	(867) 793-2311 Office (867) 793-2301 Supervisor	Fuel hauling, trucking, man power.

Table 4 - External Contacts

Organization/Authority	**Telephone Number**	**Fax Number**
NT-NU 24-Hour Spill Report Line	(867) 920-8130 spills@gov.nt.ca	(867) 873-6924
Workers Safety and Compensation Commission	(867) 979-8500	(867) 979-8501
Kivalliq Inuit Association	(867) 645-5725	(867) 645-2348
Nunavut Water Board	(867) 360-6338	(867) 360-6369
AANDC Inspector	(867) 645-2830	(867) 979-6445
Department of Fisheries and Ocean (DFO) – Nunavut Regional Office	(867) 979-8000	(867) 979-8039
Manager, Environmental Protection, Government of Nunavut	(867) 975-7748	(867) 975-5981
Kivalliq Health Services – Baker Lake	(867) 793-2816 *Dial 0*	(867) 793-2812
Baker Lake Hamlet Office	(867) 793-2874	
Baker Lake Fire Emergency	(867) 793-2900	
RCMP Regular Hour RCMP 24 Hour Emergency Number	(867) 793-0123 (867) 793-1111	
Canadian Coast Guard (in the event of a spill to the marine environment) Superintendent Environmental Response	(800) 265-0237 (519) 383-1954 (519) 381-6186 (cell)	(519) 337-2498
Transport Canada – Marine Safety Jaideep Johar **Ian Salisbury**	 (204) 880-0754 or (204) 984-8618 **(780) 495-8360**	 **(780) 495-8607**

All above phone numbers are current as of July 9, 2015.

SECTION 5 • ACTION PLAN

Spills may be the result of any of the following occurrences:

- Tanks, drums or containers may develop leaks or rupture;
- Failure of equipment such as valves, piping or containment structures;
- Overfilling;
- Improper storage;
- Spills during transfer of fuel, chemicals or waste products; and
- Spills resulting from accidents during transportation.
- Seepage from tailings impoundment or waste rock storage facilities that may migrate off site to receiving water or land

5.1 INITIAL ACTION

For all spill emergencies, it is required that priority actions be undertaken. These are:

- Respond Quickly;
- Ensure Safety; and
- Report the Spill.

5.1.1 Respond Quickly

- Identify the spilled material;
- Be alert – ensure safety of yourself and others by notifying them of the incident;
- Shut off ignition sources such as vehicles and unplug electrical equipment – NO SMOKING;
- Attend to the injured;
- Assess the severity of the spill; and
- Contact the Incident Commander, identify the location and request assistance as required. Incident Commander will mobilize the Emergency Response Team if required.

The primary form of ensuring safety is by using preventative measures. All personnel who deal with chemicals must have training in first aid and safe materials handling, including the Workplace Hazardous Materials Information System (WHMIS). In addition, regular training updates and site- specific exercises/drills are integral to preventing incidents.

5.1.2 Ensure safety

- Consult the MSDS and Product Guides for further information on the substance;
- Keep people away from spill site;
- Wear appropriate PPE such as impervious clothing, goggles, and gloves when containing the spill;
- Approach spill from upwind IF IT IS SAFE TO DO SO;
- Assess whether the spill, leak, or system failure can be readily stopped or brought under control;
- Stop product flow or leak if possible and IF IT IS SAFE TO DO SO;
- Do not contain compounds (e.g. gasoline, aviation fuel) if vapors might ignite – allow them to evaporate; and
- Depending on the type of compound spilled and IF IT IS SAFE TO DO SO, contain product using booms, berms, absorbent pads, earthen dike, trenches or improvise with materials at hand.

5.1.3 Report Spill

- Spill reporting will follow Spill Reporting procedure MBK-ENV-0016. This procedure can be found in Appendix K
- Obtain all necessary information to complete the spill report form for spills that meet the criteria listed in Table 1. Spills that meet regulatory reporting criteria must be reported to the NWT-NU 24 Hour Spill Line/AANDC/Kivalliq Inuit Association (KIA) and the Nunavut Water Board by AEM Environment Staff. Minor spills that do not meet regulatory reporting criteria must still be reported. This must be done within 24 hours using the AEM internal Spill Report Form.; and
- For spills that meet regulatory reporting criteria, a detailed spill report will be submitted to the AANDC Water License Inspector and the KIA Land's Inspector by AEM Environment Staff no later than 30 days after the initial reporting of the spill. This report will contain the amount and type of spilled product, the GPS location of the spill and the measures taken to contain, cleanup and restore the spill site.

Procedures will vary depending on the season and materials spilled. The MSDS for spilled materials and/or Transport Canada's "Emergency Response Guidebook" must be consulted to ensure that safety procedures are followed. Response procedures specific to spills on land, water, snow and ice are presented in the following sections as general guidelines.

5.2 SPILLS ON LAND

Response to spills on land will include control techniques involving the use of two types of barriers: dikes and trenches. Barriers should be placed down-gradient (down-slope) from the source of the spill, and as close as possible to the source of the spill. Barriers will slow the progression of the material spilled and will also serve as containment to allow for recovery.

Depending on the volume spilled, the site of the spill as well as available material, a dike may be built with soil, booms, lumber, snow, etc. A plastic liner, if necessary, can be placed at the toe of and over the dykes to protect the underlying soil or other material and to facilitate recovery of the material. Dikes will be constructed in such a way as to accumulate a thick layer of free product in a single area (V-shaped or U-shaped).

Trenches are useful in the presence of permeable soil and when the spilled material is migrating below the ground surface. A plastic liner should be placed on the down-gradient edge of the trench to protect the underlying soil. Liners should not be placed at the bottom of the trench to allow water to continue flowing underneath the layer floating oil.

The use of absorbent materials to recover a large volume of spilled liquids such as petroleum based material should be avoided. Large volumes of free-product should be recovered, as much as possible, by using vacuums and pumps, and containerized. Mixtures of water and fuel may be processed through an oil-water separator. However absorbent materials work well for smaller volumes of spilled hydrocarbon based materials such as fuel. Absorbent sheets should be used to soak up residual fuel on water, on the ground (soil and rock), and on vegetation. Peat moss may also be sprinkled on vegetation to absorb films of petroleum products.

5.3 SPILLS ON WATER

Response to spills on water will include procedures that include containment, diversion and recovery techniques. The following elements must be taken into consideration when conducting response operations:

- Type of water body or water course (lake, stream, river);
- Water depth and surface area;
- Wind speed and direction;
- Type of shoreline; and
- Seasonal considerations (open-water, freeze-up, break-up, frozen).

The most common type of spill that could be anticipated is a petroleum hydrocarbon (fuel oil) spill during fuel transfers/transport. Containment of an oil slick in water will require the deployment of mobile floating booms to intercept, control, contain and concentrate (i.e., increase thickness) the floating oil. One end of the boom will be anchored to shore while the other will be towed by a boat and used to circle the oil slick and return it close to shore for recovery using a skimmer. Reducing the surface area of the slick will increase its thickness and thereby improve recovery. Mechanical recovery equipment (i.e., skimmers and oil/water separators) will be mobilized to site if required.

Measures will be taken to protect sensitive and accessible shoreline. The oil slick will be monitored to determine the direction of migration. In the absence of strong winds the oil will likely flow towards the discharge of the lake. Measures will be taken to block and concentrate the oil slick at the lake discharge using booms where it will subsequently be recovered using a portable skimmer, vacuum, or sorbent materials.

In small slowly-flowing rivers, streams, channels, inlets or ditches, inverted weirs (i.e., siphon dams) will be used to stop and concentrate moving oil for collection while allowing water to continue to flow unimpeded. In the case of floating oil, in a stream, heading for a culvert (i.e., at a road crossing) a culvert block will be used to stop and concentrate moving oil for collection while allowing water to continue to flow unimpeded. In both cases oil will then be recovered using a portable skimmer or sorbent materials.

In the case of spills in larger rivers, with fast moving currents, diversion booming will be used to direct the oil slick ashore for recovery. Single or multiple booms (i.e., cascading) may be used for diversion. Typically, the booms are anchored across the river at an angle. The angle will depend on the current velocity. Choosing a section of a river that is both wider and shallower will make boom deployment easier. Diversion booming may also be used to direct an oil slick away from a sensitive area to be protected.

5.4 SPILLS ON SNOW AND ICE

In general, snow and ice will slow the movement of hydrocarbons. The presence of snow may also hide the

oil slick and make it more difficult to follow its progression. Snow is generally a good natural sorbent, as hydrocarbons will have a tendency to be soaked up by snow through capillary action. However, the use of snow as a sorbent material will be limited as much as possible. Snow and frozen ground will also prevent hydrocarbons from migrating down into soil or at least slow the migration process. Ice will prevent seepage of fuel into the water.

Most response procedures for spills on land discussed previously may be used for spills on snow and ice. The use of dykes (i.e., compacted snow berms lined with plastic sheeting) or trenches (dug in ice) will slow the progression of the fuel and will also serve as containment to allow recovery of the fuel.

Free-product will be recovered by using a vacuum, a pump, or sorbent materials. Contaminated snow and ice will be scraped up manually or using heavy equipment depending on volumes. The contaminated snow and ice will be placed in containers or within plastic lined berms on land.

5.5 DISPOSAL OF SPILLED MATERIAL

For this section you can refer to the *Landfarm Design and Management Plan.* All contaminated spill pads, and booms are placed within Quatrex bags for shipment to an approved disposal facility. All the petroleum hydrocarbon contaminated soil is placed into the landfarm for treatment. Spills over 100 L of non-petroleum hydrocarbon material (e.g. solvents, glycol) will be placed in drums and stored in the on-site hazardous material area for shipment south to approve facilities during barge season. Spills of non-petroleum hydrocarbon material fewer than 100 L will be placed in the Tailings Storage Facility. For spills fewer than 100 L of petroleum hydrocarbon contaminated snow will be placed in a designated area of the landfarm and treated as contact water after snowmelt. For spills over 100 L of petroleum hydrocarbon contaminated snow will be excavated and stored in labeled drums. After snow melt, the contaminated water will be pumped through the site's oil-water separator (carbon filter) to remove petroleum hydrocarbon residue. The treated water will be sampled per Part F, Item 6 of the NWB Water License, and discharged to the Stormwater Management Pond if criteria are met. If criteria are not met, water will be treated as hazardous material and shipped south. Also, after snowmelt, visible product will be cleaned up with absorbent pads or booms.

5.6 EVENT MONITORING

The Event Monitoring (EM) program addresses the site specific monitoring that is required following any accidental release. A "release" may be caused by a spill or an emergency (Meadowbank Gold Project Emergency Response Plan; August 2013).

The EM program is designed to verify whether contamination of the surface soil, nearby receiving environment and active zone has occurred as a result of an accidental release of a hazardous material or contaminated water, through monitoring of surface runoff and nearby receiving environment following remediation of any release. It is anticipated that owing to the presence of permafrost beneath most of the mine footprint, there will be minimum impact to groundwater. A complete list of hazardous materials use during operations of the mine is provided in the *Meadowbank Gold Project Hazardous Materials Management Plan (October 2013).*
The EM plan is developed on a site specific basis subsequent to a spill or accidental release, and considers the type of product spilled, the potential receptors and the potential for any remaining contamination after clean up. The plan is done in coordination with the Environmental Superintendent.

In the event of an accidental release, the water quality of the downstream receptor and possibly upstream of the receiving point, if any, is to be sampled (during the ice-free season) and analyzed. Should the spill have happened over snow cover, water and possibly soil sampling is to take place at the earliest feasible time after thaw to verify if there has been any impact to the receiving water or soil quality. The specific parameters monitored as part of the EM program will depend on the nature of the spill, and will be determined for the specific hazardous material released.

EM sampling is to occur following the clean-up of a release and the frequency of sampling will depend on the type of material spilled (wet or dry spill), the environment into which the chemical was released (surface water body or soil; frozen or thawed), and the quantity of spill material. The EM program for a particular spill will cease upon obtaining satisfactory analytical results (within 20% of background level, to accommodate for analytical accuracy) from the potentially affected areas or as required by regulators.

.

SECTION 6 • HAZARDOUS MATERIALS STORED ON SITE

A variety of petroleum products and other hazardous materials will be used as part of the mining operations. Large quantities of petroleum products will be stored at various sites. Explosives will also be stored on site. Other hazardous materials will be used but in smaller quantities. Nonetheless, all these products are considered as potential environmental and safety hazards.

Material Safety Data Sheets (MSDS) of all materials transported, stored and used on-site will be made available at strategic locations near to where hazardous materials or toxic substances are stored or utilized. Appendices E to J provide General Response Procedures for Spilled Chemical Substances.

Table 6 identifies the predominant hazardous materials transported, stored and generated at the site. You can refer to the *Hazardous Materials Management Plan* for more details.

Table 5 - Materials stored at site during operations

Material	Maximum Amount present on Site	Maximum Amount transported per unit	Storage Location
Acetylene	500 cylinders	300 cylinders per sea can	Inventory Lay down
Activated Carbon	350 Mt	10 Mt per sea can	Inventory Lay down and Process Plant lay down
Ammonium Nitrate	10 000 Mt	20 Mt per sea can	Emulsion plant
Ammonium Nitrate Fuel Oil (ANFO)	Manufactured on demand	20 000 kg per truck	Emulsion plant
Motor Oil	Estimated at 800 000L	20 800L per sea can	Inventory Lay down, garage
Trojan Boosters (Blasting Systems)	34 000 kg	15 Mt per sea can	Emulsion plant
Borax, Anhydrous	7 500 kg	3 375 kg per sea can	Inventory Lay down and Process Plant lay down
Calcium Chloride	600 000L	10 000L per sea can	Inventory Lay down
Calcium Hydroxide	NOT IN INVENTORY		Inventory Lay down
Calcium Oxide	NOT IN INVENTORY		
Calcium Peroxide	NOT IN INVENTORY		
Carbon Dioxide	10 cylinders	10 cylinders per sea can	
Copper Sulphate	500 Mt	20 Mt per sea can	Inventory Lay down and Process Plant lay down
Diesel Fuel	5.5 million Liters	40 000L per tanker	Tank farm
Dyno Split (Detagel)	135 000 kg	15 Mt per sea can	Emulsion plant

Nonel EZTL	1 400 kg	15 Mt per sea can	Emulsion plant
Nonel MS	1 800 kg	15 Mt per sea can	Emulsion plant
Ethylene Glycol	60 000L	10 000L per sea can	Inventory Lay down
Ferric Chloride Hexahydrate	NOT IN INVENTORY		
Ferric Subsulfate Solution	NOT IN INVENTORY		
Hydrofluoric Acid	NOT IN INVENTORY		
Hydrogen Peroxide	NOT IN INVENTORY		
Jet A Fuel	50 000L	11 000L Tanker	Tank, tarmac
Lead Acid Batteries	500L	500L per sea can	Warehouse
Magnafloc 10 (Flocculant)	300 Mt	15 Mt per sea can	Inventory Lay down
Nitric Acid	120 000L	8 000L per sea can	Inventory Lay down
Portland Cement	3 500 Mt	20 Mt per sea can	Dyke and Construction lay down
Sodium Cyanide	1 300 Mt	19 Mt per sea can	Inventory Lay down and Process Plant lay down
Sodium Hydroxide	10 kg	10 kg in sea can	Warehouse
Sodium Nitrate	10.2 Mt	5.1 Mt per sea can	Inventory Lay down
Sulfur	4 600 Mt	20 Mt per sea can	Inventory Lay down Process Plant lay down Quarry 1
Unleaded Gasoline	50 000L	40 000L tanker	Tank farm
Varsol	4 000L	2000 L per sea can	Inventory Lay down

SECTION 7 • POTENTIAL SPILL ANALYSIS

In order to prepare for emergency spill response, potential spill analysis was conducted and on various worst case scenarios. The exercise serves to identify potential risk areas, as well as to determine the fate of spilled products and their environmental effects. One potential scenario was identified for the Meadowbank Gold Project:

- Road between Baker Lake and the Meadowbank Mine Site – spill contents of a tanker truck into water body.

Scenario #1: Road Accident Tanker Truck Spill on AWPAR

Description of incident: Spill of the contents of a fuel tanker to the ground or water during transport from the Baker Lake to the Meadowbank Mine Site.

Potential causes: Vehicle accident, human error, mechanical failure

Hazardous products spilled: Diesel fuel, aviation fuel

Maximum volume spilled: 40,000 litres

Immediate receiving medium: Stream, river or lake

Distance and direction to nearest receiving body of water: N/A

Resources to protect: Streams, rivers and lakes

Estimated emergency response time: Maximum time is 90 minutes depending on location of spill (assuming truck driver is injured and cannot commence spill response procedures). Minimum time to respond to a spill on the AWPAR is 15 minutes.

Spill response procedures: Contain and recover oil slick downriver as described in Section 5.3, protect shorelines using sorbent booms. Collect free-product for temporary storage. Clean-up soiled shorelines. If the response crew arrives before the complete spill, seal the leak where feasible, contain and recover oil spill on ground using dykes, sumps or trenches as described in Section 5.2. Also if the truck driver is not injured, he will act as a first responder and immediately initiate the spill contingency plan as defined in Section 5 using the spill kit kept in the fuel trucks.

SECTION 8 • RESPONSE EQUIPMENT

8.1 GENERAL EQUIPMENT

This section addresses the emergency response machinery, equipment, tools and other resources that will be made available on-site for spill counter measures.

Mobile Equipment available to AEM, that will be used for spill contingency include:

- Graders
- Cranes
- Snowmobiles
- Vacuum Truck
- Loaders
- Backhoe
- Bulldozer
- Forklift
- Water Trucks
- Excavators
- Winch Trucks
- Pickup Trucks
- Generator Sets
- Fire Truck
- Aluminum Boats
- Fuel Trucks
- Bobcat
- Haul Trucks
- Snow Cat

If required, additional equipment on site will be made available to assist with spill recovery.

Temporary containment systems are also available on site and include:

- Booms
- Drums
- Tanks
- Tailings Pond
- Spill absorbent material packages/pads
- Silt fencing
- Maritime Barrier

Emergency transportations that will be used under an emergency situation are:

- Aircraft (fixed wing or helicopter)
- 4-wheel drive vehicles
- Snowmobiles
- Boats
- Tundra Buggy

Communication equipment on site includes radios, telephones, faxes and other wireless communication systems that will be used in the event of an emergency situation.

Spill Response kits are strategically located where required (Figure 6). Each department and work area is responsible for providing sufficient spill response kits in their respective work areas. The kits are kept in marked and accessible locations. The locations include all fuel storage areas, chemical storage areas and so on.

All of the mobile equipment on site (heavy equipment) contains an emergency spill kit.

An Environmental Emergency Trailer which is easily accessible and mobile is located on site which contains the following items:

- Pump Elastec
- Pump accessories
- Vaccum ends
- 45 gallons top
- Tubing 2 inches diameter
- Tubing 3 or 4 inches diameter
- Diesel Fuel jerry can (place on a miniberm)
- Spill kit accessory (red box)
- Drums opener
- Wescot (to open empty drum screw)
- Empty drums
- 2 drums berm
- 4 drums berm 4x8
- Tarp 20x30
- Tarp 30x50
- Oil white spill pads
- Universal boom 5x10
- Universal boom 8x10
- ABS pipe : 10' (4")
- ABS pipe : 10' (6")
- Cell U-Sorb
- Sphagsorb
- 3 Size of Wedge wood
- Plug pattie
- Quattrex bags
- Hand shovel
- Ice braker chisel
- Sledge hammer
- Rod bar (4')

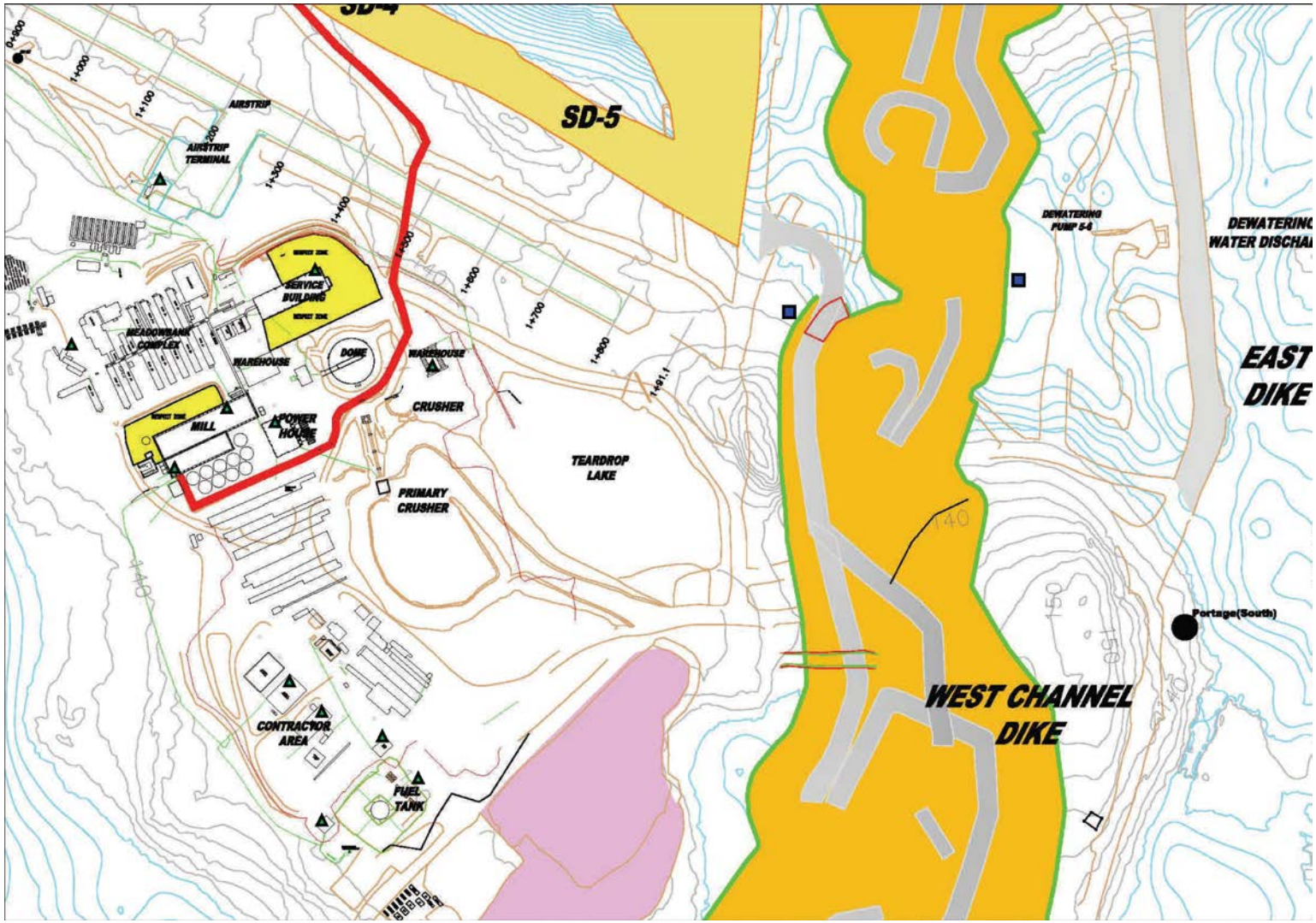
Along the AWPR there are 9 environmental emergency sea cans. These sea cans are strategically placed along the road at water crossings (Figure 7). Each environmental emergency sea can contains the following material:

- Empty drums (Sealed)
- Mini berm 36"x36" x4'
- 4 drum spill berm 4x8
- Tarp 20'x30'
- Tarp 30'x50'
- Oil white spill pads
- Universal boom 5"x10' (Chemical)
- Universal boom 8"x10' (Chemical)
- Oil only booms 5"x10' (Hydro-carbons)
- Maritime barrier (Baffle)
- ABS pipe : 10' (4")
- Cell U-Sorb
- Amerisorb peat moss

- Oil gator absorbent
- Plug pattie
- Quattrex bags
- Fork lift crate (pallets)
- Long handle round point shovel
- Chisel point crow bar 16 lbs 57"
- Ice braker chisel
- Sledge hammer 12 lbs 36"
- Rod bar (4')

If required, external resources are available in the Hamlet of Baker Lake and those contacts are found in Table 5.

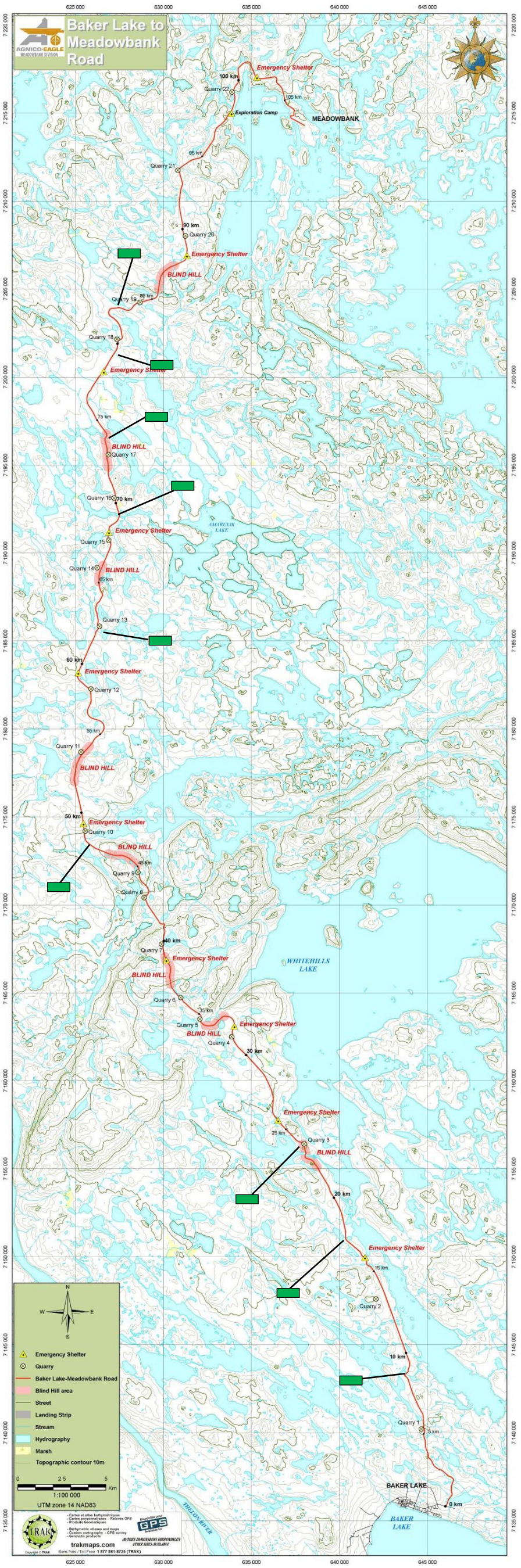
Figure 6 : Spill Response Equipment Location



Spill Kits

Large Spill Kits for Mine Ops

Figure 7 : Map of AWAPR Including Locations of Environmental Emergency Sea cans



Environmental Emergency Sea cans

SECTION 9 • TRAINING & EMERGENCY SPILL/EXERCISE

9.1 TRAINING

9.1.1 On-site Personnel

A designated ERT consisting of on-site personnel has been established. AEM will ensure that the ERT is trained and present for major spill response at all times. All members of the team are trained and familiar with emergency and spill response resources, including their location and access, the SCP, and appropriate emergency spill response methodologies. The ERT has up to 40 members, each of whom train 8 hours per month.

The following training is included:

- A review of the spill response plan and responsibilities of the ERT members;
- The nature, status, and location of fuel and chemical storage facilities;
- The on-site and off-site spill response equipment and how to use it;
- Emergency contact lists;
- Desktop exercises of “worst case” scenarios; and
- The likely causes and possible effects of spills.

Every employee at AEM receives spill and waste management training during their initial site orientation so they are able to respond to small spills and raise the alarm if a larger response is required. ERT members receive more extensive HAZMAT training and learn how to respond while wearing personal protective clothing. The road crew between Baker Lake and Meadowbank also received training regarding the actions that they have to do during an emergency or major spill on the road. You can find records of different trainings that AEM personnel have attended in Appendix K. The Environmental Department regularly attends tool-box sessions to provide information on spill response, spill prevention and spill reporting procedures.

SECTION 10 • LIST OF ACRONYMS

ANFO	Ammonium Nitrate Fuel Oil
AWPR	All Weather Private Road
CCME	Canadian Council of Ministers of the Environment
DFO	Fisheries and Oceans Canada
EMS	Environmental Management System
ERP	Emergency Response Plan
ERT	Emergency Response Team
ERTC	Emergency Response Team Coordinator
GN	Government of Nunavut
HCN	Hydrogen Cyanide
HMMP	Hazardous Materials Management Plan
AANDC	Aboriginal Affairs and Northern Development Canada
LEL	Lower Explosion Limit
AEM	Agnico Eagle Mines Limited
MSDS	Materials Safety Data Sheets
NIOSH	National Institute for Occupational Safety and Health
OHSP	Occupational Health & Safety Plan
PCB	Polychlorinated Biphenyls
PPE	Personal Protective Equipment
SCP	Spill Contingency Plan
TDG	Transportation of Dangerous Goods
WHMIS	Workplace Hazardous Materials

Appendix A

Environmental Department weekly inspection template

Appendix B

Shipboard Oil Pollution Emergency Plan

Appendix C

Shipping Company certificate of entry and acceptance boats
Communication protocol
Safety management system for entry into confined water
Safety management system for monthly safety meeting

Appendix D

NWT/NU Spill Report Form

Appendix E

General Response Procedures for Spilled Chemical Substances

Explosives

E.1 Ammonium Nitrate
E.2 Ammonium Nitrate Fuel Oil (ANFO)

E.1 Ammonium Nitrate

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank camp.

The first step against prevention of potential spills and association hazards is the application of proper storage procedures for bulk Ammonium Nitrate, including the following:

- Good housekeeping of the storage facility will prevent spilling and or contamination of materials;
- Ammonium nitrate should be stored away from combustible materials and fuels, as well as other blasting accessories (i.e. boosters, delays, detonating cords and detonators);
- The storage facility should be well ventilated;
- Proper signage restricting the use/exposure of ammonium nitrate to ignition sources should be posted (e.g. no hot work, smoking or vehicle maintenance); and
- The storage facility should be locked at all times with only authorized personnel allowed access.

The following is a general spill response procedure for ammonium nitrate. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required. AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For an ammonium nitrate spill (solid):

1) Isolate and evacuate the spill area;

2) Contact your Supervisor who will then contact the On-Scene Coordinator and coordinate appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

3) Put on appropriate personal protective equipment. For an ammonium nitrate spill this includes:

   a) Gloves **as recommended by the MSDS or glove manufacturer;**

   b) Protective eyeglasses or chemical safety goggles or face shield **as recommended by the MSDS;**

   c) Lab coat, coveralls or TyvekTM coveralls **as recommended by the MSDS; and**

   d) Half mask air-purifying respirator with cartridges and/filters **as recommended by the MSDS or respirator manufacturer;**

4) Ventilate (open windows/doors to outdoors) closed spaces before entering;

5) Remove all sources of heat and ignition (no smoking, flares, sparks or flames in immediate area) and remove uncontaminated combustible materials and organic compounds (wood, paper, oil, etc.,) from spill area;

6) For spills to land, protect the spill area from storm water runoff by constructing a ditch or dike using suitable absorbent materials, soil or other appropriate barrier;

7) Vacuum or sweep the spill residue using non-metal, non-sparking tools and place the residue in a labelled,

plastic, container (plastic pail with lid or double heavy duty plastic bags) for re-use or off-site disposal at a licensed disposal facility;

Note: Recovered solid, if generally free from impurities, may be suitable for its intended use. In this case, place solid in suitable container with lid, and ***clearly label the container per WHMIS Guidelines****.*

Note: Minimize dust generation during the operation.

8) Remove and bag personal protective equipment for cleaning and disposal at a licensed facility. Thoroughly wash potential skin contact locations after handling.

E.2 Ammonium Nitrate Fuel Oil (ANFO)

Currently no ANFO is stored at the site. ANFO is fabricated as required, with ammonium nitrate and fuel oil. In the event that ANFO would be stored at the camp, AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank Gold Project. Proper handling and disposal of ANFO is an important first step in mitigating against spills and associated hazards.

The proper storage procedures are as follows:

- ANFO should only be used under the supervision of authorized trained personnel;
- ANFO should be kept away from heat, sparks, and flames, as well as initiating explosives, oxidizing agents, combustibles, and other sources of heat;
- Containers should be protected from physical damage and in dry, well ventilated conditions;
- Transportation to the Mine site will be in accordance with Section 14 of the *Mines Act* and Regulations and the *Transportation of Dangerous Goods Act*. Transport vehicles will be in sound mechanical condition and equipped with proper safety equipment. Loaded vehicles will not be left unattended and only authorized personnel will be responsible for the security of the explosives under their control; and
- Explosives that have been identified as deteriorated or damaged will need to be disposed of or destroyed. The appropriate method of disposal or destruction and subsequent course of action will be determined by authorized personnel or the explosive supplier.

The following is a general spill response procedure for ammonium nitrate fuel oil – ANFO. The following procedure does not apply to emulsions or other explosives. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required. AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For an ANFO spill (solid):

1) Isolate and evacuate the spill area;

2) Immediately extinguish any open flames and remove ignition sources (no smoking, flares, sparks in immediate area) IF SAFE TO DO SO. **Fires involving large quantities of ANFO should not be fought;**

3) Contact the On-Scene Coordinator who will assemble ERT members and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

4) Put on appropriate personal protective equipment. For an ANFO spill this includes:

    a): Gloves **as recommended by the MSDS or glove manufacturer;**

    b) Protective eyeglasses or chemical safety goggles or face shield **as recommended by the MSDS;**

    c) Lab coat, coveralls or TyvekTM coveralls **as recommended by the MSDS;**

    d) Shoe covers or rubber boots;

    e) Half mask air-purifying respirator with cartridges and/filters **as recommended by the MSDS or respirator manufacturer;**

5) If the spill has occurred outdoors, stay upwind and avoid low lying areas. Ventilate (open windows/doors to outdoors) closed spaces before entering. Ensure adequate explosion proof ventilation for clean-up;

6) Remove all sources of heat and ignition (no smoking, flares, sparks or flames in immediate area) and remove uncontaminated combustible materials and organic compounds (wood, paper, oil, etc.,) from spill area;

7) Do not operate radio transmitters within 100 m of electric detonators;

8) For spill on land, protect the spill area from storm water runoff by constructing a ditch or dike using suitable absorbent materials, soil or other appropriate barrier. For spill to water, utilize damming, and/or water diversion to minimize the spread of contamination;

9) Collect, sweep or shovel spilled material and the other contaminated material/soil using non- metallic, spark-proof tools and place residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags) for off-site disposal at a licensed disposal facility;

Note: Recovered solid, if generally free from impurities, may be suitable for its intended use. In this case, place solid in suitable container with lid, and ***clearly label the container per WHMIS Guidelines.***

Note: The drums/containers/residues are to be stored in ventilated areas away from incompatible materials for eventual off-site disposal at a licensed disposal facility.

10) Remove and bag personal protective equipment for cleaning or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated leather articles including shoes that cannot be decontaminated.

Appendix F

General Response Procedures for Spilled Chemical Substances

F.1 Compressed Gases

F.1 Compressed Gases

AEM commits to review, modify and approve as required to establish this procedure as appropriate for Meadowbank Gold Project.

The following is a general spill response procedure for compressed gases. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required. AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a compressed (inert and flammable) gas leak:

1) IF SAFE TO DO SO and it will stop the gas leak, turn off cylinder valve;

2) If the leak cannot be stopped by closing the cylinder valve, and it is **an inert atmospheric gas** (e.g. nitrogen, carbon dioxide, etc.) isolate and evacuate the affected area. If the leak is a **flammable gas** and the leak is outside of a ventilated building enclosure that will contain the gas, immediately activate the fire alarm system and evacuate the area/building;

3) Contact the On-Scene Coordinator who will assemble spill response team members and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

4) If possible and safety permits, adjust leaking cylinder so that gas escapes rather than liquid;

5) If possible and safety permits, eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area) and turn off electrical equipment;

6) If the spilled has occurred outdoors, stay upwind and avoid low lying areas. If the spill has occurred inside a building, prevent spread of vapour throughout the building by closing doors to other rooms and hallways. If the room's air exchange system distributes air throughout the building, then it may also be necessary to have it shut-down. Allow vapours to ventilate outdoors by opening windows and doors to the exterior; and

7) Isolate area until gas has dispersed. On-Scene Coordinator to verify safe conditions.

Appendix G

General Response Procedures for Spilled Chemical Substances

G.1 Flammable and Combustible Liquids

G.1 Flammable and Combustible Liquids

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank Gold Project. The following is a general spill response procedure for flammable or combustible liquids, particularly petroleum hydrocarbon products. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a spill of flammable or combustible petroleum hydrocarbon product (liquid):

1) Isolate and evacuate the spill area;

2) Immediately extinguish any open flames and remove ignition sources (no smoking, flares, sparks in immediate area) IF SAFE TO DO SO;

3) Stop leak and contain spill (**see Step 9**) IF SAFE TO DO SO;

4) Contact the On-Scene Coordinator who will assemble ERT members if required and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

5) Put on appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

   a) Gloves **as recommended by the MSDS or glove manufacturer;**

   b) Splash goggles or face shield;

   c) Shoe covers or rubber boots;

   d). Lab coat or TyvekTM coveralls; and

   e) Half mask air-purifying respirator with **organic vapour or combination** cartridges, or **as otherwise recommended by the MSDS or respirator manufacturer**.

6) If the spilled has occurred outdoors, stay upwind and avoid low lying areas. If the spill has occurred inside a building, prevent spread of vapour throughout the building by closing doors to other rooms and hallways. If the room's air exchange system distributes air throughout the building, then it may also be necessary to have it shut-down;

7) Ventilate (open windows/doors to outdoors) closed spaces before entering. Ensure adequate explosion-proof ventilation for clean-up. A vapour suppressing foam or water spray may be used to reduce vapours;

8) Remove all sources of ignition (no smoking, flares, sparks or flames in immediate area) and combustible materials (wood, paper, oil, etc.) within the spilled area;

9) Contain spill by using spill absorbent, spill pads or pillows, soil or snow to construct a dike that limits flow and prevents entry to sewer, waterways or onto ice. For spills to land, excavation of trenches/pits to capture spill flow may also be appropriate. If possible, compact soil or snow dikes, and place plastic tarps over the dike and at its foot to allow the product to pool on the plastic for easy recovery;

   Note: Do not use paper towels to absorb spill as this increases the rate of evaporation and vapour

concentration in the air.

Note: Do not flush with water into drainage areas or ditches as this will spread spill.

Note: Snow works well as a natural absorbent to collect and contain spilled petroleum hydrocarbons. However, its use in containing a spill will result in a water-contaminant mixture that may be more difficult to manage. It is important to scrape up the contaminated snow and ice as soon as possible.

10) Carefully cover the spill area with spill absorbent, spill pads, soil or snow, starting at the outside and working inward. Do not touch or walk through spilled material;

11) Sweep up or shovel the residue using non-metallic, spark-proof tools and place the residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags). For larger spills to land, excavate impacted absorbent material and soil, place in lined and bermed temporary storage area or directly into sealed drums/containers;

Note: The drums/containers/residues are to be stored in ventilated areas away from incompatible materials for eventual treatment at on-site landfarm or off-site disposal at a licensed disposal facility. Electrically ground all containers and transporting equipment.

Note: Larger pools of product may be pumped into empty storage tanks or drums.

12) If spill is indoors, mop the affected area using detergent and water. Dispose of this water to drums for eventual off-site disposal at a licensed disposal facility. Spills to land may require further excavation or remediation of contaminated soil until acceptable soil quality is achieved. The On- Scene Coordinator and/or Environmental Superintendent will assess this requirement;

13) For spills to water, immediately limit the area of the spill on water using absorbent pads and booms and similar materials to capture small spills on water. Deploy and slowly draw in absorbent booms to encircle and absorb the spilled product. Recover larger spills on water with floating skimmers and pumps, as required, and discharge recovered product to drums or tanks;

Note: Petroleum hydrocarbons are generally hydrophobic, and as such, do not readily dissolves in water. They typically tend to float on the water's surface. Absorbent booms are often relied on to recover hydrocarbons that escape land containment and enter water.

Note: Antifreeze sinks and mixes with water. If released to water, attempt to isolate/confine the spill by damming or diverting the spill. Pump contaminated water to tanks or drums.

14) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated leather articles, (including shoes) that cannot be decontaminated.

Appendix H

General Response Procedures for Spilled Chemical Substances

Oxidizing Substances

H.1 Liquids
H.2 Solids

H.1 Liquids

AEM commits to review, modify and approve as required and to establish this procedure as appropriate for use at the Meadowbank Gold Project. The following is a general spill response procedure for liquid oxidizer compounds. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a liquid oxidizer spill:

1) Isolate and evacuate the spill area;

2) Stop leak and contain spill (**see Step 8**) IF SAFE TO DO SO;

3) Contact the On-Scene Coordinator who will assemble ERT members if required and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

4) Put on the appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

   a) Gloves **as recommended by the MSDS or glove manufacturer;**

   b) Splash goggles or face shield;

   c). Shoe covers or rubber boots;

   d) Lab coat, coveralls or TyvekTM coveralls **as recommended by the MSDS**; and

   e) Half mask air-purifying respirator with cartridges and/or filters **as recommended by the MSDS or respirator manufacturer**.

5) Ventilate closed spaces before entering. Ensure adequate explosion-proof ventilation for clean-up;

6) Remove and/or moisten with water any combustible material (wood, paper, oil, etc.) affected by the spill;

7) Use water spray to reduce vapours or divert vapour cloud drift, if required;

8) Contain spill by using non-combustible spill absorbent, soil or snow to construct a dike that limits flow and prevents entry to sewer, waterways or onto ice. For spills to land, excavation of trenches/pits to capture spill flow may also be appropriate;

   *Note: Flushing area with flooding quantities of water may also be appropriate assuming this does not make clean up and waste management more difficult– **refer to the MSDS**.*

9) Carefully cover the spill area with spill absorbent, soil or snow, starting at the outside and working inward. Use non-combustible absorbent. Do not touch or walk though spilled material.

10) Sweep up or shovel the spill residue using non-metal, non-sparking tools and place the residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags) for off- site disposal at a licensed disposal facility;

11) For indoor spills, mop the affected area using detergent and water. Flushing area with flooding quantities of water may also be appropriate – **refer to the MSDS**. Dispose of this water to the sanitary sewer, process stream or waste drums as appropriate. Spills to land may require further excavation or remediation of contaminated soil until acceptable soil quality is achieved. The On- Scene Coordinator and/or Environmental Superintendent will assess this requirement; and

12) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated.

H.2 Solids

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank Gold Project.

The following is a general spill response procedure for solid oxidizer compounds. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a solid oxidizer spill:

1) Isolate and evacuate the spill area;

2) Contact the On-Scene Coordinator who will assemble ERT members if required and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

3) Put on the appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

   a) Gloves **as recommended by the MSDS or glove manufacturer;**

   b) Safety glasses or goggles;

   c) Lab coat; and

   d) Half mask air-purifying respirator with **N95 or greater protection** particulate filter or **as recommended by the MSDS or respirator manufacturer**.

4) Remove all sources of heat and ignition (no smoking, flares, sparks or flames in immediate area) and remove uncontaminated combustible materials and organic compounds (wood, paper, oil, etc.,) from spill area;

5) For spills to land, protect the spill area from storm water runoff by constructing a ditch or dike using suitable non-combustible absorbent materials, soil or other appropriate barrier. For spill to water, utilize damming, and/or water diversion to minimize the spread of contamination;

6) Vacuum, sweep or shovel the spill residue using non-metal, non-sparking tools and place the residue into a labelled, plastic, container (plastic pail with lid or double heavy duty plastic bags) for re- use or off-site disposal at a licensed disposal facility;

   *Note: Recovered solid, if generally free from impurities, may be suitable for its intended use. In this case, place solid in suitable container with lid, and **clearly label the container per WHMIS Guidelines**.*

   Note: Minimize dust generation.

7) If there is still oxidizer residue left in the spill area, neutralize with appropriate agent **as recommended by the MSDS**, or for spills to land continue to excavate until no visible spilled solid remains. Use non-combustible spill absorbent or soil to absorb the neutralized residue. Place in suitable drums/containers for disposal to a licensed facility;

8) For indoor spills, mop the affected area using detergent and water. Dispose of this water to the sanitary

sewer, process stream or waste drums as appropriate; and

9) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated.

Appendix I

General Response Procedures for Spilled Chemical Substances

Poisonous and Toxic Substances

I.1 Sodium Cyanide

I.1 Sodium Cyanide

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank Gold Project. The following is a general spill response procedure for solid Sodium Cyanide.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a Sodium Cyanide (solid) spill:

1) Isolate and evacuate the spill area;

2) Contact the On-Scene Coordinator who will assemble ERT members and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

3) Put on the appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

    a) Impermeable Gloves **as recommended by the MSDS or glove manufacturer;**
    b) TyChem; and
    c) SCBA – Self Contained Breathing Apparatus
    d) Rubber Boots

    Note: For worker safety, maintain readily accessible supply of cyanide response kits on site.

4) Ventilate area of spill or leak;

5) Avoid exposure to acids, water or weak alkalis which can react to form toxic hydrogen cyanide (HCN) gas.

6) Contain spill to prevent release to sewer, waterway or onto ice. For spills to land, protect the spill area from storm water runoff by constructing a ditch or dike using absorbent materials, soil or other appropriate barrier. If raining, cover spill area with tarp or plastic to minimize contact with water and prevent subsequent runoff. For spill to water, utilize damming, and/or water diversion to minimize the spread of contamination;

7) Shovel the spilled material into labelled drums, containers or plastic bags for re-use or off-site disposal at a licensed disposal facility.

    Note: Recovered solid, if generally free from impurities, may be suitable for its intended use. In this case, place solid in suitable container with lid, and ***clearly label the container per WHMIS Guidelines****.*

    Note: Minimize dust generation.

8) If there is still spilled sodium cyanide residue left in the spill area, neutralize with appropriate agent **as recommended by the MSDS** (sodium or calcium hypochlorite solution), or for spills to land continue to excavate until no visible spilled solid remains. Use suitable spill absorbent or soil to absorb the neutralized residue. Place in suitable drums/containers for disposal to a licensed facility. Collect material and place in a closed container for recovery or disposal;

IMPORTANT: ***It is strictly prohibited to add any chemicals or neutralizing solutions to a Sodium Cyanide Spill near a drainage system, or near or in a water body.***

9) For indoor spills, mop the affected area using detergent and water. Dispose of this water to waste

drums/containers for disposal to a licensed facility; and

10) Remove and bag personal protective equipment for disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated.

Appendix J

General Response Procedures for Spilled Chemical Substances

Corrosive Substances

J.1 Acids, Liquids
J.2 Acids, Solids
J.3 Bases/Alkali, Liquids
J.4 Bases/Alkali, Solids

Response to Spilled Chemicals

IMPORTANT: ***It is strictly prohibited to add any chemicals or neutralizing solutions to a Spilled Chemicals near a drainage system, or near or in a water body.***

J.1 Acids, Liquids

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank Gold Project.

The following is a general spill response procedure for liquid acid compounds. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required. AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a liquid acid spill:

1) Isolate & evacuate the spill area;

2) Stop leak and contain spill (**see Step 8 below**) IF SAFE TO DO SO;

3) Contact the On-Scene Coordinator who will assemble ERT members if required and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

4) Put on appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

    a) Gloves **as recommended by the MSDS or glove manufacturer;**

    b) Splash goggles or face shield;

    c) Shoe covers or rubber boots;

    d) Lab coat or TyvekTM coveralls; and

    e) Half mask air-purifying respirator with **acid gas or combination** cartridges, or **as otherwise recommended by the MSDS or respirator manufacturer**.

5) If the spill has occurred outdoors, stay upwind and stay out of low areas. If the spill has occurred inside a building, prevent spread of vapour throughout the building by closing doors to other rooms and hallways. If the room's air exchange system distributes air throughout the building, then it may also be necessary to have it shut-down;

6) Ventilate (open windows/doors to outdoors) closed spaces before entering;

7) Remove all sources of ignition (no smoking, flares, sparks or flames in immediate area);

8) Contain spill by using spill absorbent, spill pads or pillows, or dry soil to construct a dike that limits flow and prevents entry to sewer, waterways or onto ice. For spills to land, excavation of trenches/pits to capture spill flow may also be appropriate. Ideally, use spill absorbent that contains a mild neutralizing agent **as recommended by the MSDS;**

*Note: Many acids, particularly concentrated acids react violently in the presence of water. Do not flush spill area with water unless the **MSDS** indicates acceptable.*

Note: Nitric Acid reacts violently and explosively with organic chemicals and organic material such as wood, cotton and paper; therefore, do not use organic absorbent material on Nitric acid.

Note: Hydrofluoric acid will fume during neutralization. Provide adequate ventilation and approach from upwind. Neutralize carefully with sodium bicarbonate, soda ash or lime. Use water spray to disperse the gas/vapour if required. Remove all sources of ignition.

9) Carefully cover the spill area with spill absorbent, spill pads or dry soil, starting at the outside and working inward. If practical, neutralize spill using **MSDS-recommended** or commercially available neutralizers. Use pH indicator paper to determine if spill is neutralized (pH 7);

Note: Use caution as neutralization reactions generate heat.

10) Sweep or shovel the neutralized spill residue using non-metal, non-sparking tools and place the residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags) for off-site disposal at a licensed disposal facility;

11) Check the pH of the spill area. If it is less than pH 6, then further neutralize with a dilute solution of a suitable reagent **as identified on the MSDS** or for spill to land continue to excavate contaminated soil;

12) For indoor spills, mop the affected area using detergent and water. Dispose of this water to the sanitary sewer, process stream or waste drums as appropriate;

13) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated; and

14) After the spill has been cleaned up, the area should be free of vapours. However, if personnel note odours or irritation, isolate the spill area; re-clean the area as per **Steps 11 and 12** or wait at least **1 hour** before re-entering or until considered safe by the On-Scene Coordinator or Environmental Superintendent.

J.2 Acids, Solids

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use on the Meadowbank Gold Project.

The following is a general spill response procedure for solid acid compounds. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a solid acid spill;

1) Isolate and evacuate the spill area;

2) Contact the On-Scene Coordinator who will assemble ERT members if required and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

3) Put on the appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

    a) Gloves **as recommended by the MSDS or glove manufacturer;**

    b) Safety glasses or goggles;

    c) Lab coat; and

    d) Half mask air-purifying respirator with **N95 or greater protection** particulate filter, or **as otherwise recommended by the MSDS or respirator manufacturer**.

4) Contain spill to prevent release to sewer, waterway or onto ice. For spills to land, protect the spill area from storm water runoff by constructing a ditch or dike using absorbent materials, dry soil or other appropriate barrier. If raining, cover spill area with tarp or plastic to minimize contact with water and prevent reaction and/or subsequent runoff. For spill to water, utilize damming, and/or water diversion to minimize the spread of contamination;

5) If necessary to minimize dust production, slightly moisten the solid. Use water, or if the material is water reactive, another inert liquid **as recommended by the MSDS;**

6) Sweep up or shovel the residue using non-metallic, spark-proof tools and place the residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags) for reuse or off-site disposal at a licensed disposal facility;

    *Note: Recovered solid, if generally free from impurities, may be suitable for its intended use. In this case, place solid in suitable container with lid, and **clearly label the container per WHMIS Guidelines**.*

7) Remaining solid acid residue may be neutralized using a dilute solution of appropriate agent **as recommended by the MSDS** (e.g. sodium bicarbonate - baking soda), or for spills to land continue to excavate until no visible spilled solid remains. Check the pH of the spill area; the final pH should be between pH 6 and 10. Use spill absorbent, spill pads or dry soil to absorb the neutralized residue;

    Note: Use caution as neutralization reactions generate heat.

8) For indoor spills, mop the affected area using detergent and water. Dispose of this water to the sanitary sewer, process stream or waste drums as appropriate; and

9) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated.

J.3 Bases/Alkali, Liquids

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank exploration camp.

The following is a general spill response procedure for liquid alkali or base compounds. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a liquid alkali or base spill:

1) Isolate & evacuate the spill area;

2) Stop leak and contain spill (**see Step 8**) IF SAFE TO DO SO;

3) Contact the On-Scene Coordinator who will assemble ERT members and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

4) Put on the appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

    a) Gloves **as recommended by the MSDS or glove manufacturer;**

    b) Splash goggles or face shield;

    c) Shoe covers or rubber boots;

    d) Lab coat or TyvekTM coveralls; and

    e) Half mask air-purifying respirator with cartridges/filters **as recommended by the MSDS or respirator manufacturer**.

5) If the spill has occurred outdoors, stay upwind and stay out of low areas. If the spill has occurred inside a building, prevent spread of vapour throughout the building by closing doors to other rooms and hallways. If the room's air exchange system distributes air throughout the building, then it may also be necessary to have it shut-down;

6) Ventilate (open/windows to outdoors) closed spaces before entering;

7) Remove all sources of ignition (no smoking, flares, sparks or flames in immediate area) and combustible materials (wood, paper, oil, etc.);

8) Contain spill by using spill absorbent, spill pads or pillows, or dry soil to construct a dike that limits flow and prevents entry to sewer, waterways or onto ice. For spills to land, excavation of trenches/pits to capture spill flow may also be appropriate. Ideally, use spill absorbent that contains a mild neutralizing agent **as recommended by MSDS;**

    Note: Use caution as neutralization reactions generate heat.

9) Carefully cover the spill area with spill absorbent, spill pads or dry soil, starting at the outside and working inward. If practical, neutralize spill using MSDS-recommended or commercially available neutralizers. Use

pH indicator paper to determine if spill is neutralized (pH 7);

Note: Use caution as neutralization reactions generate heat.

10) Sweep or shovel the neutralized spill residue using non-metal, non-sparking tools and place the residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags) for off-site disposal at a licensed disposal facility;

11) Check the pH of the spill area. If it is greater than pH 10, then further neutralize with a dilute solution of a suitable reagent **as identified on the MSDS**, or for spill to land continue to excavate contaminated soil;

12) For indoor spills, mop the affected area using detergent and water. Dispose of this water to the sanitary sewer, process stream or waste drums as appropriate;

13) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated; and

14) After the spill has been cleaned up, the area should be free of vapours. However, if personnel note odours or irritation, isolate the spill area; re-clean as per **Steps 11 and 12** or wait at least **1 hour** before re-entering or until it is considered to be safe by the On-Scene Coordinator or Environmental Superintendent.

J.4 Bases/Alkali, Solids

AEM commits to review, modify and approve as required to establish this procedure as appropriate for use at the Meadowbank Gold Project.

The following is a general spill response procedure for solid alkali or base compounds. Consult the MSDS for the specific spilled compound to determine whether deviations from the general guidance are required.

AEM commits to review and test, and if necessary, modify and update thus spill response procedure on an annual basis.

For a solid alkali or base spill;

1) Isolate and evacuate the spill area;

2) Contact the On-Scene Coordinator who will assemble ERT members if required and the appropriate spill response materials outside the spill area. **Obtain and read the MSDS** for the substance to determine the chemical-specific hazards and to identify any special precautions that must be taken;

3) Put on the appropriate personal protective equipment. Depending on the scale of the spill and properties of the spilled substance, this can include:

   a) Gloves **as recommended by the MSDS or glove manufacturer;**

   b) Safety glasses or goggles;

   c) Lab coat; and

   d) Half mask air-purifying respirator with **N95 or greater protection** particulate filter or **as recommended by the MSDS or respirator manufacturer**.

4) Contain spill to prevent release to sewer, waterway or onto ice. For spills to land, protect the spill area from storm water runoff by constructing a ditch or dike using absorbent materials, dry soil or other appropriate barrier. If raining, cover spill area with tarp or plastic to minimize contact with water and prevent reaction and/or subsequent runoff. For spill to water, utilize damming, and/or water diversion to minimize the spread of contamination;

5) If necessary to minimize dust production, slightly moisten the solid. Use water, or if the material is water reactive, another inert liquid **as recommended by the MSDS**;

   Note: Do not use water to flush bases in powdered form, such as calcium oxide (lime), as this material is not very soluble.

6) Sweep or shovel the residue using non-metallic, spark-proof tools and place the residue into a labelled, plastic, waste container (plastic pail with lid or double heavy duty plastic bags) for offsite disposal at a licensed disposal facility;

   *Note: Recovered solid, if generally free from impurities, may be suitable for its intended use. In this case, place solid in suitable container with lid, and **clearly label the container per WHMIS Guidelines**.*

7) Remaining solid alkali or base residue may be neutralized using a dilute solution of appropriate acid. Check the pH of the spill area; the final pH should be between pH 6 and 10. Use spill absorbent, spill pads or dry soil to absorb the neutralized residue;

8) For indoor spills, mop the affected area using detergent and water. Dispose of this water to the sanitary sewer, process stream or waste drums as appropriate; and

9) Remove and bag personal protective equipment for cleaning, informing laundry personnel of contaminant hazards, or disposal at a licensed disposal facility. Thoroughly wash with soap potential skin contact locations after handling. Properly dispose of contaminated clothing that cannot be decontaminated.

Appendix K

Agnico Eagle Spill Response Training Records

Appendix L

Dyno Nobel Emergency Response Plan

Appendix M

MBK-ENV-0016 Spill Reporting Procedure